



**IFC**

**2015**

**CODE AND  
COMMENTARY**

VOLUME 1

The complete IFC with  
commentary after each  
section



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2015 International Fire Code® Commentary

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# PREFACE

The principal purpose of the Commentary is to provide a basic volume of knowledge and facts relating to building construction as it pertains to the regulations set forth in the 2015 *International Fire Code*. The person who is serious about effectively designing, constructing and regulating buildings and structures will find the Commentary to be a reliable data source and reference to almost all components of the built environment.

As a follow-up to the *International Fire Code*, we offer a companion document, the *International Fire Code Commentary—Volume I*. Volume I covers Chapters 1 through 19 of the 2015 *International Fire Code*. The basic appeal of the Commentary is thus: it provides in a small package and at reasonable cost thorough coverage of many issues likely to be dealt with when using the *International Fire Code* — and then supplements that coverage with historical and technical background. Reference lists, information sources and bibliographies are also included.

Throughout all of this, effort has been made to keep the vast quantity of material accessible and its method of presentation useful. With a comprehensive yet concise summary of each section, the Commentary provides a convenient reference for regulations applicable to the construction of buildings and structures. In the chapters that follow, discussions focus on the full meaning and implications of the code text. Guidelines suggest the most effective method of application, and the consequences of not adhering to the code text. Illustrations are provided to aid understanding; they do not necessarily illustrate the only methods of achieving code compliance.

The format of the Commentary includes the full text of each section, table and figure in the code, followed immediately by the commentary applicable to that text. At the time of printing, the Commentary reflects the most up-to-date text of the 2015 *International Fire Code*. Each section's narrative includes a statement of its objective and intent, and usually includes a discussion about why the requirement commands the conditions set forth. Code text and commentary text are easily distinguished from each other. All code text is shown as it appears in the *International Fire Code*, and all commentary is indented below the code text and begins with the symbol ❖.

Readers should note that the Commentary is to be used in conjunction with the *International Fire Code* and not as a substitute for the code. The Commentary is advisory only; the code official alone possesses the authority and responsibility for interpreting the code.

Comments and recommendations are encouraged, for through your input, we can improve future editions. Please direct your comments to the Codes and Standards Development Department at the Chicago District Office.

The International Code Council would like to extend its thanks to the following individuals for their contributions to the technical content of this commentary:

Jeff Hugo  
Elley Klausbruckner



## Arrangement and Format of the 2015 IFC

Before applying the requirements of the IFC it is beneficial to understand its arrangement and format. The IFC, like other codes published by the International Code Council, is arranged and organized to follow sequential steps that generally occur during a plan review or inspection. The 2015 IFC is organized into seven Parts as illustrated in the tables below. Each Part represents a broad subject matter and includes the chapters that logically fit under the subject matter of each Part. It is also foreseeable that additional chapters will need to be added in the future as regulations for new processes or operations are developed. Accordingly, the reorganization was designed to accommodate such future chapters by providing reserved (unused) chapters in several of the Parts. This will allow the subject matter parts to be conveniently and logically expanded without requiring a major renumbering of the IFC chapters.

<b>2015 ORGANIZATION OF THE IFC</b>	
<b>Parts and Chapters</b>	<b>Subject Matter</b>
Part I – Chapters 1 and 2	Administrative and definitions
Part II – Chapters 3 and 4	General safety provisions
Part III – Chapters 5 through 11	Building and equipment design features
Part III – Chapters 12 through 19	Reserved for future use
Part IV – Chapters 20 through 37	Special occupancies and operations
Part IV – Chapters 38 through 49	Reserved for future use
Part V – Chapters 50 through 67	Hazardous materials
Part V – Chapters 68 through 79	Reserved for future use
Part VI – Chapter 80	Referenced standards
Part VII – Appendices A through M	Adoptable and informational appendices

The IFC requirements for fire-resistive construction, interior finish, fire protection systems, means of egress and construction safeguards are directly correlated to the chapters containing parallel requirements in the IBC, as follows:

<b>IFC Chapter</b>	<b>Subject</b>
7	Fire and smoke protection features
8	Interior finish, decorative materials and furnishings
9	Fire protection systems
10	Means of egress
33	Fire safety during construction and demolition



# LEGISLATION

The *International Codes* are designed and promulgated to be adopted by reference by legislative action. Jurisdictions wishing to adopt the 2015 *International Fire Code Commentary* as an enforceable set of regulations for the safeguarding of life and property from fire and explosion hazards arising from the storage, handling and use of hazardous substances, materials and devices, and from conditions hazardous to life or property in the occupancy of buildings and premises should ensure that certain factual information is included in the adopting legislation at the time adoption is being considered by the appropriate governmental body. The following sample adoption legislation addresses several key elements, including the information required for insertion into the code text.

## SAMPLE LEGISLATION FOR ADOPTION OF THE *INTERNATIONAL FIRE CODE* ORDINANCE NO. \_\_\_\_\_

A[N] [ORDINANCE/STATUTE/REGULATION] of the [NAME OF JURISDICTION] adopting the 2015 edition of the *International Fire Code*, regulating and governing the safeguarding of life and property from fire and explosion hazards arising from the storage, handling and use of hazardous substances, materials and devices, and from conditions hazardous to life or property in the occupancy of buildings and premises in the [NAME OF JURISDICTION]; providing for the issuance of permits and collection of fees therefor; repealing [ORDINANCE/STATUTE/REGULATION] No. \_\_\_\_\_ of the [NAME OF JURISDICTION] and all other ordinances or parts of laws in conflict therewith.

The [GOVERNING BODY] of the [NAME OF JURISDICTION] does ordain as follows:

**Section 1.** That a certain document, three (3) copies of which are on file in the office of the [TITLE OF JURISDICTION'S KEEPER OF RECORDS] of [NAME OF JURISDICTION], being marked and designated as the *International Fire Code*, 2015 edition, including Appendix Chapters [FILL IN THE APPENDIX CHAPTERS BEING ADOPTED] (see *International Fire Code* Section 101.2.1, 2015 edition), as published by the International Code Council, be and is hereby adopted as the Fire Code of the [NAME OF JURISDICTION], in the State of [STATE NAME] regulating and governing the safeguarding of life and property from fire and explosion hazards arising from the storage, handling and use of hazardous substances, materials and devices, and from conditions hazardous to life or property in the occupancy of buildings and premises as herein provided; providing for the issuance of permits and collection of fees therefor; and each and all of the regulations, provisions, penalties, conditions and terms of said Fire Code on file in the office of the [NAME OF JURISDICTION] are hereby referred to, adopted, and made a part hereof, as if fully set out in this legislation, with the additions, insertions, deletions and changes, if any, prescribed in Section 2 of this ordinance.

**Section 2.** That the following sections are hereby revised:

Section 101.1. Insert: [NAME OF JURISDICTION]

Section 109.4. Insert: [OFFENSE, DOLLAR AMOUNT, NUMBER OF DAYS]

Section 111.4. Insert: [DOLLAR AMOUNT IN TWO LOCATIONS]

**Section 3.** That the geographic limits referred to in certain sections of the 2015 *International Fire Code* are hereby established as follows:

Section 5704.2.9.6.1 (geographic limits in which the storage of Class I and Class II liquids in above-ground tanks outside of buildings is prohibited): [JURISDICTION TO SPECIFY]

Section 5706.2.4.4 (geographic limits in which the storage of Class I and Class II liquids in above-ground tanks is prohibited): [JURISDICTION TO SPECIFY]

Section 5806.2 (geographic limits in which the storage of flammable cryogenic fluids in stationary containers is prohibited): [JURISDICTION TO SPECIFY]

Section 6104.2 (geographic limits in which the storage of liquefied petroleum gas is restricted for the protection of heavily populated or congested areas): [JURISDICTION TO SPECIFY]

**Section 4.** That [ORDINANCE/STATUTE/REGULATION] No. \_\_\_\_\_ of [NAME OF JURISDICTION] entitled [FILL IN HERE THE COMPLETE TITLE OF THE LEGISLATION OR LAWS IN EFFECT AT THE PRESENT TIME SO THAT THEY WILL BE REPEALED BY SPECIFIC REFERENCE] and all other ordinances or parts of laws in conflict herewith are hereby repealed.

**Section 5.** That if any section, subsection, sentence, clause or phrase of this legislation is, for any reason, held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this ordinance. The [GOVERNING BODY] hereby declares that it would have passed this law, and each section, subsection, clause or phrase thereof, irrespective of the fact that any one or more sections, subsections, sentences, clauses and phrases be declared unconstitutional.

**Section 6.** That nothing in this legislation or in the Fire Code hereby adopted shall be construed to affect any suit or proceeding impending in any court, or any rights acquired, or liability incurred, or any cause or causes of action acquired or existing, under any act or ordinance hereby repealed as cited in Section 4 of this law; nor shall any just or legal right or remedy of any character be lost, impaired or affected by this legislation.

**Section 7.** That the [JURISDICTION'S KEEPER OF RECORDS] is hereby ordered and directed to cause this legislation to be published. (An additional provision may be required to direct the number of times the legislation is to be published and to specify that it is to be in a newspaper in general circulation. Posting may also be required.)

**Section 8.** That this law and the rules, regulations, provisions, requirements, orders and matters established and adopted hereby shall take effect and be in full force and effect [TIME PERIOD] from and after the date of its final passage and adoption.

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## Part I—Administrative

# Chapter 1: Scope and Administration

### General Comments

This chapter addresses the administration and enforcement of the code. The objectives and mandate for enforcement are beyond the scope of this chapter. Before adopting the code, a state or local government must establish an agency with staff trained to administer and enforce the code. The administrative relationships, designation of the enforcement authority (fire code official), funding, training and certification of inspectors and scope of the enforcement program are determined by the adopting body.

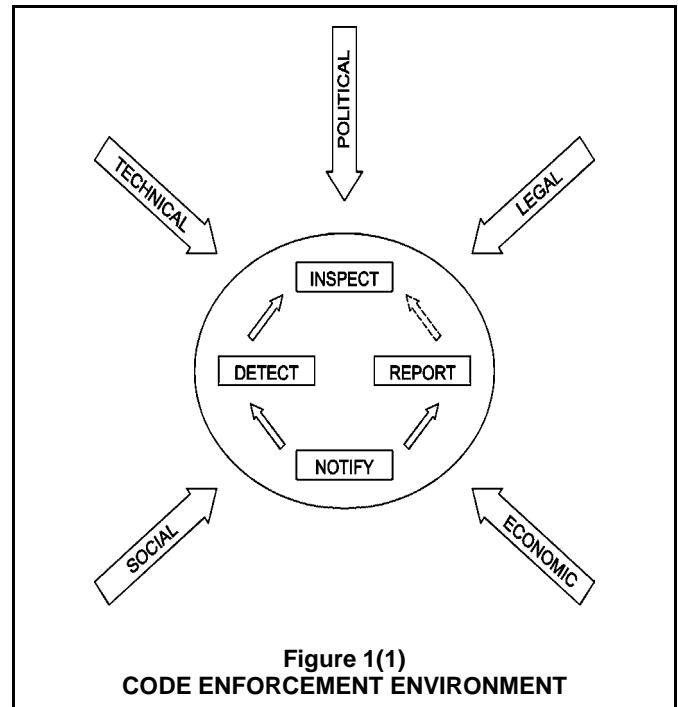
Management personnel generally perform functions, such as planning, organizing, directing, controlling, analyzing and budgeting. Though the code administrator's duties may include all of these functions, this chapter takes a much narrower view of the code administrative function, dealing mainly with technical and legal areas. Fire prevention code administration must be considered in the context of a complex environment containing political, social, economic, technical and legal dimensions. Enforcement, too, is a broad, all-inclusive term that includes a range of activities aimed at identifying and eliminating hazards; in this case, hazards causing or contributing to a fire or impairing life safety.

Four functions are commonly associated with enforcement: inspecting, detecting, notifying and reporting [see Commentary Figure 1(1)]. This chapter describes the technical and legal requirements associated with administering a code enforcement program to achieve these functions. The examination of these concepts specifically provides a better understanding of the fire code official's authority, duties and liabilities.

Two main duties of the fire code official are administration and enforcement. In administration, the following concepts are most important:

### Code Administrative Environment

Many administrative or management functions are not addressed in the code. Before the provisions of this document can be of any use, many basic questions must be answered. Jurisdictions adopting a code enforcement program are using discretionary powers to fulfill a community need. The need in the community must be clearly identified, the program mission clearly established and the most appropriate delivery system selected. To address the technical and legal demands of the code administrative environment, the code



assumes that jurisdictions adopting the document are interested in protecting the health, safety and welfare of its citizens from the effects of fires and explosions. Additionally, the code assumes that these jurisdictions are authorized to use the police power of the state to receive these benefits. Finally, the code assigns principal responsibility for enforcing this document to the department or agency (fire department or fire prevention bureau) most frequently available to perform this mission.

The particular objectives and social or political mandate of a code enforcement program are not considered in the context of this document. These items, however, are often cited as the most frustrating problems faced by code administrators. Code enforcers often complain of being overwhelmed by demands for leniency or special consideration based on the economic, social or political effects of their decisions.

As stated, this chapter establishes ground rules for enforcing the code; however, these ground rules are only the technical and legal requirements binding both fire code officials and the general public. For guidance on the political, social and economic considerations associated with code enforcement activities, adopting

authorities must turn elsewhere; however, none of this is intended to imply that these considerations are absent from the code process. To the contrary, by establishing these requirements as “minimums,” the ICC voting membership (see ICC Board of Directors Policy CP-28) has, through a democratic process of public hearings and debate, attempted to weigh these considerations carefully when deliberating, modifying and adopting the provisions appearing in this document. In the end, each jurisdiction must give careful consideration to how these requirements should be adopted; who should be responsible for enforcing them; how enforcement personnel should be trained; how the operation will be financed; and when and how to modify or change operations, if necessary. These considerations deserve careful, thorough public attention before a decision is made to adopt and enforce the code.

### Scope and Applicability of the Code

The code applies to new and existing structures and premises as prescribed in Sections 102.1 and 102.2, in matters related to occupancy and maintenance for the protection of lives and property from fire. Conditions related to fire spread, occupant hazard protection and maintenance are regulated as follows:

**Retroactivity:** Because the code applies to both new and existing structures and premises as prescribed in Sections 102.1 and 102.2, the existing building provisions may be considered retroactive. Existing structures and premises built in compliance with the codes and standards in effect at the time of their original construction or alteration are not in all cases exempt from code compliance.

**Other codes and standards:** The code relies heavily on other codes and standards to specify a means of complying with its provisions, including, among others, the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>), the *International Mechanical Code*<sup>®</sup> (IMC<sup>®</sup>), the *International Fuel Gas Code*<sup>®</sup> (IFGC<sup>®</sup>) and the standards referenced in the text. Additionally, other federal, state and local codes and ordinances may establish certain requirements related to fire protection and life safety. Code requirements are intended to complement other regulations. When conflicts arise between code provisions and the referenced standards, the code provisions apply. Where a standard provides additional technical detail or guidance beyond that provided in the related code text, the fire code official must use judgment when applying these provisions to prevent conflicts with the code provisions. If a conflict arises, it is the fire code official's duty to determine which provisions secure the code's intent. When a conflict between codes or other legal action causes a portion of this document to be “struck down,” such action is not intended to invalidate the remaining code provisions. The severability of code provisions, however, does not imply that these same provisions

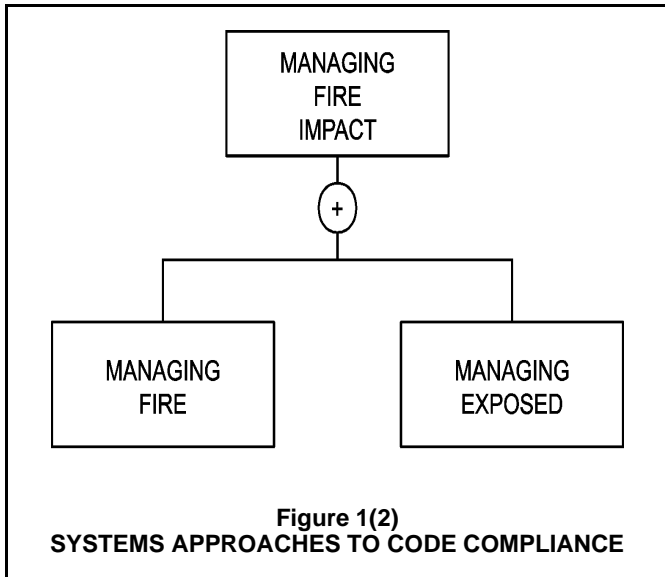
should be considered or applied outside of their context as a part of the code.

### Fire Code Official's Judgment

The code relies heavily not only on other codes and standards but also on the judgment and experience of the fire code official.

**Approval:** The code details occupancy and maintenance requirements; however, it relies heavily on performance criteria, as opposed to detailed specifications, to accomplish this task. The fire code official, therefore, must exercise judgment when approving or permitting operations, processes and procedures required by the code. Proof of compliance may include certification or labeling by independent testing laboratories; however, regardless of the conclusions of these external agencies and authorities, the fire code official remains the sole judge of what fulfills the intent of the code. This becomes particularly important when the fire code official is asked to evaluate equivalent methods and materials. Having piles of data may seem helpful, but the data may prove to be meaningless when it is considered in the context of the code's intent. Data in support of alternative methods and materials must demonstrate not only compliance with the code's intent but also relevance to the issues at hand. Evidence, such as a label or an independent laboratory test report, may sometimes be used inappropriately to support an application for recognition of equivalency. The fire code official must evaluate all submitted evidence to make sure it applies to its intended use, as well as to the code's intent. In an increasingly technical and litigious society, learning how to make such judgments may be the biggest challenge facing fire code officials. Relying on strict interpretations of intent or the “letter” of the code may be the conservative way, but conservative approaches may simply increase the social and political pressures confronting fire code officials. Decision-making aids employing contemporary computer technology permit a designer to propose more innovative and creative responses to complex problems. Fire code officials must begin to recognize, use and interpret these tools and data to maintain effective protection. These models permit designers to quickly and easily evaluate the relationships and performance of a variety of complex variables.

Another model that does not rely on a computer is NFPA 550 [see Commentary Figure 1(2)]. This model requires little training to use or understand and is an all-inclusive representation of the variables contributing to fire safety. The model may, therefore, serve as a useful tool for qualitatively evaluating the contribution of various approaches to an overall fire safety system. Once equivalent alternative methods have been identified using the Fire Safety Concepts Tree (see “General Comments” in Chapter 3), quantitative (cost/benefit) analyses may be applied.



**Fire Code Officials and Liability**

Like all professionals, fire code officials are subject to legal action. The two most common legal actions that may be pursued against fire code officials are breach of contract lawsuits and tort claims. Tort claims, by far, are the most common lawsuits. These lawsuits allege that some damage, injury or harm (a tort) resulted from the actions of the fire code official. A successful tort claim must prove that the plaintiff was injured or harmed; that the fire code official had a legal duty or obligation to perform with respect to the plaintiff and that the cause of the plaintiff's injury was the fire code official's actions or inactions while performing these duties.

The Law of Torts includes the following:

*The tort.* Damages arising from the acts of fire code officials fall into two broad categories: property and personal [see Commentary Figure 1(3)]. Property torts involve the control, use, operation or ownership of personal and real property by private individuals. Personal torts involve physical, verbal or written assaults on the character, person, psyche or privacy of individuals. Such assaults or invasions may involve actual contact or threat of harm. For example, fire code officials' acts of commission may restrain business or trade activity, while acts of omission may fail to recognize that haz-

Property Trespass Conversion Nuisance	Personal Assault and Battery False Arrest or Imprisonment Defamation, Slander and Libel
--	--

Source: Rosenbauer, D.L., *Introduction to Fire Protection Law*.

**Figure 1(3)**  
**TYPES OF TORTS**

ards need to be corrected, thus resulting in life or property losses.

Two actions dominate lawsuits filed against enforcement authorities: Most lawsuits either allege improper acts by the fire code official (acts of commission) or failure to fulfill specified or implied legal obligations (acts of omission). In the former, plaintiffs usually seek temporary or permanent relief from a fire code official's decision. In these actions, plaintiffs usually allege improper interpretation or application of the code or its intent. Other lawsuits usually allege failure to exercise a reasonable standard of care in the performance of duties of the fire code official. In either type of lawsuit, and often in the case of omissions, plaintiffs seek compensatory and even punitive damages. Infringements on constitutional protections may be, though occurring infrequently, the basis for lawsuits against fire code officials. Common constitutional issues raised in lawsuits against fire code officials include violations of the Fourth Amendment's protection against unreasonable searches and seizures, the Sixth Amendment's due process protections and the Fourteenth Amendment's equal protection provisions. First Amendment rights guaranteed under freedom of association protections may be raised in cases involving public assembly occupancies, especially churches.

*Condition of negligence:* To prevail in a tort claim action, a plaintiff must demonstrate negligence on the part of the defendant. Negligence may be simple—a failure to exercise reasonable or adequate care when performing assigned duties (commonly known as misfeasance)—or it may be gross—represented by wanton, willful, reckless or malicious disregard for public safety. Criminal activities, including dereliction (nonfeasance) or the failure to perform required assigned duties, may be cause for claims of gross negligence. Likewise, malfeasance, the willful or malicious violation of a legal duty, may constitute grossly negligent behavior. The following three elements must be proven to sustain a claim of negligence: the defendant had a duty to act, the defendant failed to exercise the required standard of care in the performance of that duty and, as a result of that failure, damage was incurred or harm was suffered by the plaintiff.

*Duty to act.* The code establishes few duties of the fire code official; instead, it places greatest emphasis on the responsibility of structure or premises owners and operators to perform their duties with adequate regard for public health, safety and welfare. The duties owed to the the public by the fire code official fall under the following categories: approvals, enforcement, personnel, inspections, investigations, reports and record keeping. Other duties may be assumed by fire code officials through the performance of their official duties. Recently, some courts have ruled that failure to perform timely reinspections or exhaust legal remedies against violators in fire code cases creates a special relationship between the fire code official and the occupants of properties in violation of the code, especially when the

occupants do not own the property and are not responsible for code compliance. Some court rulings have even implied that conducting inspections not otherwise required by the code constitutes an *ultra vires* (beyond the authority of) liability. Fire code officials should consult their jurisdiction's legal counsel to determine how these decisions, the jurisdiction's enforcement policies and the code provisions combined affect their enforcement program and jurisdictional and personal liabilities.

**Standard of care:** Taken together, the fire code official's duties are the basis for determining his or her standard of care. When assessing whether fire code officials have met this standard, judges and juries must determine whether they performed the required duties as reasonable, comparably trained and experienced fire code officials. Failure to meet the appropriate standard of care may be classified in three ways: nonfeasance, misfeasance or malfeasance. Nonfeasance is the failure to perform a required duty. Improper performance of a required duty constitutes misfeasance, and malicious or willful violation of a required duty is malfeasance. Of the three, misfeasance or simple negligence is the most common cause of action. The code and most tort claims either hold the government immune from specific claims of misfeasance or severely limit damage awards in such cases. For all purposes, sovereign immunity—the doctrine inherited from British common law mandating that “the King can do no wrong”—is obsolete. Similarly, courts in many states have abandoned the public duty doctrine, which states that a duty to all is a duty to no one. Holding that most code provisions and governmental regulations secure benefits for select groups, some state courts recognize that specific enforcement activities secure greater benefits for some members of the public than others. Such judicial reasoning holds that the inspector's duty applies to the individual who may be injured as a result of failure to detect a hazard or diligently pursue compliance. Moreover, this duty may include acts of omission, such as failure to perform required inspections. With courts today recognizing only limited immunity for government officials, fire code officials must become more aware of their duties and liabilities. Although tort claim acts limit damage awards, they still permit lawsuits to proceed against governmental officials and agencies to determine their responsibility for negligent acts. Claims of gross negligence arising from nonfeasance or malfeasance are less common than misfeasance actions but are predictably harder to defend. The code provides no relief from liability where the fire code official either fails to perform a required duty or acts *ultra vires*; that is, beyond his or her authority. The jurisdiction is generally immune from claims when its agents perform acts beyond the scope of their authority, unless such acts were implicitly endorsed by the government (explicit endorsement may constitute a discretionary governmental act and, similarly, immunize the government). Nonfeasance is considered a criminal offense in many jurisdictions. An employee's dereliction of duty exempts the jurisdiction from immunity under most circumstances, unless the employee's failure to

perform was the direct result of explicit instructions from governmental superiors; however, the employee may be held criminally liable.

In addition to the Law of Torts, the following have an impact on fire code officials and liability:

**Awards:** Lawsuits may seek declarative judgments (injunctive relief or monetary awards) in favor of the plaintiff. Monetary awards fall into four categories: nominal, special, compensatory and punitive. The first purpose of monetary awards should be to the claimant or plaintiff for real losses. This is the purpose of compensatory and special damages. Compensatory awards reimburse the claimant or plaintiff for the direct costs resulting from the defendant's negligence or carelessness. Many times, a plaintiff will also seek additional compensation for the indirect results of the defendant's acts. Such special damage claims may result in additional compensation beyond that provided by compensatory damages. Punitive awards are intended to punish the defendant for the misdeed and discourage him or her from future unlawful activity. These awards are often held up as examples to the community as a whole and are a way to discourage unlawful activities by others. Nominal damage awards serve to assign blame in intentional tort cases when the facts of the case do not merit a substantial settlement.

**Protection:** The best protection against a lawsuit is professional conduct and preparation; that is, training, education and research. Lawsuits filed against public officials have become commonplace and are probably inevitable. In 1983, H. M. Markman suggested six rules to manage legal liability [see Commentary Figure 1(4)].

- **You cannot prevent someone from filing a lawsuit against you.**
- **Do not take the lawsuit personally.**
- **Understand your risk exposure or exposures.**
- **Be professional.**
- **You are not an insurer.**
- **Do not make stupid mistakes.**

**Figure 1(4)  
MARKMAN'S SIX RULES**

Although no single rule should be considered more important than another, the last one is perhaps the best to remember. Everyone makes mistakes, so strive to learn from the mistakes rather than repeat them. Nonetheless, every mistake may be potential exposure. Acting professionally helps minimize exposure to error, especially when training, and common sense is encouraged. Using common sense, exercising reasonable care and acting professionally are no insurance against a lawsuit, but they all may provide considerable protection in the event a lawsuit is filed. No matter how hard

someone may try to avoid a lawsuit, someone may sue. When a lawsuit is filed, the most important things to remember are not to take it personally and not to forget the other five rules.

### Enforcement

The enforcement duty of the fire code official's position is composed of four distinct functions: inspection, detection, notification and reporting. All four functions define phases in the enforcement process duties of fire code officials.

During the code enforcement process, structures or premises requiring inspections are identified. Inspectors are assigned and inspections are performed. During these inspections, any code violations found are usually noted. Then, the owner or occupant is verbally advised or notified that the deficiencies noted are code violations. To promote code compliance, the inspector may suggest remedial actions that may be taken to establish compliance. Finally, a written violation notice serving as further notice to the owner or occupant is issued. The written notice also serves as a permanent record or report of the inspection.

### Inspection

Inspections are careful examinations of plans or premises for the presence of fire and life safety hazards. Upon observing a hazardous condition, the fire code official begins a process directed at correcting the situation. This may be accomplished by removing or eliminating the hazardous condition or providing some countermeasure designed to lessen its effects on the property, occupants or neighbors. Inspections should demonstrate a systematic method that keeps the inspection process in a proper perspective and recognizes that code enforcement is limited to legal and technical means of pursuing fire safety. Achieving fire safety objectives means using a balanced approach composed of some elements seeking to prevent ignitions and others attempting to control fire effects. Fire safety objectives are not defined by the code but rather by the users. Each jurisdiction must establish what risks and costs are reasonable while pursuing fire safety.

There may be as many different methods of conducting inspections as there are inspectors. No single method is necessarily the correct one; however, each method probably has some strong and weak points. The following three approaches can form the basis for any number of different inspection techniques.

*Outside to inside:* Beginning outside is not only logical but necessary. Inspectors too often neglect hazards and clues outside the building that suggest significant danger to the occupants. An inspector must ask the following question: "Do the things I see outside match those I see inside?" For example:

- Do doors identified as exits inside actually discharge outside to acceptable refuge areas or the public way?

- Are trash receptacles or other obstructions outside located so the effectiveness of exits is not reduced, or do receptacles alone pose a fire hazard?
- Does the site permit sufficient access for fire-fighter rescue operations and fire suppression?

*Top to bottom:* Once inside a structure, deciding where to start is more than a matter of preference. One question inspectors may ask is: "If completeness is the principal criterion, why not start at the bottom and work up?" The answer to this question is that walking down stairs is easier than walking up stairs. This easier path of travel allows the inspector to concentrate more completely on the inspection itself. After performing many inspections, there will not be a need for additional exercise obtained from beginning at the bottom.

*General to specific:* Without constructing a detailed inspection framework, many fire code officials find it helpful to move from the general to the specific when evaluating occupancies and hazards. This helps keep the whole problem in focus while preserving attention to detail. The inspector can focus on a specific problem without losing sight of the "big picture."

### Detection

Systematic inspection procedures, like those described, should aid in the detection of code violations. By keeping the premises, processes or objectives in clear focus, the inspector keeps the task in context. A systematic inspection process implies not only organization but an understanding of the entire process. Achieving fire safety objectives means understanding how structures, premises, occupants and fire interact [see Commentary Figure 1(5)]. To keep the system in balance and prevent uncontrolled fires means understanding how people use structures and premises.

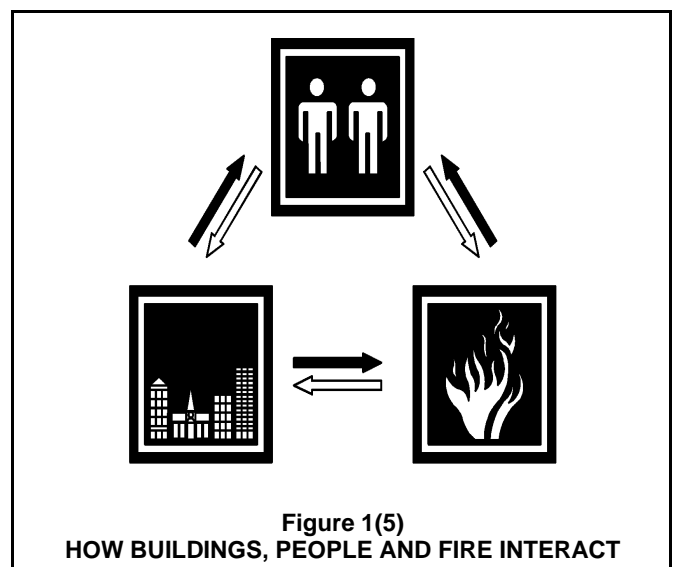


Figure 1(5)  
HOW BUILDINGS, PEOPLE AND FIRE INTERACT

In such a context, a fire hazard is anything that either fails to prevent an uncontrolled fire or permits a fire to spread unchecked. Similarly, hazardous conditions are

those preventing occupants from escaping or fire fighters from entering a structure and premises to control a fire.

**Notification**

Inspection programs cannot identify and abate all hazards. Code enforcement alone cannot secure absolute protection for people and property. Further, many code requirements maintain or reinforce features not intended to prevent a fire but rather to minimize a fire's effects should one occur. Every inspection program, therefore, should consider the benefits of educating building owners and occupants about the hazards endangering their lives and property. Not only do such efforts help secure compliance with code requirements, but they are likely to secure long-term commitments to fire safety as well. Another equally apt metaphor describes the fire prevention process as the "Three E's": engineering, education and enforcement. A balanced approach composed of these three elements can be an especially effective way of achieving desired fire safety objectives.

**Reporting**

The first three elements of the code enforcement process are directed at identifying and eliminating hazards at their source. Reporting is intended to help document and reinforce the lessons learned from the previous three phases. The words, "If it's not written down, it didn't happen!" reinforce the message that reporting is just as important as any of the other three elements of the code enforcement system. Few people enjoy paperwork. Without documentation, however, prosecuting an effective code enforcement program becomes nearly

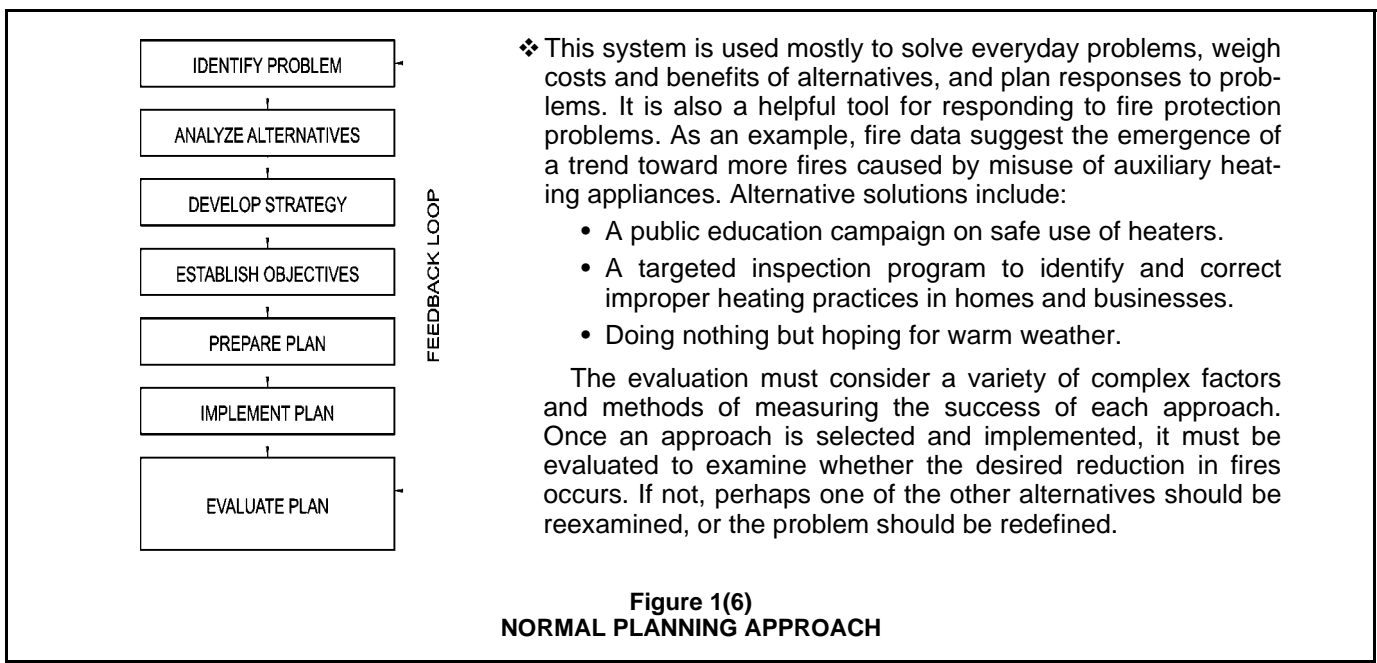
impossible. Accurate, concise and timely records are essential for both legal and historical reasons. Documenting the inspection and violation history of a particular premises or owner is essential when prosecuting criminal actions under the code provisions.

Commentary Figure 1(6) illustrates a systems approach using data generated by fire incidents and inspections to direct code enforcement, public education activities or code development. This approach is equivalent to the one typically used to make ordinary decisions about problems with many competing solutions, to plan for the future and to consider the cost and benefits of these decisions.

Understanding the code administration process and the environment influencing it allows the fire code official to be more effective. Adhering to the provisions of Chapter 1 not only minimizes the fire code official's liability, but also provides an effective code enforcement program. Just as owners and occupants have obligations under the code, so does the fire code official. Following these procedures enables him or her to identify and respond to the community's needs, thus reducing the community's fire risk.

**Purpose**

Chapter 1 establishes provisions to ensure that code administration and enforcement is reasonable, appropriate and fair. This chapter outlines the duties and powers of the fire code official; the scope of the fire code official's authority to enforce the code; the applicability of the document and proofs of compliance; the means of securing compliance with its provisions and procedures for protecting due process rights of applicants, owners, occupants and others affected by the code provisions and the enforcement activities of the fire code official.



## PART 1—GENERAL PROVISIONS

SECTION 101  
SCOPE AND GENERAL REQUIREMENTS

[A] **101.1 Title.** These regulations shall be known as the *Fire Code* of [NAME OF JURISDICTION], hereinafter referred to as “this code.”

❖ This section identifies jurisdictional applicability in legal terms. The local jurisdiction is to insert its name into this section by including a modification to the code in the adopting ordinance. This will make the code applicable to the local jurisdiction. See page xxi of the code for a sample ordinance for adoption.

[A] **101.2 Scope.** This code establishes regulations affecting or relating to structures, processes, premises and safeguards regarding all of the following:

1. The hazard of fire and explosion arising from the storage, handling or use of structures, materials or devices.
2. Conditions hazardous to life, property or public welfare in the occupancy of structures or premises.
3. Fire hazards in the structure or on the premises from occupancy or operation.
4. Matters related to the construction, extension, repair, alteration or removal of fire suppression or alarm systems.
5. Conditions affecting the safety of fire fighters and emergency responders during emergency operations.

❖ The code does not attempt to achieve perfection by requiring every conceivable or available safeguard for every structure, premises or operation within the scope of the code; rather, the code seeks to establish a minimum acceptable safety level to balance the many factors that must be considered, including loss statistics, relative hazard and the economic and social impact. The code is maintained through the use of a democratic code development process so that everyone affected by these minimum requirements has an equal opportunity to present his or her concern, both for and against any of the requirements.

The question is often asked, “Does the code apply only to buildings and facilities, or does it cover vehicles as well?” Though the scope text does not specifically mention vehicles, vehicles are intended to be covered by the terms of “... use of ... devices ...” and “... occupancy of ... structures or premises ...” in Items 1 and 2 of the section. It is clear that the code specifically intends to regulate vehicles because, in some cases, there are regulations in the code that are specific to vehicles, such as those in Sections 309 and 5706. However, in most cases, unless vehicles are specifically mentioned, provisions in the code would not apply to them (see also Section 904.12).

[A] **101.2.1 Appendices.** Provisions in the appendices shall not apply unless specifically adopted.

❖ The code has several appendices, which provide additional information regarding the provisions in the code and additional regulations that are available for adoption if desired by the adopting jurisdiction. If the jurisdiction decides to include any of the appendices as part of the code, each of the appendices to be adopted must be specifically listed in the adoption ordinance for the code. A sample adoption ordinance is on page xxi of the code.

[A] **101.3 Intent.** The purpose of this code is to establish the minimum requirements consistent with nationally recognized good practice for providing a reasonable level of life safety and property protection from the hazards of fire, explosion or dangerous conditions in new and existing buildings, structures and premises, and to provide a reasonable level of safety to fire fighters and emergency responders during emergency operations.

❖ Code requirements regulate conditions that are likely to cause or contribute to fires or explosions, endanger life or property if a fire occurs or contribute to the spread of a fire. The intent of the code is to regulate conditions related to the health, safety and welfare of the public, the fire fighters and other emergency responders called upon to conduct emergency operations in or on any building, structure or premises. Note that the code requirements are minimum (see commentary, Section 101.2 for a discussion on minimum requirements).

While the code does serve as a maintenance code for buildings constructed in accordance with the IBC, it has provisions that go far beyond maintenance of construction regulations for buildings. Much of the code prescribes construction regulations of several sorts, which can be seen throughout the code in the general provisions for safety and in special occupancies, processes and equipment. These regulations supplement the construction regulations in the IBC for cases where special hazards exist.

A common question that arises is, “Is it the intent of the code to apply to noncommercial structures?” Yes. The code applies to all structures within a jurisdiction, including residential occupancies, unless such occupancies are specifically excluded within the text of a particular code section. For example, Sections 503.1.1 and 507.1 require that all occupancies, including residential occupancies, be provided with fire apparatus access and a water supply for fire fighting. Though it is true that there are many provisions in the code that would not normally be applicable to a residential occupancy based on the scope of the particular provision, the overall application of the code is not limited to commercial structures (see the commentary to Section 503.1.1 and Appendix D107.1 for further discussion of this topic).

## SCOPE AND ADMINISTRATION

[A] **101.4 Severability.** If a section, subsection, sentence, clause or phrase of this code is, for any reason, held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this code.

- ❖ All sections of the code not invalidated by legal action remain in effect. While a dispute over a particular issue (such as hazardous materials quantity limitation) may have caused litigation that resulted in the provision being found unconstitutional, the remainder of the code is still applicable.

[A] **101.5 Validity.** In the event any part or provision of this code is held to be illegal or void, this shall not have the effect of making void or illegal any of the other parts or provisions hereof, which are determined to be legal; and it shall be presumed that this code would have been adopted without such illegal or invalid parts or provisions.

- ❖ The code provisions are intended to be construed as severable. If any part of the code is ruled invalid by a court of competent jurisdiction, the remaining sections of the code are intended to stand as though the invalid section never existed. Fire code officials and adopting bodies should carefully and promptly evaluate the impact of any such ruling on ongoing enforcement activities and the remaining code provisions. Such changes that are necessary to preserve and protect the enforcement authority of the jurisdiction and the public should be instituted through legislative action as soon as practical. Additionally, the International Code Council® (ICC®) should be advised of court actions invalidating any code provisions. For the same reason local officials must evaluate the effects of court decisions, the influence of court decisions on the remainder of the code must be evaluated for national impact.

### SECTION 102 APPLICABILITY

[A] **102.1 Construction and design provisions.** The construction and design provisions of this code shall apply to:

1. Structures, facilities and conditions arising after the adoption of this code.
  2. Existing structures, facilities and conditions not legally in existence at the time of adoption of this code.
  3. Existing structures, facilities and conditions where required in Chapter 11.
  4. Existing structures, facilities and conditions that, in the opinion of the *fire code official*, constitute a distinct hazard to life or property.
- ❖ This section establishes the scope of application of the code provisions that regulate construction and design. Construction and design requirements include, but are not limited to, the installation of fire protection systems; drainage and secondary containment facilities for hazardous materials; fire-resistive construction and the activities stated in Section 105.7 for which a construction permit is required.

Item 1 specifies that the construction and design code requirements apply to new construction that occurs following the adoption of the code.

Item 2 means that the construction and design code requirements are to apply to existing structures that did not have a certificate of occupancy at the time the code was adopted. An example would be a building that was built when there was no adopted construction code in the jurisdiction.

Item 3 refers to Chapter 11, "Construction Requirements for Existing Buildings," which was added in the 2009 edition of the code to assemble in a single location all of the construction and design code requirements that specifically target existing structures, facilities and conditions for retroactive application, which had previously been scattered throughout the code.

Item 4 generally requires the fire code official to determine that a "distinct hazard to life or property" exists prior to enforcing a construction and design code provision retroactively. Simply claiming that a violation exists because a building does not comply with the most recent edition of the code does not necessarily establish that a hazard actually exists. The fire code official should be prepared to demonstrate, based on evidence or case histories that would be defensible in a court of law, that a distinct hazard exists. This would be especially true where enforcement would result in substantial expense to the property owner or when a building has remained in compliance with the edition of the code under which it was originally constructed.

Further legal counsel should be consulted prior to the retroactive application of the code in order to establish the defensibility of the fire code official's determination in a court of law. Also, similar occupancies in the jurisdiction should be treated equally using a written policy to avoid the possibility of charges of selective enforcement.

[A] **102.2 Administrative, operational and maintenance provisions.** The administrative, operational and maintenance provisions of this code shall apply to:

1. Conditions and operations arising after the adoption of this code.
  2. Existing conditions and operations.
- ❖ This section specifies that the administrative, operational and maintenance requirements of the code apply to conditions and operations that exist when the code is adopted and new conditions and operations that begin after the code is adopted. Although Sections 102.1 and 102.2 are the controlling sections for retroactive application of the code to existing buildings, they do not provide for retroactive code application solely on the basis of a change in ownership or the occupying tenant. If a change in the occupancy group or the character of use occurs, the current edition of the code becomes enforceable. In such cases, Section 102.3 also applies.

**[A] 102.3 Change of use or occupancy.** Changes shall not be made in the use or occupancy of any structure that would place the structure in a different division of the same group or occupancy or in a different group of occupancies, unless such structure is made to comply with the requirements of this code and the *International Building Code*. Subject to the approval of the *fire code official*, the use or occupancy of an existing structure shall be allowed to be changed and the structure is allowed to be occupied for purposes in other groups without conforming to all of the requirements of this code and the *International Building Code* for those groups, provided the new or proposed use is less hazardous, based on life and fire risk, than the existing use.

❖ A change in occupancy in an existing structure may change the level of inherent hazards that the code was initially intended to address.

Regardless of whether the change is to an occupancy considered to be more or less hazardous, this section applies the provisions of the IBC for new construction to the existing structure with the new occupancy to match the specific requirements of the code to the specific hazards of the new occupancy. For example, a change from an existing Group M mercantile occupancy to a Group B business occupancy renders all Group B provisions applicable to all portions of the structure where the occupancy has changed, or that are adversely affected by the change.

**[A] 102.4 Application of building code.** The design and construction of new structures shall comply with the *International Building Code*, and any *alterations*, additions, changes in use or changes in structures required by this code, which are within the scope of the *International Building Code*, shall be made in accordance therewith.

❖ The code is the companion fire and life safety maintenance code to the IBC. Maintenance of other building features is governed by other *International Codes*<sup>®</sup> (I-Codes<sup>®</sup>). When existing buildings change occupancy group or are altered, increased in area or demolished, the IBC provisions must apply. When compliance with the code requires alterations, additions or modifications within the scope of the IBC, the IBC regulations and the building official's authority must prevail. This makes it essential that the code officials responsible for enforcing the building and fire codes establish a sound working relationship. Clear communication is essential to achieve compliance with the respective code officials' orders.

**[A] 102.5 Application of residential code.** Where structures are designed and constructed in accordance with the *International Residential Code*, the provisions of this code shall apply as follows:

1. Construction and design provisions of this code pertaining to the exterior of the structure shall apply including, but not limited to, premises identification, fire apparatus access and water supplies. Where interior or exterior systems or devices are installed, construc-

tion permits required by Section 105.7 of this code shall apply.

2. Administrative, operational and maintenance provisions of this code shall apply.

❖ This section clarifies the extent to which the *International Residential Code*<sup>®</sup> (IRC<sup>®</sup>) and the code are interrelated and how the provisions of the code apply to the development of one- and two-family dwelling projects built under the IRC.

The IRC is designed and intended for use as a stand-alone code for the construction of detached one- and two-family dwellings and townhouses not more than three stories in height. As such, the construction of detached one- and two-family dwellings and townhouses is regulated exclusively by the IRC and not subject to the provisions of any other I-Codes other than to the extent specifically referenced. Although the IRC regulates the construction of detached one- and two-family dwellings and townhouse structures, it does not regulate the design and construction of emergency access to and community fire protection for residential developments containing such dwelling structures. Accordingly, where the code is adopted, the design, construction, regulation and maintenance of fire apparatus access roads for servicing such residential developments must comply with the provisions of Section 503 and, if adopted, Appendix D. Also, the design, construction, regulation and maintenance of fire protection water supplies for servicing such residential developments must comply with the provisions of Section 507 and, if adopted, Appendices B and C. These specific requirements of the code are applicable because they include design and construction regulations that provide necessary emergency access and community fire protection for residential developments containing structures that are regulated within the scope of the IRC.

**[A] 102.6 Historic buildings.** The provisions of this code relating to the construction, *alteration*, repair, enlargement, restoration, relocation or moving of buildings or structures shall not be mandatory for existing buildings or structures identified and classified by the state or local jurisdiction as historic buildings where such buildings or structures do not constitute a distinct hazard to life or property. Fire protection in designated historic buildings shall be provided with an *approved* fire protection plan as required in Section 1103.1.1.

❖ This section provides a blanket exception from code requirements when the building in question has historic value. The most important criterion for application of this section is that the building must be recognized by a qualified party or agency as having historic significance. Usually this is done by a state or local authority after considerable scrutiny of the historical value of the building. Most, if not all, states have such authorities, as do many local jurisdictions. The agencies with such authority can be located at the state or local government level or through the

local chapter of the American Institute of Architects (AIA). This section does require an approved fire protection plan. More specifically reference is made to Section 1103.1.1, which provides some minimal requirements. Section 1103.1.1 requires a plan to be developed in accordance with NFPA 914. The reference to NFPA 914 provides specific guidance to code officials, design professionals and building owners as to the provisions that are applicable to fire protection plans for historic buildings in order to provide a reasonable level of building and life safety provisions.

**[A] 102.7 Referenced codes and standards.** The codes and standards referenced in this code shall be those that are listed in Chapter 80, and such codes and standards shall be considered to be part of the requirements of this code to the prescribed extent of each such reference and as further regulated in Sections 102.7.1 and 102.7.2.

❖ The use of referenced codes and standards to cover certain aspects of various occupancies and operations rather than write parallel or competing requirements into the code is a long-standing and successful code development principle. Often, however, questions and potential conflicts in the use of referenced codes and standards can arise, which can lead to inconsistent enforcement of the code. This section establishes the relationship between the code and the codes or standards that it references. A referenced code or standard or portion thereof is to be considered an enforceable extension of the code as if the specified content of the referenced code or standard were included in the body of the code. The extent to which the provisions of a referenced standard may be enforced is limited to those portions of the standard that are specifically identified in the code section that makes the reference. As an example of such limiting references, in regard to Chapter 57, “Flammable and Combustible Liquids,” the question has been posed as to whether the entire referenced standard, NFPA 30, is applicable since it is referenced 30 times in Chapter 57. The answer is no. The applicability of NFPA 30 content would be limited to only the specific content indicated in the code section making the reference, e.g., Section 5703.6.2 limits the applicable NFPA 30 content to only Chapter 27 of that document; Section 5704.2.7 limits the applicable NFPA 30 content to only the tank design, fabrication and construction provisions of Chapters 21 and 22 or 23 of that document, and various other code sections such as 5704.2.7.8 and 5704.2.7.9 limit the reference to specifically enumerated sections of NFPA 30.

**[A] 102.7.1 Conflicts.** Where conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

❖ Where a code section referencing a standard contains no content limitation, any applicable provisions of the standard may be applied to the extent that they do not conflict with similar provisions in the code or other I-Codes. See the commentary to Section

102.7.2 for further discussion of conflicting provisions.

**[A] 102.7.2 Provisions in referenced codes and standards.** Where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code, the provisions of this code, as applicable, shall take precedence over the provisions in the referenced code or standard.

❖ This new section expands upon the provisions of Section 102.7.1 by making it clear that, even if a referenced standard contains requirements that parallel the code (or the other referenced I-Codes) in the standards own duly referenced section(s), the provisions of the code (or the other referenced I-Codes) will always take precedence. One of the most common examples of such conflicting provisions is that many referenced standards contain building construction requirements that may differ from the requirements of the IBC whose applicability is established in Section 102.4 of the code. In such cases, the IBC would supersede the standard.

**[A] 102.8 Subjects not regulated by this code.** Where applicable standards or requirements are not set forth in this code, or are contained within other laws, codes, regulations, ordinances or bylaws adopted by the jurisdiction, compliance with applicable standards of the National Fire Protection Association or other nationally recognized fire safety standards, as *approved*, shall be deemed as prima facie evidence of compliance with the intent of this code. Nothing herein shall derogate from the authority of the *fire code official* to determine compliance with codes or standards for those activities or installations within the *fire code official's* jurisdiction or responsibility.

❖ This section provides guidance for situations in which no specific standard is designated in the code or otherwise adopted by the jurisdiction. In this instance, compliance with the requirements of a standard of the NFPA or other nationally recognized standards can be approved by the fire code official.

**[A] 102.9 Matters not provided for.** Requirements that are essential for the public safety of an existing or proposed activity, building or structure, or for the safety of the occupants thereof, that are not specifically provided for by this code, shall be determined by the *fire code official*.

❖ Evolving technology in our society will sometimes result in a situation or circumstance that the code does not cover. The reasonable application of the code to such hazardous, unforeseen conditions is provided in this section. Clearly, such a section is needed and the fire code official's experience and judgment must be used. The section, however, does not override requirements that may be preferred when the code provides alternative methods. Additionally, the section can be used to implement the general performance-oriented language of the code in specific enforcement situations.

**[A] 102.10 Conflicting provisions.** Where there is a conflict between a general requirement and a specific requirement,

the specific requirement shall be applicable. Where, in a specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern.

- ❖ The provisions of this section provide guidance to both fire code officials and other code users on the application of the code when different sections specify different materials, methods of construction or other requirements.

The importance of this section should not be understated. It resolves the question of how to handle conflicts between the general and specific provisions found in the code or those instances where different sections specify different requirements. This section provides a necessary hierarchy for application of code provisions and clarifies code applications that would otherwise leave persistent questions and lead to debate. The code requires that where different sections of the code apply but contain different requirements, the most restrictive provisions shall govern. The code also resolves conflicts between the general requirements of any particular issue with any specific requirements of the same issue by indicating that the specific requirements take precedence over the general requirements.

**[A] 102.11 Other laws.** The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law.

- ❖ Compliance with the requirements of the code does not entail authorization, approval or permission to violate the regulations of other local, state or federal laws. Other laws, ordinances and regulations not regulated or enforced by the fire code official could be in existence and enforced by another authority having jurisdiction over those provisions. Although the requirements may have similar provisions to those of the code, the work must be in conformance with the other regulations.

**[A] 102.12 Application of references.** References to chapter or section numbers, or to provisions not specifically identified by number, shall be construed to refer to such chapter, section or provision of this code.

- ❖ There are many instances in the code where a reference is merely a chapter number, section number or, in some cases, a provision not specified by number. In all such situations, these references are to the content of the code and not some other code or publication.

## PART 2—ADMINISTRATIVE PROVISIONS

### SECTION 103 DEPARTMENT OF FIRE PREVENTION

**[A] 103.1 General.** The department of fire prevention is established within the jurisdiction under the direction of the *fire code official*. The function of the department shall be the

implementation, administration and enforcement of the provisions of this code.

- ❖ The traditional enforcement agency for the code is the fire department or fire prevention bureau of a state, county or municipal government. Such agencies usually perform administrative functions and provide public safety services related to fire protection; however, a variety of less-traditional arrangements have also been used to enforce the code, including private corporations, such as fire districts and fire companies employed by a local government to act as its agent; police and other law enforcement agencies; building, housing or zoning authorities; and community and economic development departments. Regardless of who is designated by the legislative or administrative authority to adopt and enforce the code, this section establishes the legal duty of the fire code official to enforce the code.

**[A] 103.2 Appointment.** The *fire code official* shall be appointed by the chief appointing authority of the jurisdiction; and the *fire code official* shall not be removed from office except for cause and after full opportunity to be heard on specific and relevant charges by and before the appointing authority.

- ❖ A fire code official's independence is essential so that public safety decisions are not based on political, economic or social expediency. This is not to say that social, political and economic considerations should not matter when deciding some code questions, but the interests of public health, safety and welfare must not be compromised to achieve such objectives. Protection of officials from removal from office without cause helps ensure that reasonable and competent professionals will be willing to serve.

**[A] 103.3 Deputies.** In accordance with the prescribed procedures of this jurisdiction and with the concurrence of the appointing authority, the *fire code official* shall have the authority to appoint a deputy *fire code official*, other related technical officers, inspectors and other employees.

- ❖ Most jurisdictions require more than one official to enforce the code. With the technical and legal demands on code enforcers increasing, additional personnel will certainly be required in this area to serve adequately the public interest. Though the professional qualifications of fire code officials are not detailed in the code, individuals appointed to code enforcement positions should be technically competent, motivated, well-adapted and possess good written and oral communication skills.

Many jurisdictions find it helpful, if not essential, to appoint an individual who is second-in-command and who would assume leadership of the organization in the absence of the chief code enforcement official.

**[A] 103.4 Liability.** The *fire code official*, member of the board of appeals, officer or employee charged with the enforcement of this code, while acting for the jurisdiction, in good faith and without malice in the discharge of the duties required by this code or other pertinent law or ordinance,

## SCOPE AND ADMINISTRATION

shall not thereby be rendered civilly or criminally liable personally, and is hereby relieved from all personal liability for any damage accruing to persons or property as a result of an act or by reason of an act or omission in the discharge of official duties.

❖ The fire code official, other department employees and members of the appeals board are not intended to be held liable, both civilly or criminally, for those actions performed in accordance with the code in a reasonable and lawful manner. However, the responsibility of the fire code official in this regard is subject to local, state and federal laws that may supersede this provision. This section further establishes that fire code officials (or subordinates) must not be liable for costs in any legal action instituted in response to the performance of lawful duties. Section 103.4.1 states that those costs are to be borne by the state, county or municipality, as applicable. The best way to be certain that the fire code official's action is a "lawful duty" is always to cite the applicable code section on which the enforcement action is based.

**[A] 103.4.1 Legal defense.** Any suit or criminal complaint instituted against any officer or employee because of an act performed by that officer or employee in the lawful discharge of duties and under the provisions of this code shall be defended by the legal representatives of the jurisdiction until the final termination of the proceedings. The *fire code official* or any subordinate shall not be liable for costs in an action, suit or proceeding that is instituted in pursuance of the provisions of this code; and any officer of the department of fire prevention, acting in good faith and without malice, shall be free from liability for acts performed under any of its provisions or by reason of any act or omission in the performance of official duties in connection therewith.

❖ Section 103.4 establishes that fire code officials or subordinates must not be liable for costs in any legal action, whether criminal or civil in nature, in response to the performance of lawful duties. This section states that these costs must be borne by the state or municipality. The best way to be certain that the fire code official's action is a lawful duty is to always cite the applicable code section substantiating the action.

## SECTION 104

### GENERAL AUTHORITY AND RESPONSIBILITIES

**[A] 104.1 General.** The *fire code official* is hereby authorized to enforce the provisions of this code and shall have the authority to render interpretations of this code, and to adopt policies, procedures, rules and regulations in order to clarify the application of its provisions. Such interpretations, policies, procedures, rules and regulations shall be in compliance with the intent and purpose of this code and shall not have the effect of waiving requirements specifically provided for in this code.

❖ The duty of the fire code official is to enforce the code. Because the fire code official must also act on all questions related to this responsibility, except as

specifically exempted by statutory requirements or elsewhere in the code, the fire code official is the "authority having jurisdiction" for all matters relating to the code and its enforcement.

This section also gives the fire code official interpretation authority. Note, however, that the interpretations are to be consistent with the intent and purpose of the code and are not allowed to set aside any specific requirement in the code.

**[A] 104.2 Applications and permits.** The *fire code official* is authorized to receive applications, review *construction documents* and issue permits for construction regulated by this code, issue permits for operations regulated by this code, inspect the premises for which such permits have been issued and enforce compliance with the provisions of this code.

❖ The fire code official is obligated to receive, review and act on permit applications required by the code as detailed in Section 105. All permitted premises must be inspected either before or after the permit is issued to determine compliance with the code provisions and terms of the permit.

**[A] 104.3 Right of entry.** Where it is necessary to make an inspection to enforce the provisions of this code, or where the *fire code official* has reasonable cause to believe that there exists in a building or upon any premises any conditions or violations of this code that make the building or premises unsafe, dangerous or hazardous, the *fire code official* shall have the authority to enter the building or premises at all reasonable times to inspect or to perform the duties imposed upon the *fire code official* by this code. If such building or premises is occupied, the *fire code official* shall present credentials to the occupant and request entry. If such building or premises is unoccupied, the *fire code official* shall first make a reasonable effort to locate the *owner*, the *owner's* authorized agent or other person having charge or control of the building or premises and request entry. If entry is refused, the *fire code official* has recourse to every remedy provided by law to secure entry.

❖ This section establishes the right of the fire code official to enter the premises to make the permit inspections required by Section 105.2.2. Permit application forms typically include a statement in the certification signed by the applicant (who is the owner or owner's authorized agent) granting the fire code official the authority to enter areas covered by the permit to enforce related code provisions.

The right to enter other structures or premises is more limited. First, to protect the right of privacy, the owner or occupant must grant the building official permission before an interior inspection of the property can be conducted. Permission is not required for inspections that can be accomplished from within the public right-of-way. Second, such access may be denied by the owner or occupant. Unless the inspector has reasonable cause to believe that a violation of the code exists, access may be unattainable. Third, fire code officials must present proper identification (see Section 104.4) and request admittance during

reasonable hours—usually the normal business hours of the establishment—to be admitted. Fourth, inspections must be aimed at securing or determining compliance with the provisions and intent of the regulations that are specifically within the established scope of the fire code official's authority.

Searches to gather information for the purpose of enforcing other codes, ordinances or regulations are considered unreasonable and are prohibited by the Fourth Amendment to the U.S. Constitution. "Reasonable cause" in the context of this section must be distinguished from "probable cause," which is required to gain access to property in criminal cases. The burden of proof establishing reasonable cause may vary among jurisdictions. Usually, an inspector must show that the property is subject to inspection under the provisions of the code; that the interests of the public health, safety and welfare outweigh the individual's right to maintain privacy and that such an inspection is required solely to determine compliance with the provisions of the code.

Many jurisdictions do not recognize the concept of an administrative warrant and may require the fire code official to prove probable cause in order to gain access upon refusal. This burden of proof is usually more substantial, often requiring the fire code official to stipulate in advance why access is needed (usually access is restricted to gathering evidence for seeking an indictment or making an arrest); what specific item or information is sought; its relevance to the case against the individual subject; how knowledge of the relevance of the information or items sought was obtained; and how the evidence sought will be used. In all such cases, the right to privacy must always be weighed against the right of the fire code official to conduct an inspection to verify that public health, safety and welfare are not in jeopardy. Such important and complex constitutional issues should be discussed with the jurisdiction's legal counsel. Jurisdictions should establish procedures for securing the necessary court orders when an inspection is deemed necessary following a refusal.

**[A] 104.3.1 Warrant.** Where the *fire code official* has first obtained a proper inspection warrant or other remedy provided by law to secure entry, an *owner*, the *owner's* authorized agent or occupant or person having charge, care or control of the building or premises shall not fail or neglect, after proper request is made as herein provided, to permit entry therein by the *fire code official* for the purpose of inspection and examination pursuant to this code.

❖ Very simply, the requirements in this section specify that when the fire code official has obtained a warrant to inspect the property, the owner, owner's authorized agent or occupant is to allow the fire code official entry to do the inspection (see commentary, Section 104.3).

**[A] 104.4 Identification.** The *fire code official* shall carry proper identification when inspecting structures or premises in the performance of duties under this code.

❖ This section requires the fire code official (including, by definition, all authorized designees) to carry appropriate official identification in the course of conducting the duties of the position. Such official identification may take the form of a badge, an identification card or both and removes any question as to the purpose and authority of the inspector.

**[A] 104.5 Notices and orders.** The *fire code official* is authorized to issue such notices or orders as are required to affect compliance with this code in accordance with Sections 109.1 and 109.2.

❖ The fire code official is required to issue orders to abate illegal or hazardous conditions and to pursue correction or abatement of hazardous conditions by issuing legal notices and orders as described by the code. Courts are increasingly ruling that failure to follow up and pursue appropriate legal remedies promptly exposes both the fire code official and the jurisdiction to a liability in tort.

**[A] 104.6 Official records.** The *fire code official* shall keep official records as required by Sections 104.6.1 through 104.6.4. Such official records shall be retained for not less than 5 years or for as long as the structure or activity to which such records relate remains in existence, unless otherwise provided by other regulations.

❖ In keeping with the need for an efficiently conducted business practice, the fire code official must keep official records. Such documentation provides a valuable resource of information if questions arise throughout the life of the building and its occupants. The code requires that the construction documents be kept until the project is complete or for at least 5 years, whichever is longer.

**[A] 104.6.1 Approvals.** A record of approvals shall be maintained by the *fire code official* and shall be available for public inspection during business hours in accordance with applicable laws.

❖ Records of prior approvals may be needed to determine the status of an existing operation or for future validation of a specific condition.

**[A] 104.6.2 Inspections.** The *fire code official* shall keep a record of each inspection made, including notices and orders issued, showing the findings and disposition of each.

❖ Records of inspections are needed to support the issuance of a certificate of occupancy. The inspection records should document any code violations that were subsequently corrected.

**104.6.3 Fire records.** The fire department shall keep a record of fires occurring within its jurisdiction and of facts concerning the same, including statistics as to the extent of such fires

and the damage caused thereby, together with other information as required by the *fire code official*.

- ❖ Fire records provide a history of the fire experience of a facility and a cumulative record for all of the facilities of a jurisdiction. Fire records support consideration for construction code requirements based on the need to prevent additional fire occurrences.

**[A] 104.6.4 Administrative.** Application for modification, alternative methods or materials and the final decision of the *fire code official* shall be in writing and shall be officially recorded in the permanent records of the *fire code official*.

- ❖ The written approval of modifications or alternative materials and methods of construction or operation are needed to support the approval of these items in the future. This file could be used to verify that an existing condition had been previously approved.

**[A] 104.7 Approved materials and equipment.** Materials, equipment and devices *approved* by the *fire code official* shall be constructed and installed in accordance with such approval.

- ❖ The code is a compilation of criteria with which materials, equipment, devices and systems must comply to be acceptable for a particular application. The fire code official has a duty to evaluate such materials, equipment, devices and systems for code compliance and, when compliance is determined, approve them for use. As a result of this approval, the material, equipment, device or system must be constructed and installed in compliance with that approval, and with all the conditions and limitations considered as a basis for that approval. For example, the manufacturer's instructions and recommendations are to be followed if the approval of the material was based, even in part, on those instructions and recommendations.

The approval authority given to the fire code official is a significant responsibility and is a key to code compliance. The approval process is first technical and then administrative and must be approached that way. For example, if data to determine code compliance are required, such data should be in the form of test reports or engineering analysis—not simply taken from a sales brochure.

**[A] 104.7.1 Material and equipment reuse.** Materials, equipment and devices shall not be reused or reinstalled unless such elements have been reconditioned, tested and placed in good and proper working condition and *approved*.

- ❖ Used materials, equipment and devices are considered to have completed their life span; however, adequate substitutes are occasionally not available for existing items that still serve a useful and practical purpose. In such cases, existing used equipment should be approved, provided the application is consistent with the purpose for which the equipment was designed, the function is the same as the “new” item, if one were available, and the intended use can be demonstrated as not compromising the public's safety.

**[A] 104.7.2 Technical assistance.** To determine the acceptability of technologies, processes, products, facilities, materials and uses attending the design, operation or use of a building or premises subject to inspection by the *fire code official*, the *fire code official* is authorized to require the *owner* or owner's authorized agent to provide, without charge to the jurisdiction, a technical opinion and report. The opinion and report shall be prepared by a qualified engineer, specialist, laboratory or fire safety specialty organization acceptable to the *fire code official* and shall analyze the fire safety properties of the design, operation or use of the building or premises and the facilities and appurtenances situated thereon, to recommend necessary changes. The *fire code official* is authorized to require design submittals to be prepared by, and bear the stamp of, a registered design professional.

- ❖ No one person has the technical knowledge to evaluate all of the various operations and uses from a safety standpoint. This section provides the fire code official the authority to require the owner or owner's authorized agent to provide a technical opinion safety report. The report is to be prepared by parties that have the technical ability to evaluate the design of the facility or the operational process in question. A registered design professional is commonly used for these services. It is critical that the preparer of the report have the proper background and experience for the project since the credibility of the report depends on these qualifications.

**[A] 104.8 Modifications.** Where there are practical difficulties involved in carrying out the provisions of this code, the *fire code official* shall have the authority to grant modifications for individual cases, provided the *fire code official* shall first find that special individual reason makes the strict letter of this code impractical and the modification is in compliance with the intent and purpose of this code and that such modification does not lessen health, life and fire safety requirements. The details of action granting modifications shall be recorded and entered in the files of the department of fire prevention.

- ❖ The fire code official may amend or make exceptions to the code as needed to respond to “practical difficulties” in work on new or existing buildings. Consideration of a particular difficulty is to be based on the application of the owner and a demonstration that the intent of the code is satisfied. This section is not intended to allow a code provision to be set aside or ignored; rather, it is intended to provide for the acceptance of equivalent protection. Such modifications do not, however, extend to actions that are necessary to correct violations of the code. In other words, a code violation or the expense of correcting a code violation cannot constitute a practical difficulty.

Comprehensive written records are an essential part of an effective administrative system. Unless clearly written records of the considerations and documentation used in the modification process are created and maintained, subsequent enforcement action cannot be supported.

**[A] 104.9 Alternative materials and methods.** The provisions of this code are not intended to prevent the installation of any material or to prohibit any method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. The *fire code official* is authorized to approve an alternative material or method of construction where the *fire code official* finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, *fire resistance*, durability and safety. Where the alternative material, design or method of construction is not approved, the *fire code official* shall respond in writing, stating the reasons why the alternative was not approved.

- ❖ Performance requirements have replaced detailed specifications to permit ready substitution and integration of new technologies in the marketplace. The code is not intended to restrict or prevent the development or application of new technologies or applications of existing technologies, provided they meet the intent of the code to protect public health, safety and welfare. When new methods or materials are developed, they should be evaluated.

The fire code official has the authority to recognize alternative and equivalent methods and materials, provided they maintain the level of protection required by the code. One of the most frequent criticisms of codes is that their provisions apply too broadly to classes of occupancies and, therefore, are incapable of recognizing the inherent dissimilarities within occupancy groups. While some criticism may be justified, it is the fire code official's duty to evaluate scrupulously the conditions in each case, as well as judge whether the intent of the code (to provide the minimum acceptable level of protection to life and property) is met. Fire code officials should, therefore, be prepared to use decision aids, the appeal process and outside experts as needed to show that code requirements are met.

The last sentence is similar to that included in Section 105.2.1 when a permit application is rejected. The reason for this additional level of communication is that the nonapproval of an alternative method is not the same as the nonapproval of a permit. In other words, the permit application may have been approved but an alternative method might not be approved until a later date. However, the reasons for responding to the applicant in writing are the same. In order to ensure effective communication and due process of law, the reasons for denial are required to be in writing. Similar language is found in all of the I-Codes.

**[A] 104.9.1 Research reports.** Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved* sources.

- ❖ When an alternative material or method is proposed for construction, it is incumbent upon the fire code

official to determine whether the alternative is, in fact, equivalent to the methods prescribed by the code. Reports providing evidence of this equivalency are required to be supplied by an approved source, meaning a source that the fire code official finds to be reliable and accurate. The ICC Evaluation Service (ICC-ES) is an example of an agency that provides research reports for alternative materials and methods.

**[A] 104.9.2 Tests.** Where there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the *fire code official* shall have the authority to require tests as evidence of compliance to be made at no expense to the jurisdiction. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the *fire code official* shall approve the testing procedures. Tests shall be performed by an *approved* agency. Reports of such tests shall be retained by the *fire code official* for the period required for retention of public records.

- ❖ To provide the basis on which the fire code official can make a decision regarding an alternative material or method, sufficient technical data, test reports and documentation must be provided for evaluation. If evidence satisfactory to the fire code official indicates that the alternative material or construction method is equivalent to that required by the code, he or she may approve it. Any such approval cannot have the effect of waiving any requirements of the code. The burden of proof of equivalence lies with the applicant who proposes the use of alternative materials or methods.

The fire code official must require the submission of any appropriate information and data to assist in the determination of equivalency. This information must be submitted before a permit can be issued. The type of information required includes test data in accordance with referenced standards, evidence of compliance with the referenced standard specifications and design calculations. A research report issued by an authoritative agency is particularly useful in providing the fire code official with the technical basis for evaluation and approval of new and innovative materials and methods of construction. The use of authoritative research reports can greatly assist the fire code official by reducing the time-consuming engineering analysis necessary to review these materials and methods. Failure to substantiate adequately a request for the use of an alternative is a valid reason for the building official to deny a request. Any tests submitted in support of an application must have been performed by an agency approved by the fire code official based on evidence that the agency has the technical expertise, equipment and quality assurance to properly conduct and report the necessary testing. The test reports submitted to the fire code official must be retained in accordance with the requirements of Section 104.6.

**104.10 Fire investigations.** The *fire code official*, the fire department or other responsible authority shall have the authority to investigate the cause, origin and circumstances of any fire, explosion or other hazardous condition. Information that could be related to trade secrets or processes shall not be made part of the public record, except as directed by a court of law.

❖ The prompt and thorough investigation of fires is important for many reasons, not the least of which is the identification of incendiary fires and prosecution of arsonists. In such cases, the duty of the fire code official is clear—evidence must be preserved and leads pursued through criminal prosecution, if possible. However, a more important and frequently overlooked aspect of fire investigation is loss analysis. Whether or not the fire code official has jurisdiction to investigate incendiary fires and prosecute arsonists, it is extremely important that the enforcement agency be involved in the process of determining why fires occur; what can be done to prevent fires; how their effects can be lessened and how people behave once fires occur. Such lessons gleaned from past tragedies have influenced the code-development efforts of various organizations across the country

**104.10.1 Assistance from other agencies.** Police and other enforcement agencies shall have authority to render necessary assistance in the investigation of fires when requested to do so.

❖ When needed, the fire code official has the authority to ask for assistance from the police department or other enforcement agencies, such as fire code officials in nearby jurisdictions, to investigate fires.

**104.11 Authority at fires and other emergencies.** The fire chief or officer of the fire department in charge at the scene of a fire or other emergency involving the protection of life or property, or any part thereof, shall have the authority to direct such operation as necessary to extinguish or control any fire, perform any rescue operation, investigate the existence of suspected or reported fires, gas leaks or other hazardous conditions or situations, or take any other action necessary in the reasonable performance of duty. In the exercise of such power, the fire chief is authorized to prohibit any person, vehicle, vessel or thing from approaching the scene, and is authorized to remove, or cause to be removed or kept away from the scene, any vehicle, vessel or thing that could impede or interfere with the operations of the fire department and, in the judgment of the fire chief, any person not actually and usefully employed in the extinguishing of such fire or in the preservation of property in the vicinity thereof.

❖ This section describes the specific conditions of authority that are granted to the fire code official at a fire or other emergencies. The first half of the paragraph simply describes the fire code official's authority to carry out the fire operation at the site. The fire code official also needs to be able to control who and what is allowed to be at the site so that emergency operations are not hampered.

**104.11.1 Barricades.** The fire chief or officer of the fire department in charge at the scene of an emergency is authorized to place ropes, guards, barricades or other obstructions across any street, alley, place or private property in the vicinity of such operation so as to prevent accidents or interference with the lawful efforts of the fire department to manage and control the situation and to handle fire apparatus.

❖ This section gives the fire code official the authority to control access to the emergency site so that fire-fighting operations can occur without interference. This authority is also addressed in Section 104.11.

**104.11.2 Obstructing operations.** Persons shall not obstruct the operations of the fire department in connection with extinguishment or control of any fire, or actions relative to other emergencies, or disobey any lawful command of the fire chief or officer of the fire department in charge of the emergency, or any part thereof, or any lawful order of a police officer assisting the fire department.

❖ This section requires that fire department operations not be obstructed and that directions from the fire department official in command at the emergency site be carried out. This is necessary for efficient emergency operations.

**104.11.3 Systems and devices.** Persons shall not render a system or device inoperative during an emergency unless by direction of the fire chief or fire department official in charge of the incident.

❖ This section is an extension of the requirements in Section 104.11. The fire department official is in complete charge of the fire-fighting operation at the site. No person is to tamper with the equipment needed for the emergency.

## SECTION 105 PERMITS

**[A] 105.1 General.** Permits shall be in accordance with Sections 105.1.1 through 105.7.18.

❖ This section includes the regulations covering permits, including a comprehensive list of the kinds of activities that require permits.

**[A] 105.1.1 Permits required.** A property owner or owner's authorized agent who intends to conduct an operation or business, or install or modify systems and equipment that are regulated by this code, or to cause any such work to be performed, shall first make application to the *fire code official* and obtain the required permit.

❖ This section identifies that the property owner or an owner's authorized agent is required to make application and obtain a permit. It is important that the owner or an owner's authorized agent performs this function to confirm that they are aware of and give consent for permitted operations that may include hazardous materials that could pollute or contaminate the property. See the commentary for permit fees (Section 113.1) and keeping permits on the premises and available for inspection (Section 105.3.5).

**105.1.2 Types of permits.** There shall be two types of permits as follows:

1. Operational permit. An operational permit allows the applicant to conduct an operation or a business for which a permit is required by Section 105.6 for either:
  - 1.1. A prescribed period.
  - 1.2. Until renewed or revoked.
2. Construction permit. A construction permit allows the applicant to install or modify systems and equipment for which a permit is required by Section 105.7.

❖ The types of activities that require an operational permit are listed in Section 105.6. Construction activities that require a permit are listed in Section 105.7.

**105.1.3 Multiple permits for the same location.** Where more than one permit is required for the same location, the *fire code official* is authorized to consolidate such permits into a single permit provided that each provision is listed in the permit.

❖ The code allows for a number of activities to be included on a single permit in order to decrease the paperwork for all concerned. In this instance, the permit must list in detail the activities that are covered by the combined permit.

**[A] 105.1.4 Emergency repairs.** Where equipment replacement and repairs must be performed in an emergency situation, the permit application shall be submitted within the next working business day to the *fire code official*.

❖ This section recognizes that, in some cases, emergency replacement and repair work must be done as quickly as possible, so it is not practical to take the necessary time to apply for and obtain approval. A permit for the work must be obtained the next day that the building department is open for business. Any work performed before the permit is issued must be done in accordance with the code and corrected if not approved by the fire code official. For example, if a concealed trap failed on a Sunday, the plumber could replace the trap at that time, but he would have to apply for a permit on Monday and have the repair pass an inspection.

**[A] 105.1.5 Repairs.** Application or notice to the *fire code official* is not required for ordinary repairs to structures, equipment or systems. Such repairs shall not include the cutting away of any wall, partition or portion thereof, the removal or change of any required *means of egress*, or rearrangement of parts of a structure affecting the egress requirements; nor shall any repairs include addition to, alteration of, replacement or relocation of any standpipe, fire protection water supply, *automatic sprinkler system*, fire alarm system or other work affecting fire protection or life safety.

❖ This section distinguishes between alterations, wherein the code is to be applicable, and ordinary repairs, which are maintenance activities that do not require a permit.

**[A] 105.1.6 Annual permit.** Instead of an individual construction permit for each alteration to an already *approved* system or equipment installation, the *fire code official* is authorized to issue an annual permit upon application therefor to any person, firm or corporation regularly employing one or more qualified tradespersons in the building, structure or on the premises owned or operated by the applicant for the permit.

❖ Some large buildings or industrial facilities require repair, replacement or alteration of systems and equipment on a frequent basis. This section allows the fire code official to issue an annual permit for such work. This relieves both the fire department and the owners of such facilities from the burden of filing and processing individual applications for this activity; however, there are restrictions on who is entitled to these permits. They can be issued only for work on a previously approved installation and only to an individual or corporation that employs persons specifically qualified in the trade for which the permit is issued. If tradespeople who perform the work involved are required to be licensed in the jurisdiction, only those persons would be permitted to perform the work. If trade licensing is not required, the fire code official must review and approve the qualifications of the persons who will perform the work. The annual permit can apply only to the individual property that is owned or operated by the applicant.

**[A] 105.1.6.1 Annual permit records.** The person to whom an annual permit is issued shall keep a detailed record of alterations made under such annual permit. The *fire code official* shall have access to such records at all times or such records shall be filed with the *fire code official* as designated.

❖ The work performed in accordance with an annual permit must be inspected by the fire code official, so it is necessary to know when and where such work was performed. This can be accomplished by having records of the work available to the building official either at the premises or in the official's office, as determined by the official.

**[A] 105.2 Application.** Application for a permit required by this code shall be made to the *fire code official* in such form and detail as prescribed by the *fire code official*. Applications for permits shall be accompanied by such plans as prescribed by the *fire code official*.

❖ Applications provided by the jurisdiction should be complete, concise and relevant. Though the burden of proof is on the applicant to supply all necessary information to determine compliance with the code provisions, it is the fire code official's duty to request sufficient information to make a reasonable and informed judgment prior to approving a permit.

**[A] 105.2.1 Refusal to issue permit.** If the application for a permit describes a use that does not conform to the requirements of this code and other pertinent laws and ordinances, the *fire code official* shall not issue a permit, but shall return

the application to the applicant with the refusal to issue such permit. Such refusal shall, where requested, be in writing and shall contain the reasons for refusal.

- ❖ This section directs the fire code official not to issue a permit if the application describes a use that does not conform to the requirements of the code. Note that this direction is not advisory. The fire code official would be in violation of the code if a permit were issued in such circumstances.

**[A] 105.2.2 Inspection authorized.** Before a new operational permit is *approved*, the *fire code official* is authorized to inspect the receptacles, vehicles, buildings, devices, premises, storage spaces or areas to be used to determine compliance with this code or any operational constraints required.

- ❖ The inspections described in this section are necessary for the fire code official to determine that the application for an operational permit complies with the code prior to issuing that permit. Operations may not proceed without an operational permit.

**[A] 105.2.3 Time limitation of application.** An application for a permit for any proposed work or operation shall be deemed to have been abandoned 180 days after the date of filing, unless such application has been diligently prosecuted or a permit shall have been issued; except that the *fire code official* is authorized to grant one or more extensions of time for additional periods not exceeding 90 days each. The extension shall be requested in writing and justifiable cause demonstrated.

- ❖ Permit applications lingering indefinitely in an incomplete condition can be an administrative nuisance to the fire code official, while also overburdening the filing system. This section establishes 180 days as the time limit for the permit applicant to provide the fire code official with sufficient information to evaluate the application and take appropriate action. 180 days should normally be more than enough time for an applicant to satisfy code requirements for submittal of construction documents and all other required information.

There may be circumstances, however, that could cause an application to age beyond 180 days prior to permit issuance, such as awaiting issuance of a report by a quality assurance agency. If the fire code official is satisfied that every effort is being made by the applicant to pursue the application, an extension of time would be acceptable.

**[A] 105.2.4 Action on application.** The *fire code official* shall examine or cause to be examined applications for permits and amendments thereto within a reasonable time after filing. If the application or the *construction documents* do not conform to the requirements of pertinent laws, the *fire code official* shall reject such application in writing, stating the reasons therefor. If the *fire code official* is satisfied that the proposed work or operation conforms to the requirements of this code and laws and ordinances applicable thereto, the *fire code official* shall issue a permit therefor as soon as practicable.

- ❖ While the fire code official has the duty to take all necessary and prudent actions to determine the

applicant's compliance with the code, the evaluation must be completed promptly. Once the fire code official's review of the application is complete, either a permit will be issued or a written disapproval notice will be given. The disapproval notice must outline the reasons for rejection and should include a list of applicable code sections with which the applicant must comply to obtain approval.

**[A] 105.3 Conditions of a permit.** A permit shall constitute permission to maintain, store or handle materials; or to conduct processes that produce conditions hazardous to life or property; or to install equipment utilized in connection with such activities; or to install or modify any *fire protection system* or equipment or any other construction, equipment installation or modification in accordance with the provisions of this code where a permit is required by Section 105.6 or 105.7. Such permission shall not be construed as authority to violate, cancel or set aside any of the provisions of this code or other applicable regulations or laws of the jurisdiction.

- ❖ In effect, a permit is a contract or covenant between the jurisdiction and the applicant, allowing the applicant to operate, perform, conduct or direct a hazardous operation, process or occupancy. As with all contracts, the terms remain binding for a finite period. This process allows continual review of the applicant's compliance with the contract's terms. Failure to meet the terms of the contract may result in the applicant's forfeiture of the right to conduct or operate the process, operation or occupancy, and subsequently the fire code official may revoke the permit without further notice.

This section also states the fundamental premise that the permit is only a license to proceed with the work. It is not a license to violate, cancel or set aside any provisions of the code. This is significant because, even if there are errors or oversights in the permit approval process, the permit applicant, not the fire code official, is responsible for code compliance.

**[A] 105.3.1 Expiration.** An operational permit shall remain in effect until reissued, renewed or revoked, or for such a period of time as specified in the permit. Construction permits shall automatically become invalid unless the work authorized by such permit is commenced within 180 days after its issuance, or if the work authorized by such permit is suspended or abandoned for a period of 180 days after the time the work is commenced. Before such work recommences, a new permit shall be first obtained and the fee to recommence work, if any, shall be one-half the amount required for a new permit for such work, provided that changes have not been made and will not be made in the original construction documents for such work, and provided further that such suspension or abandonment has not exceeded one year. Permits are not transferable and any change in occupancy, operation, tenancy or ownership shall require that a new permit be issued.

- ❖ A construction permit is invalid when 180 days go by without any of the authorized work being done. The permit holder should be notified in writing that the permit is invalid, including the reasons why.

Permits are neither transferable nor assignable because they are agreements between two specific parties: the fire code official, who is acting for the jurisdiction, and the applicant. Any changes amending the application or terms of the original agreement will require a new application and permit approval.

**[A] 105.3.2 Extensions.** A permittee holding an unexpired permit shall have the right to apply for an extension of the time within which the permittee will commence work under that permit where work is unable to be commenced within the time required by this section for good and satisfactory reasons. The *fire code official* is authorized to grant, in writing, one or more extensions of the time period of a permit for periods of not more than 180 days each. Such extensions shall be requested by the permit holder in writing and justifiable cause demonstrated.

- ❖ The significant issue in this section is that an extension of time is to be granted when justifiable cause is demonstrated by the permit applicant. For example, a construction permit might be granted for certain equipment installation, but the equipment might not be received at the site until after the installation permit expires. To get a time extension, the applicant is to submit a request in writing to the fire code official, including a written explanation of why the work did not proceed within the permit time frame.

**[A] 105.3.3 Occupancy prohibited before approval.** The building or structure shall not be occupied prior to the *fire code official* issuing a permit and conducting associated inspections indicating the applicable provisions of this code have been met.

- ❖ The owner of an existing structure may request that the fire code official issue a certificate of occupancy for the structure, provided that there are no pending violations. A final inspection is usually done to verify that the work covered by the permit has been completed in accordance with the code.

**[A] 105.3.4 Conditional permits.** Where permits are required and upon the request of a permit applicant, the *fire code official* is authorized to issue a conditional permit to occupy the premises or portion thereof before the entire work or operations on the premises is completed, provided that such portion or portions will be occupied safely prior to full completion or installation of equipment and operations without endangering life or public welfare. The *fire code official* shall notify the permit applicant in writing of any limitations or restrictions necessary to keep the permit area safe. The holder of a conditional permit shall proceed only to the point for which approval has been given, at the permit holder's own risk and without assurance that approval for the occupancy or the utilization of the entire premises, equipment or operations will be granted.

- ❖ The fire code official is allowed to issue a conditional permit prior to the completion of all work. Such a permit is to be issued only when the building or structure is available for safe occupancy prior to full completion. The permit is intended to acknowledge that

some building features may not be completed even though the building is safe for occupancy.

**[A] 105.3.5 Posting the permit.** Issued permits shall be kept on the premises designated therein at all times and shall be readily available for inspection by the *fire code official*.

- ❖ Note that this section does not require the permit to be posted, but it is to be kept on site at all times for inspection by the fire code official.

**[A] 105.3.6 Compliance with code.** The issuance or granting of a permit shall not be construed to be a permit for, or an approval of, any violation of any of the provisions of this code or of any other ordinance of the jurisdiction. Permits presuming to give authority to violate or cancel the provisions of this code or other ordinances of the jurisdiction shall not be valid. The issuance of a permit based on *construction documents* and other data shall not prevent the *fire code official* from requiring the correction of errors in the *construction documents* and other data. Any addition to or alteration of *approved construction documents* shall be *approved* in advance by the *fire code official*, as evidenced by the issuance of a new or amended permit.

- ❖ This section includes an important principle regarding construction documents. The fire code official has the authority to require that errors in construction be corrected, even if the construction is based on documents that were part of the applicant's submittal for a construction permit. Thus, the code requirements are not set aside by approved drawings that may include noncomplying items of construction. Any changes amending the application or construction of the original agreement will require a new application and permit approval.

**[A] 105.3.7 Information on the permit.** The *fire code official* shall issue all permits required by this code on an *approved* form furnished for that purpose. The permit shall contain a general description of the operation or occupancy and its location and any other information required by the *fire code official*. Issued permits shall bear the signature of the *fire code official* or other *approved* legal authorization.

- ❖ This section describes the form of the permit and requires that it be either signed by the fire code official or otherwise reflect the legal authorization of the jurisdiction. In many jurisdictions, permits are electronically generated and do not require a traditional signature.

**[A] 105.3.8 Validity of permit.** The issuance or granting of a permit shall not be construed to be a permit for, or an approval of, any violation of any of the provisions of this code or of any other ordinances of the jurisdiction. Permits presuming to give authority to violate or cancel the provisions of this code or other ordinances of the jurisdiction shall not be valid. The issuance of a permit based on *construction documents*, operational documents and other data shall not prevent the *fire code official* from requiring correction of errors in the documents or other data.

- ❖ This section states the fundamental premise that the permit is only a license to proceed with the work. It is

not a license to violate, cancel or set aside any provisions of the code. This is significant because it means that despite any errors or oversights in the approval process, the permit applicant, not the fire code official, is responsible for code compliance. Also, the permit can be revoked in accordance with Section 105.5.

**[A] 105.4 Construction documents.** *Construction documents* shall be in accordance with Sections 105.4.1 through 105.4.6.

❖ This section states the scope of the sections covering construction documents.

**[A] 105.4.1 Submittals.** *Construction documents* and supporting data shall be submitted in two or more sets with each application for a permit and in such form and detail as required by the *fire code official*. The *construction documents* shall be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

**Exception:** The *fire code official* is authorized to waive the submission of *construction documents* and supporting data not required to be prepared by a registered design professional if it is found that the nature of the work applied for is such that review of *construction documents* is not necessary to obtain compliance with this code.

❖ A detailed description of the work for which an application is made must be submitted in the form and detail required by the fire code official. Construction documents are to be prepared by a registered design professional when required by state laws in effect in the jurisdiction. States have professional registration laws that specify the type of construction documents to be prepared by a registered design professional. The code relies on these state laws to determine when a registered design professional is required.

The requirement for the preparation of construction documents and the submittal of calculations is specified by the code in several chapters. For example, Section 901.2 specifies that construction documents and calculations are to be submitted for fire protection systems when required by the fire code official.

**[A] 105.4.1.1 Examination of documents.** The *fire code official* shall examine or cause to be examined the accompanying *construction documents* and shall ascertain by such examinations whether the work indicated and described is in accordance with the requirements of this code.

❖ The requirements of this section are related to those found in Section 105.2.4 regarding the action of the fire code official in response to a permit application. The fire code official can delegate review of the construction documents to subordinates as provided for in Section 103.3.

**[A] 105.4.2 Information on construction documents.** *Construction documents* shall be drawn to scale upon suitable material. Electronic media documents are allowed to be submitted where *approved* by the *fire code official*. *Construction documents* shall be of sufficient clarity to indicate the loca-

tion, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code and relevant laws, ordinances, rules and regulations as determined by the *fire code official*.

❖ Construction documents are not sketches. They are comprehensive drawings, drawn to scale, that provide the details to verify the work will comply with the code. The permit applicant must be familiar with the code requirements to prepare code-compliant construction documents. If the applicant is not familiar with the code, the construction documents will most likely not have sufficient detail to determine compliance and, thus, not be satisfactory as the basis for a permit.

**[A] 105.4.2.1 Fire protection system shop drawings.** Shop drawings for the fire protection system(s) shall be submitted to indicate compliance with this code and the *construction documents*, and shall be *approved* prior to the start of installation. Shop drawings shall contain all information as required by the referenced installation standards in Chapter 9.

❖ It is common for the fire protection contractor(s) for a project not to have been selected at the time a permit is issued; thus, detailed shop drawings for fire protection systems would not be available. Because they provide the information necessary to determine code compliance, as specified in the appropriate referenced standard in Chapter 9, detailed shop drawings for fire protection systems must be submitted and approved by the fire code official before the contractor can begin installing the system. For example, the professional responsible for the design of an automatic sprinkler system should determine that the water supply is adequate, but will not be able to prepare a final set of hydraulic calculations if the specific materials and pipe sizes, lengths and arrangements have not been identified. Once the installing contractor is selected, specific hydraulic calculations can be prepared. Factors such as classification of the hazard, amount of water supply available and the density or concentration to be achieved by the system are to be included with the submission of the shop drawings. Specific data sheets identifying sprinklers, pipe dimensions, power requirements for smoke detectors, etc., should also be included with the submission.

**[A] 105.4.3 Applicant responsibility.** It shall be the responsibility of the applicant to ensure that the *construction documents* include all of the fire protection requirements and the shop drawings are complete and in compliance with the applicable codes and standards.

❖ This requirement is similar to the one in Section 901.2 regarding construction documents for fire protection systems.

The requirement in this section regarding shop drawings applies to all types of shop drawings, not just those for fire protection systems. The permit applicant is responsible for the review of the shop drawings, not the fire code official. The permit appli-

cant is also responsible for seeing that the work on the job site complies with the code. Since a lot of the construction work is done in accordance with shop drawings, the applicant should review those drawings for code compliance to make sure field construction complies with the code.

**[A] 105.4.4 Approved documents.** *Construction documents approved by the fire code official are approved with the intent that such construction documents comply in all respects with this code. Review and approval by the fire code official shall not relieve the applicant of the responsibility of compliance with this code.*

❖ The applicant is responsible for making sure that construction complies with the code. If approved drawings include errors that do not comply with the code, the fire code official still has the authority to require that the errors be corrected. Thus, it is important that the permit applicant is familiar with code requirements to prevent preparation of construction documents that do not meet the code.

**[A] 105.4.4.1 Phased approval.** *The fire code official is authorized to issue a permit for the construction of part of a structure, system or operation before the construction documents for the whole structure, system or operation have been submitted, provided that adequate information and detailed statements have been filed complying with pertinent requirements of this code. The holder of such permit for parts of a structure, system or operation shall proceed at the holder's own risk with the building operation and without assurance that a permit for the entire structure, system or operation will be granted.*

❖ The fire code official has the authority to issue a partial permit to allow for the practice of "fast tracking" a job. Any construction under a partial permit is, as stated in the code, "at the holder's own risk" and "without assurance that a permit for the entire structure, system or operation will be granted." The fire code official is under no obligation to accept work or issue a complete permit in violation of the code, ordinances or statutes simply because a partial permit has been issued. "Fast tracking" puts an unusual administrative and technical burden on the fire code official. The purpose is to proceed with construction while the design continues for other aspects of the work. Coordinating and correlating the code aspects into the project in phases requires attention to detail and project tracking so that all code issues are addressed.

**[A] 105.4.5 Amended construction documents.** *Work shall be installed in accordance with the approved construction documents, and any changes made during construction that are not in compliance with the approved construction documents shall be resubmitted for approval as an amended set of construction documents.*

❖ Any amendments to the approved construction documents must be filed before constructing the amended item. In the broadest sense, amendments include all addenda, change orders, revised drawings and

marked-up shop drawings. Fire code officials should maintain a policy that all amendments be submitted for review. Otherwise, a significant amendment may not be submitted, resulting in an activity that is not approved and that causes a needless delay in obtaining approval of the finished work.

**[A] 105.4.6 Retention of construction documents.** *One set of construction documents shall be retained by the fire code official for a period of not less than 180 days from date of completion of the permitted work, or as required by state or local laws. One set of approved construction documents shall be returned to the applicant, and said set shall be kept on the site of the building or work at all times during which the work authorized thereby is in progress.*

❖ It is important that a complete, current set of construction documents be kept on the job site at all times. Another set of construction documents is to be kept by the fire code official until final approval of the completed work. It is not unusual for state laws to establish records-retention criteria, and the intent of this section is to not only make the code consistent with such laws but also to provide a minimum post-construction retention period since the months immediately following construction completion are typically when most disputes arise that depend on the construction documents for resolution. The construction documents are part of the official records of the department and should be kept in accordance with Section 104.6.

**[A] 105.5 Revocation.** *The fire code official is authorized to revoke a permit issued under the provisions of this code where it is found by inspection or otherwise that there has been a false statement or misrepresentation as to the material facts in the application or construction documents on which the permit or approval was based including, but not limited to, any one of the following:*

1. The permit is used for a location or establishment other than that for which it was issued.
2. The permit is used for a condition or activity other than that listed in the permit.
3. Conditions and limitations set forth in the permit have been violated.
4. There have been any false statements or misrepresentations as to the material fact in the application for permit or plans submitted or a condition of the permit.
5. The permit is used by a different person or firm than the name for which it was issued.
6. The permittee failed, refused or neglected to comply with orders or notices duly served in accordance with the provisions of this code within the time provided therein.
7. The permit was issued in error or in violation of an ordinance, regulation or this code.

❖ The fire code official must revoke all permits shown to be based, all or in part, on any false statement or misinterpretation of fact. An applicant may subsequently

reapply for a permit. The code specifies seven specific conditions that allow the fire code official to revoke a permit.

**105.6 Required operational permits.** The *fire code official* is authorized to issue operational permits for the operations set forth in Sections 105.6.1 through 105.6.48.

- ❖ Sections 105.6.1 through 105.6.48 list the conditions requiring operational permits. Many of the items are stated in general terms, in which case the fire code official is to determine whether a specific operation is a significant hazard that requires a permit.

**105.6.1 Aerosol products.** An operational permit is required to manufacture, store or handle an aggregate quantity of Level 2 or Level 3 aerosol products in excess of 500 pounds (227 kg) net weight.

- ❖ See Chapter 51 for code requirements covering aerosol products (see commentary, Section 105.6).

**105.6.2 Amusement buildings.** An operational permit is required to operate a special amusement building.

- ❖ For requirements that apply to special amusement buildings, see Sections 202, 907.2.12 and 914.7.1, and Section 411 of the IBC (see commentary, Section 105.6).

**105.6.3 Aviation facilities.** An operational permit is required to use a Group H or Group S occupancy for aircraft servicing or repair and aircraft fuel-servicing vehicles. Additional permits required by other sections of this code include, but are not limited to, hot work, hazardous materials and flammable or combustible finishes.

- ❖ See Chapter 20 for aviation facility requirements (see commentary, Section 105.6).

**105.6.4 Carbon dioxide systems used in beverage dispensing applications.** An operational permit is required for carbon dioxide systems used in beverage dispensing applications having more than 100 pounds of carbon dioxide.

- ❖ A permit is required only for larger systems, having more than 100 pounds of carbon dioxide, where the hazard of release and possible asphyxiation is more likely. The amount correlates with the applicability of Section 5307. See commentaries for Sections 908.7 and 5307 for more detailed requirements.

**105.6.5 Carnivals and fairs.** An operational permit is required to conduct a carnival or fair.

- ❖ See Section 3103.3 for carnival requirements (see commentary, Section 105.6).

**105.6.6 Cellulose nitrate film.** An operational permit is required to store, handle or use cellulose nitrate film in a Group A occupancy.

- ❖ Although cellulose nitrate film is no longer in general use, there are a small number of locations in which this type of film is archived or restored for historical purposes. This section applies to those few locations

(see Section 306 for cellulose nitrate film requirements).

**105.6.7 Combustible dust-producing operations.** An operational permit is required to operate a grain elevator, flour starch mill, feed mill, or a plant pulverizing aluminum, coal, cocoa, magnesium, spices or sugar, or other operations producing *combustible dusts* as defined in Chapter 2.

- ❖ See Chapter 22 for combustible dust-producing operations (see commentary, Section 105.6).

**105.6.8 Combustible fibers.** An operational permit is required for the storage and handling of *combustible fibers* in quantities greater than 100 cubic feet (2.8 m<sup>3</sup>).

**Exception:** A permit is not required for agricultural storage.

- ❖ See Chapter 37 for combustible fiber requirements. The exception is for agricultural storage facilities where the hazard to persons is minimal (see Section 105.6).

**105.6.9 Compressed gases.** An operational permit is required for the storage, use or handling at *normal temperature and pressure* (NTP) of *compressed gases* in excess of the amounts listed in Table 105.6.9.

**Exception:** Vehicles equipped for and using *compressed gas* as a fuel for propelling the vehicle.

- ❖ See Chapter 53 for compressed gas requirements. The exception exempts vehicles equipped for compressed gas, since the code requirements for compressed gases do not apply to them.

**TABLE 105.6.9  
PERMIT AMOUNTS FOR COMPRESSED GASES**

TYPE OF GAS	AMOUNT (cubic feet at NTP)
Corrosive	200
Flammable (except cryogenic fluids and liquefied petroleum gases)	200
Highly toxic	Any Amount
Inert and simple asphyxiant <sup>a</sup>	6,000
Oxidizing (including oxygen)	504
Pyrophoric	Any Amount
Toxic	Any Amount

For SI: 1 cubic foot = 0.02832 m<sup>3</sup>.

a. For carbon dioxide used in beverage dispensing applications, see Section 105.6.4.

- ❖ When the use of compressed gases exceeds the amounts indicated in Table 105.6.9, an operational permit is required. The quantities in the table are at normal temperature and pressure (NTP) (see Chapter 53 for compressed gas requirements). A reference is provided to Section 105.6.4 addressing a specific requirement for systems having more than 100 pounds of carbon dioxide used for beverage dispensing.

**105.6.10 Covered and open mall buildings.** An operational permit is required for:

1. The placement of retail fixtures and displays, concession equipment, displays of highly combustible goods and similar items in the mall.
2. The display of liquid- or gas-fired equipment in the mall.
3. The use of open-flame or flame-producing equipment in the mall.

❖ The listed operations in a covered or open mall building require an operational permit, since they involve a significant hazard to the occupants. See Section 308 for open-flame regulations (see Section 105.6).

**105.6.11 Cryogenic fluids.** An operational permit is required to produce, store, transport on site, use, handle or dispense *cryogenic fluids* in excess of the amounts listed in Table 105.6.11.

**Exception:** Permits are not required for vehicles equipped for and using *cryogenic fluids* as a fuel for propelling the vehicle or for refrigerating the lading.

❖ See Chapter 55 for requirements regarding cryogenic fluids. The exception exempts vehicles using cryogenic fluids, since the code requirements do not apply to them.

**TABLE 105.6.11  
PERMIT AMOUNTS FOR CRYOGENIC FLUIDS**

TYPE OF CRYOGENIC FLUID	INSIDE BUILDING (gallons)	OUTSIDE BUILDING (gallons)
Flammable	More than 1	60
Inert	60	500
Oxidizing (includes oxygen)	10	50
Physical or health hazard not indicated above	Any Amount	Any Amount

For SI: 1 gallon = 3.785 L.

❖ Where cryogenic fluids are used in excess of the amounts shown in Table 105.6.10, an operational permit is required. The listed amounts are significantly different inside or outside of a building, since the hazard is greatly reduced if a leak occurs outdoors.

**105.6.12 Cutting and welding.** An operational permit is required to conduct cutting or welding operations within the jurisdiction.

❖ See Chapter 35 for welding requirements (see commentary, Section 105.6).

**105.6.13 Dry cleaning.** An operational permit is required to engage in the business of dry cleaning or to change to a more hazardous cleaning solvent used in existing dry cleaning equipment.

❖ See Chapter 21 for dry cleaning regulations (see commentary, Section 105.6).

**105.6.14 Exhibits and trade shows.** An operational permit is required to operate exhibits and trade shows.

❖ The primary concern is to identify hazardous and highly flammable materials that could be involved in an exhibit or booth (see commentary, Section 105.6).

**105.6.15 Explosives.** An operational permit is required for the manufacture, storage, handling, sale or use of any quantity of *explosives, explosive materials*, fireworks or pyrotechnic special effects within the scope of Chapter 56.

**Exception:** Storage in Group R-3 occupancies of smokeless propellant, black powder and small arms primers for personal use, not for resale and in accordance with Section 5606.

❖ See Chapter 56 for requirements for explosives and fireworks (see commentary, Section 105.6 and Chapter 56).

The exception correlates the permit requirements for the possession, storage or use of smokeless propellant, black powder and small arms primers for personal use in Group R-3 residential occupancies with the scope of Chapter 56, as stated in Section 5601.1, Exception 4, and Section 5606.4. The exception is also consistent with NFPA 495, referenced in Chapter 56, which limits quantities allowed in residences, but allows for quantities in residences outside the scope of Chapter 56 to be regulated without a permit.

**105.6.16 Fire hydrants and valves.** An operational permit is required to use or operate fire hydrants or valves intended for fire suppression purposes that are installed on water systems and accessible to a fire apparatus access road that is open to or generally used by the public.

**Exception:** A permit is not required for authorized employees of the water company that supplies the system or the fire department to use or operate fire hydrants or valves.

❖ An operational permit is required for persons other than authorized employees of the water company or the fire department to operate fire hydrants or valves. This restriction is intended to make sure that the use will not result in a lack of water supply and pressure that may be needed for fire-fighting purposes. The exception allows water company employees or the fire department to use fire hydrants or valves without a permit. Such use is common in order to flush out the piping periodically. When fire departments or fire districts interact with water districts, they should communicate the need for the fire department to use the hydrants and valves for nonemergency situations, such as training. A notification procedure is needed to let the water district know of this planned use.

**105.6.17 Flammable and combustible liquids.** An operational permit is required:

1. To use or operate a pipeline for the transportation within facilities of flammable or *combustible liquids*.

This requirement shall not apply to the off-site transportation in pipelines regulated by the Department of Transportation (DOTn) nor does it apply to piping systems.

2. To store, handle or use Class I liquids in excess of 5 gallons (19 L) in a building or in excess of 10 gallons (37.9 L) outside of a building, except that a permit is not required for the following:
  - 2.1. The storage or use of Class I liquids in the fuel tank of a motor vehicle, aircraft, motorboat, mobile power plant or mobile heating plant, unless such storage, in the opinion of the *fire code official*, would cause an unsafe condition.
  - 2.2. The storage or use of paints, oils, varnishes or similar flammable mixtures where such liquids are stored for maintenance, painting or similar purposes for a period of not more than 30 days.
3. To store, handle or use Class II or Class IIIA liquids in excess of 25 gallons (95 L) in a building or in excess of 60 gallons (227 L) outside a building, except for fuel oil used in connection with oil-burning equipment.
4. To store, handle or use Class IIIB liquids in tanks or portable tanks for fueling motor vehicles at motor fuel-dispensing facilities or where connected to fuel-burning equipment.
 

**Exception:** Fuel oil and used motor oil used for space heating or water heating.
5. To remove Class I or II liquids from an underground storage tank used for fueling motor vehicles by any means other than the *approved*, stationary on-site pumps normally used for dispensing purposes.
6. To operate tank vehicles, equipment, tanks, plants, terminals, wells, fuel-dispensing stations, refineries, distilleries and similar facilities where flammable and *combustible liquids* are produced, processed, transported, stored, dispensed or used.
7. To place temporarily out of service (for more than 90 days) an underground, protected above-ground or above-ground flammable or *combustible liquid* tank.
8. To change the type of contents stored in a flammable or *combustible liquid* tank to a material that poses a greater hazard than that for which the tank was designed and constructed.
9. To manufacture, process, blend or refine flammable or *combustible liquids*.
10. To engage in the dispensing of liquid fuels into the fuel tanks of motor vehicles at commercial, industrial, governmental or manufacturing establishments.
11. To utilize a site for the dispensing of liquid fuels from tank vehicles into the fuel tanks of motor vehicles, marine craft and other special equipment at commer-

cial, industrial, governmental or manufacturing establishments.

- ❖ See Chapter 57 for regulations regarding flammable and combustible liquids (see commentary, Section 105.6).

**105.6.18 Floor finishing.** An operational permit is required for floor finishing or surfacing operations exceeding 350 square feet (33 m<sup>2</sup>) using Class I or Class II liquids.

- ❖ The concern of this section is the proper use and handling of Class I or II liquids that are used in the floor-finishing process. If such liquids are not used, an operational permit is not required for floor finishing.

**105.6.19 Fruit and crop ripening.** An operational permit is required to operate a fruit- or crop-ripening facility or conduct a fruit-ripening process using ethylene gas.

- ❖ See Chapter 25 for regulations for fruit- and crop-ripening processes where ethylene gas is used (see commentary, Section 105.6).

**105.6.20 Fumigation and insecticidal fogging.** An operational permit is required to operate a business of fumigation or insecticidal fogging, and to maintain a room, vault or chamber in which a toxic or flammable fumigant is used.

- ❖ See Chapter 26 for fumigation and insecticidal fogging regulations within structures (see commentary, Section 105.6).

**105.6.21 Hazardous materials.** An operational permit is required to store, transport on site, dispense, use or handle hazardous materials in excess of the amounts listed in Table 105.6.21.

- ❖ See Chapter 50 for the general provisions regarding hazardous materials. Also see Chapters 51 through 67 for regulations regarding a specific hazardous material (see commentary, Section 105.6).

**TABLE 105.6.21.** See page 3-25.

- ❖ Where the amounts of hazardous materials in the table are exceeded, an operational permit is required. This applies to the storage, transportation on site, dispensing, use or handling of the hazardous materials that are listed in the table.

Table Notes a and b create parity for Class 3 oxidizer permit amounts with the adjustments to the maximum allowable quantity per control area (MAQ) specified in Table 5003.1.1(1), Note k. This eliminates the need for small apartment complexes and similar occupancies with swimming pools to obtain permits for normal pool maintenance using relatively small amounts of material.

**105.6.22 HPM facilities.** An operational permit is required to store, handle or use hazardous production materials.

- ❖ See Chapter 27 for regulations regarding semiconductor fabrication facilities (see commentary, Section 105.6).

**TABLE 105.6.21  
PERMIT AMOUNTS FOR HAZARDOUS MATERIALS**

TYPE OF MATERIAL	AMOUNT
Combustible liquids	See Section 105.6.17
Corrosive materials	
Gases	See Section 105.6.9
Liquids	55 gallons
Solids	1000 pounds
Explosive materials	See Section 105.6.15
Flammable materials	
Gases	See Section 105.6.9
Liquids	See Section 105.6.17
Solids	100 pounds
Highly toxic materials	
Gases	See Section 105.6.9
Liquids	Any Amount
Solids	Any Amount
Oxidizing materials	
Gases	See Section 105.6.9
Liquids	
Class 4	Any Amount
Class 3	1 gallon <sup>a</sup>
Class 2	10 gallons
Class 1	55 gallons
Solids	
Class 4	Any Amount
Class 3	10 pounds <sup>b</sup>
Class 2	100 pounds
Class 1	500 pounds
Organic peroxides	
Liquids	
Class I	Any Amount
Class II	Any Amount
Class III	1 gallon
Class IV	2 gallons
Class V	No Permit Required
Solids	
Class I	Any Amount
Class II	Any Amount
Class III	10 pounds
Class IV	20 pounds
Class V	No Permit Required
Pyrophoric materials	
Gases	Any Amount
Liquids	Any Amount
Solids	Any Amount
Toxic materials	
Gases	See Section 105.6.9
Liquids	10 gallons
Solids	100 pounds
Unstable (reactive) materials	
Liquids	
Class 4	Any Amount
Class 3	Any Amount
Class 2	5 gallons
Class 1	10 gallons
Solids	
Class 4	Any Amount
Class 3	Any Amount
Class 2	50 pounds
Class 1	100 pounds

(continued)

**TABLE 105.6.21—continued  
PERMIT AMOUNTS FOR HAZARDOUS MATERIALS**

TYPE OF MATERIAL	AMOUNT
Water-reactive materials	
Liquids	
Class 3	Any Amount
Class 2	5 gallons
Class 1	55 gallons
Solids	
Class 3	Any Amount
Class 2	50 pounds
Class 1	500 pounds

For SI: 1 gallon = 3.785 L, 1 pound = 0.454 kg.

- a. 20 gallons where Table 5003.1.1(1) Note k applies and hazard identification signs in accordance with Section 5003.5 are provided for quantities of 20 gallons or less.
- b. 200 pounds where Table 5003.1.1(1) Note k applies and hazard identification signs in accordance with Section 5003.5 are provided for quantities of 200 pounds or less.

**105.6.23 High-piled storage.** An operational permit is required to use a building or portion thereof as a *high-piled storage area* exceeding 500 square feet (46 m<sup>2</sup>).

❖ See Chapter 32 for high-piled storage provisions (see commentary, Section 105.6).

**105.6.24 Hot work operations.** An operational permit is required for hot work including, but not limited to:

1. Public exhibitions and demonstrations where hot work is conducted.
2. Use of portable hot work equipment inside a structure.

**Exception:** Work that is conducted under a construction permit.

3. Fixed-site hot work equipment, such as welding booths.
4. Hot work conducted within a wildfire risk area.
5. Application of roof coverings with the use of an open-flame device.
6. Where *approved*, the *fire code official* shall issue a permit to carry out a hot work program. This program allows *approved* personnel to regulate their facility's hot work operations. The *approved* personnel shall be trained in the fire safety aspects denoted in this chapter and shall be responsible for issuing permits requiring compliance with the requirements found in Chapter 35. These permits shall be issued only to their employees or hot work operations under their supervision.

❖ See Chapter 35 for hot work regulations. The exception to Item 2 in this section recognizes that work done under a construction permit is already covered by that permit so an operational permit is not required (see commentary, Section 105.6).

**105.6.25 Industrial ovens.** An operational permit is required for operation of industrial ovens regulated by Chapter 30.

❖ See Chapter 30 for regulations regarding industrial ovens (see commentary, Section 105.6).

**105.6.26 Lumber yards and woodworking plants.** An operational permit is required for the storage or processing of lumber exceeding 100,000 board feet (8,333 ft<sup>3</sup>) (236 m<sup>3</sup>).

❖ See Chapter 28 for provisions for lumber yards and woodworking plants (see commentary, Section 105.6).

**105.6.27 Liquid- or gas-fueled vehicles or equipment in assembly buildings.** An operational permit is required to display, operate or demonstrate liquid- or gas-fueled vehicles or equipment in assembly buildings.

❖ See Section 314.4 for requirements regarding liquid- or gas-fueled vehicles inside buildings (see commentary, Section 105.6).

**105.6.28 LP-gas.** An operational permit is required for:

1. Storage and use of LP-gas.

**Exception:** A permit is not required for individual containers with a 500-gallon (1893 L) water capacity or less or multiple container systems having an aggregate quantity not exceeding 500 gallons (1893 L), serving occupancies in Group R-3.

2. Operation of cargo tankers that transport LP-gas.

❖ See Chapter 61 for liquefied petroleum gas (LP-gas) regulations. The exception to Item 1 in this section exempts small tanks with an individual capacity of 500 gallons (1893 L) or multiple small tanks with an aggregate capacity of 500 gallons (1893 L) commonly found in residential service. A permit is required where the aggregate quantity of multiple small LP-gas containers exceeds 500 gallons (1893 L). It has become commonplace for LP-gas distributors to install LP-gas systems exceeding 500 gallons (1893 L) that consist of multiple containers in series with individual containers that do not exceed 500 gallons (1893 L), thereby avoiding the permit requirement. It is appropriate to require a permit at these locations given the significant hazard associated with these quantities. Item 2 covers cargo tankers, since they transport LP-gas onto premises covered by the code and, therefore, represent a potential hazard.

**105.6.29 Magnesium.** An operational permit is required to melt, cast, heat treat or grind more than 10 pounds (4.54 kg) of magnesium.

❖ See Section 5906 for the code requirements for magnesium (see commentary, Section 105.6).

**105.6.30 Miscellaneous combustible storage.** An operational permit is required to store in any building or upon any premises in excess of 2,500 cubic feet (71 m<sup>3</sup>) gross volume of combustible empty packing cases, boxes, barrels or similar containers, rubber tires, rubber, cork or similar combustible material.

❖ See Section 315 for requirements for miscellaneous combustible material storage (see commentary, Section 105.6).

**105.6.31 Motor fuel-dispensing facilities.** An operational permit is required for the operation of automotive, marine and fleet motor fuel-dispensing facilities.

❖ See Chapter 23 for requirements for motor fuel-dispensing facilities (see commentary, Section 105.6).

**105.6.32 Open burning.** An operational permit is required for the kindling or maintaining of an open fire or a fire on any public street, alley, road, or other public or private ground. Instructions and stipulations of the permit shall be adhered to.

**Exception:** *Recreational fires.*

❖ See Section 307 for open burning provisions. Section 202 includes the definition of "Open burning." The exception exempts recreational fires, which are also defined in Section 202.

**105.6.33 Open flames and torches.** An operational permit is required to remove paint with a torch; or to use a torch or open-flame device in a wildfire risk area.

❖ See Section 308 for regulations regarding open flames (see commentary, Section 105.6).

**105.6.34 Open flames and candles.** An operational permit is required to use open flames or candles in connection with assembly areas, dining areas of restaurants or drinking establishments.

❖ See Section 308 for regulations regarding open flames (see commentary, Section 105.6).

**105.6.35 Organic coatings.** An operational permit is required for any organic-coating manufacturing operation producing more than 1 gallon (4 L) of an organic coating in one day.

❖ The manufacture of organic coatings is addressed in Chapter 29 (see commentary, Section 105.6).

**105.6.36 Places of assembly.** An operational permit is required to operate a place of assembly.

❖ Because of the higher occupant loads found in Group A occupancies, such occupancies justify an increased level of scrutiny, such as is provided through the permit process.

**105.6.37 Private fire hydrants.** An operational permit is required for the removal from service, use or operation of private fire hydrants.

**Exception:** A permit is not required for private industry with trained maintenance personnel, private fire brigade or fire departments to maintain, test and use private hydrants.

❖ The purpose of an operational permit for the removal of private fire hydrants is to see that adequate fire hydrants are maintained for use during a fire. The exception allows testing and use of private fire hydrants by trained private industry personnel without an operational permit.

**105.6.38 Pyrotechnic special effects material.** An operational permit is required for use and handling of pyrotechnic special effects material.

❖ See Chapter 56 for fireworks regulations. The definition of “Pyrotechnic special effects material” is listed in Section 56 (see commentary, Section 105.6).

**105.6.39 Pyroxylin plastics.** An operational permit is required for storage or handling of more than 25 pounds (11 kg) of cellulose nitrate (pyroxylin) plastics, and for the assembly or manufacture of articles involving pyroxylin plastics.

❖ See Chapter 65 for requirements regarding pyroxylin (cellulose nitrate) plastics (see commentary, Section 105.6).

**105.6.40 Refrigeration equipment.** An operational permit is required to operate a mechanical refrigeration unit or system regulated by Chapter 6.

❖ See Section 606 for mechanical refrigeration regulations (see commentary, Section 105.6).

**105.6.41 Repair garages and motor fuel-dispensing facilities.** An operational permit is required for operation of repair garages.

❖ See Chapter 23 for requirements for repair garages (see commentary, Section 105.6).

**105.6.42 Rooftop heliports.** An operational permit is required for the operation of a rooftop heliport.

❖ See Chapter 20 for aviation facility requirements. Section 2007 contains helistop and heliport requirements (see commentary, Section 105.6).

**105.6.43 Spraying or dipping.** An operational permit is required to conduct a spraying or dipping operation utilizing flammable or *combustible liquids*, or the application of combustible powders regulated by Chapter 24.

❖ See Chapter 24 for flammable finish requirements. Section 2404 contains the spray finishing provisions, Section 2405 addresses dipping operations and Section 2406 includes powder coating regulations (see commentary, Section 105.6).

**105.6.44 Storage of scrap tires and tire byproducts.** An operational permit is required to establish, conduct or maintain storage of scrap tires and tire byproducts that exceeds 2,500 cubic feet (71 m<sup>3</sup>) of total volume of scrap tires, and for indoor storage of tires and tire byproducts.

❖ See Chapter 34 for regulations regarding tire rebuilding and tire storage (see Section 105.6).

**105.6.45 Temporary membrane structures and tents.** An operational permit is required to operate an air-supported temporary membrane structure, a temporary stage canopy or a tent having an area in excess of 400 square feet (37 m<sup>2</sup>).

**Exceptions:**

1. Tents used exclusively for recreational camping purposes.

2. Tents open on all sides, which comply with all of the following:
  - 2.1. Individual tents having a maximum size of 700 square feet (65 m<sup>2</sup>).
  - 2.2. The aggregate area of multiple tents placed side by side without a fire break clearance of not less than 12 feet (3658 mm) shall not exceed 700 square feet (65 m<sup>2</sup>) total.
  - 2.3. A minimum clearance of 12 feet (3658 mm) to structures and other tents shall be provided.

❖ See Chapter 31 for requirements for tents and other membrane structures. The first exception in this section exempts recreational camping tents, since they are small, temporary and have few occupants. The second exception exempts relatively small tents that are very low hazard, since they are spaced at least 12 feet (3658 mm) apart (see also commentary, Section 3103.20).

**105.6.46 Tire-rebuilding plants.** An operational permit is required for the operation and maintenance of a tire-rebuilding plant.

❖ See Chapter 34 for regulations regarding tire rebuilding operations (see commentary, Section 105.6).

**105.6.47 Waste handling.** An operational permit is required for the operation of wrecking yards, junk yards and waste material-handling facilities.

❖ See Section 315 for miscellaneous combustible materials storage requirements, Section 5004 for provisions regarding the storage of hazardous materials and Section 2808 for provisions regarding yard waste and recycling facilities (see commentary, Section 105.6).

**105.6.48 Wood products.** An operational permit is required to store chips, hogged material, lumber or plywood in excess of 200 cubic feet (6 m<sup>3</sup>).

❖ See Section 2808 for requirements regarding the storage and handling of wood chips, hogged material, fines, compost and raw product in association with yard waste and recycling facilities (see commentary, Section 105.6).

**[A] 105.7 Required construction permits.** The *fire code official* is authorized to issue construction permits for work as set forth in Sections 105.7.1 through 105.7.18.

❖ This section addresses conditions requiring a construction permit (see Section 105.6). Generally, a construction permit is required when a safety related system or hazardous material storage is installed or an existing system or facility is modified. Other sections of the code may also apply.

In some cases, the requirements in Sections 105.7.1 through 105.7.18 are stated in only general terms. In these instances, the fire code official is to

evaluate the scope of work involved for the modification or installation and determine whether a construction permit is required for the specific project.

**[A] 105.7.1 Automatic fire-extinguishing systems.** A construction permit is required for installation of or modification to an automatic fire-extinguishing system. Maintenance performed in accordance with this code is not considered to be a modification and does not require a permit.

❖ See Chapter 9 for fire protection system requirements. A construction permit is required for the installation or modification of an automatic fire-extinguishing system so that the work can be verified to meet the code requirements, since the system is obviously safety related (see commentary, Section 105.7).

**[A] 105.7.2 Battery systems.** A permit is required to install stationary storage battery systems having a liquid capacity of more than 50 gallons (189 L).

❖ See Sections 602.1 and 608 for battery system requirements (see commentary, Section 105.7).

**[A] 105.7.3 Compressed gases.** Where the compressed gases in use or storage exceed the amounts listed in Table 105.6.9, a construction permit is required to install, repair damage to, abandon, remove, place temporarily out of service, or close or substantially modify a *compressed gas* system.

**Exceptions:**

1. Routine maintenance.
  2. For emergency repair work performed on an emergency basis, application for permit shall be made within two working days of commencement of work.
- ❖ See Chapter 53 for the requirements for compressed gas systems. Where the volume of the compressed gas presents a significant health hazard and the quantity exceeds the allowed amounts in Table 105.6.9, a permit is needed to trigger construction document submittal, document review and inspections of the work on the system. The exceptions exempt maintenance work and allow emergency work to proceed immediately.

**[A] 105.7.4 Cryogenic fluids.** A construction permit is required for installation of or *alteration* to outdoor stationary *cryogenic fluid* storage systems where the system capacity exceeds the amounts listed in Table 105.6.11. Maintenance performed in accordance with this code is not considered to be an *alteration* and does not require a construction permit.

❖ See Chapter 55 for the requirements for cryogenic fluids and Chapter 58 for the requirements for flammable cryogenic fluids. The application for a construction permit for cryogenic fluids is intended to trigger a plan review that will examine constraints on location and the requirements of Chapters 55 and 58.

**[A] 105.7.5 Emergency responder radio coverage system.** A construction permit is required for installation of or modification to emergency responder radio coverage systems and

related equipment. Maintenance performed in accordance with this code is not considered to be a modification and does not require a construction permit.

❖ This section establishes that a permit must be obtained for the installation or modification of the emergency responder radio coverage system (ERRCS) to ensure that the work is done correctly and that any parts replacement will be compatible with the existing system components. Since the normal maintenance of a system typically would not involve alteration of the system, it would not require a permit.

**[A] 105.7.6 Fire alarm and detection systems and related equipment.** A construction permit is required for installation of or modification to fire alarm and detection systems and related equipment. Maintenance performed in accordance with this code is not considered to be a modification and does not require a construction permit.

❖ See Section 907 for fire alarm and detection requirements. A construction permit is required for installation or modification of these systems since they are obviously safety related. A permit is not required for maintenance when no modifications are made to the systems (see commentary, Section 105.7).

**[A] 105.7.7 Fire pumps and related equipment.** A construction permit is required for installation of or modification to fire pumps and related fuel tanks, jockey pumps, controllers and generators. Maintenance performed in accordance with this code is not considered to be a modification and does not require a construction permit.

❖ See Section 913 for requirements regarding fire pumps. A construction permit is required for modification or installation of equipment that is necessary to serve the sprinkler or standpipe system. This construction work must be monitored since these are safety-related systems (see commentary, Section 105.7).

**[A] 105.7.8 Flammable and combustible liquids.** A construction permit is required:

1. To install, repair or modify a pipeline for the transportation of flammable or *combustible liquids*.
2. To install, construct or alter tank vehicles, equipment, tanks, plants, terminals, wells, fuel-dispensing stations, refineries, distilleries and similar facilities where flammable and *combustible liquids* are produced, processed, transported, stored, dispensed or used.
3. To install, alter, remove, abandon or otherwise dispose of a flammable or *combustible liquid* tank.

❖ See Chapter 57 for provisions for flammable and combustible liquids. The intent of this section is to require a construction permit for any of the three activities listed, since flammable and combustible liquids are a significant hazard (see commentary, Section 105.7).

**[A] 105.7.9 Gates and barricades across fire apparatus access roads.** A construction permit is required for the instal-

lation of or modification to a gate or barricade across a fire apparatus access road.

- ❖ The permit gives the fire code official the ability to ensure that access requirements are met.

Current code requirements for gates and barricades include an approved method of locking/securing, proper dimensions and opening width, and proper devices for operation. See the commentary to Sections 503.5 and 503.6.

**[A] 105.7.10 Hazardous materials.** A construction permit is required to install, repair damage to, abandon, remove, place temporarily out of service, or close or substantially modify a storage facility or other area regulated by Chapter 50 where the hazardous materials in use or storage exceed the amounts listed in Table 105.6.21.

**Exceptions:**

1. Routine maintenance.
  2. For repair work performed on an emergency basis, application for permit shall be made within two working days of commencement of work.
- ❖ A construction permit is needed for hazardous-material-related construction to ensure submittal of construction documents, document review and inspection of the work for code compliance. The exceptions provide exemptions for maintenance work and allow emergency work to proceed immediately, provided the permit application is submitted within two working days of starting the job.

**[A] 105.7.11 Industrial ovens.** A construction permit is required for installation of industrial ovens covered by Chapter 30.

**Exceptions:**

1. Routine maintenance.
  2. For repair work performed on an emergency basis, application for permit shall be made within two working days of commencement of work.
- ❖ A construction permit is required for industrial oven installation so that the requirements in Chapter 30 for industrial ovens can be verified. The exceptions provide exemptions for maintenance work and allow emergency work to proceed immediately, provided the permit is applied for within two working days after work begins.

**[A] 105.7.12 LP-gas.** A construction permit is required for installation of or modification to an LP-gas system. Maintenance performed in accordance with this code is not considered to be a modification and does not require a permit.

- ❖ See Chapter 61 for the requirements for LP-gas storage, handling and transportation (see commentary, Section 105.7). Ordinary maintenance that does not involve modifications to the system does not require a construction permit.

**[A] 105.7.13 Private fire hydrants.** A construction permit is required for the installation or modification of private fire hydrants. Maintenance performed in accordance with this code is not considered to be a modification and does not require a permit.

- ❖ A construction permit is needed for the installation or modification of private fire hydrants so that they remain in service for fire protection purposes. The water flow rate and pressure capability need to be maintained. Ordinary maintenance that does not involve modifications does not require a construction permit.

**[A] 105.7.14 Smoke control or smoke exhaust systems.** Construction permits are required for installation of or alteration to smoke control or smoke exhaust systems. Maintenance performed in accordance with this code is not considered to be an alteration and does not require a permit.

- ❖ Smoke control and smoke exhaust systems are required fire protection systems by Chapter 9. A permit is necessary to ensure proper design and installation. Ordinary maintenance that does not involve modifications to the system does not require a construction permit.

**[A] 105.7.15 Solar photovoltaic power systems.** A construction permit is required to install or modify solar photovoltaic power systems. Maintenance performed in accordance with this code is not considered to be a modification and does not require a permit.

- ❖ Section 605.11 regulates solar photovoltaic power system installations on buildings. Because of the unique electrical and physical hazards they present to fire fighters and the impact such systems have on fire suppression operations, a permit is required. Ordinary maintenance that does not involve modifications to the system does not require a construction permit.

**[A] 105.7.16 Spraying or dipping.** A construction permit is required to install or modify a spray room, dip tank or booth. Maintenance performed in accordance with this code is not considered to be a modification and does not require a permit.

- ❖ See Chapter 24 for flammable finish requirements. The spray finishing requirements are in Section 2404, while dipping operations regulations are in Section 2405 (see commentary, Section 105.7). Ordinary maintenance that does not involve modifications does not require a construction permit.

**[A] 105.7.17 Standpipe systems.** A construction permit is required for the installation, modification or removal from service of a standpipe system. Maintenance performed in accordance with this code is not considered to be a modification and does not require a permit.

- ❖ See Section 905 for standpipe system requirements. Construction permits are required for standpipe systems because they are safety-related fire protection

systems. Ordinary maintenance that does not involve modifications to the system does not require a construction permit.

**[A] 105.7.18 Temporary membrane structures and tents.** A construction permit is required to erect an air-supported temporary membrane structure, a temporary stage canopy or a tent having an area in excess of 400 square feet (37 m<sup>2</sup>).

**Exceptions:**

1. Tents used exclusively for recreational camping purposes.
  2. Funeral tents and curtains, or extensions attached thereto, when used for funeral services.
  3. Tents and awnings open on all sides, which comply with all of the following:
    - 3.1. Individual tents shall have a maximum size of 700 square feet (65 m<sup>2</sup>).
    - 3.2. The aggregate area of multiple tents placed side by side without a fire break clearance of not less than 12 feet (3658 mm) shall not exceed 700 square feet (65 m<sup>2</sup>) total.
    - 3.3. A minimum clearance of 12 feet (3658 mm) to structures and other tents shall be maintained.
- ❖ See Chapter 31 for requirements regarding tents and other membrane structures. The exceptions are for tents where the hazard is very low. They provide needed exemptions for tents used for recreational camping and funerals. Relatively small tents and awnings that are open on all sides and are located a minimum of 12 feet (3658 mm) apart are also exempt (see commentary, Section 3103.2).

**SECTION 106  
INSPECTIONS**

**[A] 106.1 Inspection authority.** The *fire code official* is authorized to enter and examine any building, structure, marine vessel, vehicle or premises in accordance with Section 104.3 for the purpose of enforcing this code.

❖ The first part of this section establishes the right of the fire code official to enter the premises to make the permit inspections required by Section 104. Permit application forms typically include a statement in the certification signed by the applicant (who is the owner or owner’s agent) granting the fire code official the authority to enter areas covered by the permit to enforce code provisions related to the permit.

The right to enter other structures or premises is more limited. First, to protect the right of privacy, the owner or occupant must grant the fire code official permission before the interior of the property can be inspected. Permission is not required for inspections that can be accomplished from within the public right-of-way. Second, such access may be denied by the owner or occupant. Unless the inspector has “reasonable cause” to believe that a violation of the code

exists, access may be unattainable. Third, fire code officials must present proper identification (see Section 104.4) and request admittance during reasonable hours—usually the normal business hours of the establishment—to be admitted. Fourth, inspections must be aimed at securing or determining compliance with the provisions and intent of the regulations that are specifically within the established scope of the fire code official’s authority. Searches to gather information for the purpose of enforcing other codes, ordinances or regulations are considered unreasonable and are prohibited by the Fourth Amendment to the U.S. Constitution.

Reasonable cause in the context of this section must be distinguished from probable cause, which is required to gain access to property in criminal cases. The burden of proof for establishing reasonable cause may vary among jurisdictions. Usually, an inspector must show that the property is subject to inspection under the provisions of the code (see Section 104), that the interests of the public health, safety and welfare outweigh the individual’s right to maintain privacy and that such an inspection is required solely to determine compliance with the provisions of the code. Many jurisdictions do not recognize the concept of an administrative warrant, and may require the fire code official to prove probable cause in order to gain access upon refusal. This burden of proof is usually more substantial, often requiring the fire code official to stipulate in advance why access is needed (usually access is restricted to gathering evidence for seeking an indictment or making an arrest); what specific item or information is sought; its relevance to the case against the individual subject; how knowledge of the relevance of the information or items sought was obtained; and how the evidence sought will be used. In all such cases, the right to privacy must always be weighed against the right of the fire code official to conduct an inspection to determine whether the health, safety or welfare of the public is in jeopardy. Such important and complex constitutional issues should be discussed with the jurisdiction’s legal counsel. Jurisdictions should establish procedures for securing the necessary court orders when an inspection is considered necessary following a refusal.

**[A] 106.2 Inspections.** The *fire code official* is authorized to conduct such inspections as are deemed necessary to determine the extent of compliance with the provisions of this code and to approve reports of inspection by *approved* agencies or individuals. Reports of such inspections shall be prepared and submitted in writing for review and approval. Inspection reports shall be certified by a responsible officer of such *approved* agency or by the responsible individual. The *fire code official* is authorized to engage such expert opinion as deemed necessary to report upon unusual, detailed or complex technical issues subject to the approval of the governing body.

❖ This section establishes the fire code official’s authority to inspect buildings, structures or premises to ver-

ify that the requirements of the code are met or to accept written reports of inspections by an approved agency. The code does not, however, establish the frequency of inspections or even require that inspections be conducted, since the code does not presume to interpret or influence the adopting jurisdiction's political, social and economic priorities. Jurisdictions may establish their inspection priorities and frequencies based on a variety of factors, including the availability of inspection resources; the level of available fire suppression services; the value of premises to the community; or the potential disruption to community services or stability if a fire occurs. In summary, each community determines and assumes its own acceptable risk level.

In order to expand the available resources for inspection purposes, the fire code official is also authorized to approve a third-party agency that is regularly engaged in conducting relevant tests or furnishing inspection services. Approval of such an agency may be acquired through review of the résumés and references of the agency and its personnel, and analyzing the capacity and capability of the agency to perform the work. Additional guidance can be obtained by reviewing the provisions of Sections 1703 and 1704 of the IBC.

When unusual, extraordinary or complex technical issues arise relative to building safety, the fire code official has the authority to seek the opinion and advice of experts. Since this usually involves the expenditure of funds, the approval of the jurisdiction's chief administrative authority must be obtained.

**[A] 106.2.1 Inspection requests.** It shall be the duty of the holder of the permit or their duly authorized agent to notify the *fire code official* when work is ready for inspection. It shall be the duty of the permit holder to provide access to and means for inspections of such work that are required by this code.

❖ It is the responsibility of the permit holder or other authorized person, such as the contractor performing the work, to arrange for the required inspections when completed work is ready and to allow for sufficient time for the fire code official to schedule a visit to the site to prevent work from being concealed prior to being inspected. Access to the work to be inspected must be provided, including any special means such as a ladder to gain access.

**[A] 106.2.2 Approval required.** Work shall not be done beyond the point indicated in each successive inspection without first obtaining the approval of the *fire code official*. The *fire code official*, upon notification, shall make the requested inspections and shall either indicate the portion of the construction that is satisfactory as completed, or notify the permit holder or his or her agent wherein the same fails to comply with this code. Any portions that do not comply shall be corrected, and such portion shall not be covered or concealed until authorized by the *fire code official*.

❖ This section establishes that work cannot progress beyond the point of a required inspection without the

fire code official's approval. Upon making the inspection, the fire code official must either approve the completed work or notify the permit holder or other responsible party of that which does not comply with the code. Approvals and notices of noncompliance must be in writing, as required by Section 109.3, to avoid any misunderstanding as to what is required. Any item not approved cannot be covered or concealed until it has been corrected and approved by the fire code official.

**[A] 106.3 Concealed work.** It shall be the duty of the permit applicant to cause the work to remain accessible and exposed for inspection purposes. Where any installation subject to inspection prior to use is covered or concealed without having first been inspected, the *fire code official* shall have the authority to require that such work be exposed for inspection. Neither the *fire code official* nor the jurisdiction shall be liable for expense entailed in the removal or replacement of any material required to allow inspection.

❖ This section addresses the procedure that is available to the fire code official for inspection of concealed work. In many jurisdictions, the contractor or permit holder of an operation or a construction project is to contact the local fire inspection authority when work is completed but still exposed to allow inspection. The section requires that any work to be concealed upon completion must remain exposed until an inspection is made. If the work requiring inspection is covered up before the inspection takes place, the fire code official has the authority to require removal of the concealing construction. The section also makes it clear that any expense incurred in removing or replacing material that conceals an item to be inspected is not the responsibility of either the fire code official or the jurisdiction. Obviously, this can be a time-consuming and expensive procedure that can be eliminated by good communication and cooperation between the contractor or permit holder and the fire code official.

**[A] 106.4 Approvals.** Approval as the result of an inspection shall not be construed to be an approval of a violation of the provisions of this code or of other ordinances of the jurisdiction. Inspections presuming to give authority to violate or cancel provisions of this code or of other ordinances of the jurisdiction shall not be valid.

❖ As with the issuance of permits (see commentary, Section 105.3), approval as a result of an inspection is not a license to violate the code. Further, approval in violation of the code does not relieve the applicant from complying with the code and is not valid. This is significant because even if there are errors or oversights in the approval process, the permit applicant or other recipient of the inspection, not the fire code official, is still responsible for code compliance.

## SECTION 107 MAINTENANCE

**[A] 107.1 Maintenance of safeguards.** Where any device, equipment, system, condition, arrangement, level of protection, or any other feature is required for compliance with the provisions of this code, or otherwise installed, such device, equipment, system, condition, arrangement, level of protection, or other feature shall thereafter be continuously maintained in accordance with this code and applicable referenced standards.

❖ This section does not identify who is responsible for maintenance because that determination should be made in accordance with the legal documents created between owners and occupants, such as a lease. The owner of a structure or premises, however, is usually primarily responsible for its maintenance, since the owner stands to gain the most from a well-maintained property. One of the underlying assumptions is that maintaining a commercial property in good condition allows the owner to recoup a substantial portion of his or her investment in maintenance. There are three factors that may influence owners to comply with code requirements:

- Code compliance requires only a small additional investment in the property.
- The owner has a long-term interest in the property.
- The owner expects profitability after incurring the additional expense of complying with the code.

While all these factors represent economic incentives, fire code officials should be equally aware of potential disincentives to compliance, such as assessable value, expiring tax credits or historic, architectural or aesthetic criteria. The fire code official need not belabor the justifications for compliance, but should be prepared to acknowledge the owner's rationalizations for failure to comply.

This section also emphasizes that any "otherwise installed" system that currently exists must be maintained. For example, an existing fire protection system cannot be removed from a building just because it is not required in new or existing buildings by current codes.

**[A] 107.2 Testing and operation.** Equipment requiring periodic testing or operation to ensure maintenance shall be tested or operated as specified in this code.

❖ This section addresses periodic testing or operation to verify that the equipment can be expected to operate when needed. For example, see Section 901.6 for inspection and testing requirements for fire protection systems.

Test and inspection records must be available to the fire code official for verification that the tests and inspections required by the code and the referenced standards are in compliance.

If the fire code official requests, such records must be filed with the jurisdictional office.

**[A] 107.2.1 Reinspection and testing.** Where any work or installation does not pass an initial test or inspection, the necessary corrections shall be made so as to achieve compliance with this code. The work or installation shall then be resubmitted to the *fire code official* for inspection and testing.

❖ This section simply requires an installation to be of such quality that it will pass any tests or inspections required by the code. For example, if a fire alarm system did not pass the installation test upon completion of the system, the system is to be reworked until it passes the test.

**[A] 107.3 Recordkeeping.** A record of periodic inspections, tests, servicing and other operations and maintenance shall be maintained on the premises or other *approved* location for not less than 3 years, or a different period of time where specified in this code or referenced standards. Records shall be made available for inspection by the *fire code official*, and a copy of the records shall be provided to the *fire code official* upon request.

The *fire code official* is authorized to prescribe the form and format of such recordkeeping. The *fire code official* is authorized to require that certain required records be filed with the *fire code official*.

❖ Recordkeeping of testing, inspections, servicing and other operations and maintenance are critical to the successful application of this code. Proper and consistent recordkeeping will increase the safety to both building occupants and fire fighters. This section also makes it clear that records must be provided to the fire code official upon request and maintained for a period of not less than 3 years unless a different time interval is specified in the code or a referenced standard. Also, the fire code official is authorized to prescribe the form and format of such records. The recordkeeping requirements throughout the code have been specifically coordinated with this section.

**[A] 107.4 Supervision.** Maintenance and testing shall be under the supervision of a responsible person who shall ensure that such maintenance and testing are conducted at specified intervals in accordance with this code.

❖ Maintenance supervision is needed to verify that testing and general supervision is done regularly. Section 901.6 states code requirements regarding testing and maintenance of the fire protection systems.

**107.5 Rendering equipment inoperable.** Portable or fixed fire-extinguishing systems or devices, and fire-warning systems, shall not be rendered inoperative or inaccessible, except as necessary during emergencies, maintenance, repairs, *alterations*, drills or prescribed testing.

❖ If fire protection systems are going to be effective when needed, they must be in good operating condition. This section specifies those circumstances when they are allowed to be temporarily out of service. See Section 901.6 for code requirements regarding testing and maintenance of the fire protection systems.

**[A] 107.6 Overcrowding.** Overcrowding or admittance of any person beyond the *approved* capacity of a building or a

portion thereof shall not be allowed. The *fire code official*, upon finding any overcrowding conditions or obstructions in *aisles*, passageways or other *means of egress*, or upon finding any condition that constitutes a life safety hazard, shall be authorized to cause the event to be stopped until such condition or obstruction is corrected.

❖ The key to enforcing this provision successfully is good judgment. Rarely is it possible to count accurately the number of people in any given place of public assembly. Usually, the proprietors or operators of such events have no accurate estimate of the crowd size or they are unwilling to provide an estimate. Despite these difficulties, when the number of people is too large to permit aisles and required egress elements to remain clear or at least flow smoothly, remedies must be sought. In many instances, overcrowding can be remedied by simply preventing any more occupants from entering, thus limiting the potential hazard to those occupants already inside. If the fire code official determines that preventing further access will be insufficient in itself, he or she is authorized to order the owner or operator to stop the event until the hazardous condition is abated, the approved occupant load is reestablished and resumption of the event is authorized by the fire code official.

## SECTION 108 BOARD OF APPEALS

**[A] 108.1 Board of appeals established.** In order to hear and decide appeals of orders, decisions or determinations made by the *fire code official* relative to the application and interpretation of this code, there shall be and is hereby created a board of appeals. The board of appeals shall be appointed by the governing body and shall hold office at its pleasure. The *fire code official* shall be an ex officio member of said board but shall not have a vote on any matter before the board. The board shall adopt rules of procedure for conducting its business, and shall render all decisions and findings in writing to the appellant with a duplicate copy to the *fire code official*.

❖ This section provides an objective forum for settling disputes regarding the application or interpretation of the code requirements. The board is required to issue a written decision to the appellant who brought the matter before the board and to the fire code official. Note that the fire code official is a nonvoting member of the board. The board of appeals is an effective decision-making body that is commonly used when the owner or owner's agent and the fire code official do not agree on a matter relating to the application of the code.

**[A] 108.2 Limitations on authority.** An application for appeal shall be based on a claim that the intent of this code or the rules legally adopted hereunder have been incorrectly interpreted, the provisions of this code do not fully apply, or an equivalent method of protection or safety is proposed. The

board shall not have authority to waive requirements of this code.

❖ This section states the scope of the issues that are to be addressed by the board of appeals and limits its authority to ruling on these issues. Commonly, the issues relate to the applicability of the code or the interpretation of the code to a given situation. The board listens to both the person who filed the appeal and to the fire code official before ruling on the matter.

This section specifically states that the board does not have the authority to waive code requirements; however, the board has the authority to accept an alternative method of protection or safety if, in its view, it is equivalent to the specific requirement in the code.

**[A] 108.3 Qualifications.** The board of appeals shall consist of members who are qualified by experience and training to pass on matters pertaining to hazards of fire, explosions, hazardous conditions or *fire protection systems*, and are not employees of the jurisdiction.

❖ It is important that the decisions of the board of appeals are based purely on the technical merits involved in an appeal; it is not the place for policy or political deliberations. The members of the board of appeals are, therefore, expected to have experience in matters within the scope of the code and must be of the highest character, competence and status in their professions and the community at large. Appendix A of the code provides more detailed qualifications for board of appeals members and can be adopted by jurisdictions desiring that level of expertise (see commentary, Appendix A).

## SECTION 109 VIOLATIONS

**[A] 109.1 Unlawful acts.** It shall be unlawful for a person, firm or corporation to erect, construct, alter, repair, remove, demolish or utilize a building, occupancy, premises or system regulated by this code, or cause same to be done, in conflict with or in violation of any of the provisions of this code.

❖ Section 109 establishes that compliance with the code is required, and what measures are to be taken for noncompliance.

**[A] 109.2 Owner/occupant responsibility.** Correction and abatement of violations of this code shall be the responsibility of the *owner* or the owner's authorized agent. Where an occupant creates, or allows to be created, hazardous conditions in violation of this code, the occupant shall be held responsible for the abatement of such hazardous conditions.

❖ Hazards related to use and occupancy, and not those related to fixed equipment or installations, fall within the scope of the occupants' responsibility. Owners or the owner's authorized agent, however, may become liable if they allow the unlawful operation or continua-

tion of a public nuisance on a property under their control, especially if they knowingly or willfully lease the property in violation of fire, zoning or building regulations.

The simple rule for determining what is the responsibility of the owner or owner's authorized agents, and what is the occupants' responsibility is whether the issue involves fixed equipment installations or if the structure is separate from those items related to occupancy. The owner or owner's authorized agent is usually responsible for the physical maintenance of the building or structure and its utilities and appurtenances (that is, building services and systems).

**[A] 109.3 Notice of violation.** Where the *fire code official* finds a building, premises, vehicle, storage facility or outdoor area that is in violation of this code, the *fire code official* is authorized to prepare a written notice of violation describing the conditions deemed unsafe and, where compliance is not immediate, specifying a time for reinspection.

❖ The fire code official has a duty to supply owners, agents or occupants with a written notice of code violations on the premises under their control. When possible, both the owner and the occupants should be made aware of hazardous conditions. Such notices constitute the first of several steps in the due process procedure. Violation notices must clearly indicate the defect and its location (including citation of the code section being violated), what must be done to correct the violation and the date of the reinspection. Owners, agents or occupants should also be supplied with information regarding penalties, permit applications and appeal procedures. The notice or order must be signed by the fire code official who issued it and he or she should provide a space for the owner, agent or occupants' signature to acknowledge receipt of the document. If possible, duplicate or triplicate copies should be prepared, with the original notice issued to the responsible party. Other copies should be maintained by the inspector and the departmental record keeper.

**[A] 109.3.1 Service.** A notice of violation issued pursuant to this code shall be served upon the *owner*, the owner's authorized agent, operator, occupant or other person responsible for the condition or violation, either by personal service, mail or by delivering the same to, and leaving it with, some person of responsibility upon the premises. For unattended or abandoned locations, a copy of such notice of violation shall be posted on the premises in a conspicuous place at or near the entrance to such premises and the notice of violation shall be mailed by certified mail with return receipt requested or a certificate of mailing, to the last known address of the *owner*, the owner's authorized agent, or occupant.

❖ Service methods are listed by order or preference. The first and best method is to personally serve the owners, owner's authorized agent or the occupant, in that order, at the premises cited, with a signature acknowledging receipt. The next-most desirable method is service to these same parties in the order

indicated at their place of business when it is not the premises cited.

While post office delivery by ordinary first-class mail is acceptable, most jurisdictions prefer certified mail with return receipt, followed by a certificate of mailing; however, owners or owner's authorized agents familiar with the legal process will often refuse to accept certified mail. As a result, many jurisdictions follow up returned certified mail with a request for a certificate of mailing. A certificate of mailing includes certification by the mail carrier or post office that the item was physically delivered to the address indicated, but does not verify that the addressee actually took possession of the item. The least-desirable method of service is physically posting the premises with the violation notice. When service proves difficult, many jurisdictions pursue the mailing and posting service options simultaneously to exhaust all service methods. Jurisdictions should consult legal counsel about case law regarding legal service in their communities. The following methods are most common:

- Personal to violator.
- Personal to party at premises.
- Certified mail with return receipt.
- First-class mail with certificate of mailing.
- Posting at the premises.

**[A] 109.3.2 Compliance with orders and notices.** A notice of violation issued or served as provided by this code shall be complied with by the *owner*, the owner's authorized agent, operator, occupant or other person responsible for the condition or violation to which the notice of violation pertains.

❖ The party responsible for the condition that is in non-compliance is required by this section to bring the property into code compliance. See the remainder of Section 109 for what is to be done if this does not occur.

**[A] 109.3.3 Prosecution of violations.** If the notice of violation is not complied with promptly, the *fire code official* is authorized to request the legal counsel of the jurisdiction to institute the appropriate legal proceedings at law or in equity to restrain, correct or abate such violation or to require removal or termination of the unlawful occupancy of the structure in violation of the provisions of this code or of the order or direction made pursuant hereto.

❖ The duty to pursue legal remedies through judicial due process is established by this section. Local prosecutors and fire code officials should establish policies covering the following issues regarding judicial due process proceedings:

- Length of compliance period for representative violations.
- Quality or quantity of progress toward compliance warranting an extension or representing reasonable intent to comply.

- Whether court filings should be sought during the appeal application period.
- Rules for obtaining arrest warrants for code violations.
- Rules for obtaining administrative and criminal search warrants.

The cooperation of the police department and other law enforcement agencies should be coordinated in advance. When necessary to enforce code provisions, arrangements should be made to have police or other law enforcement personnel make arrests for code violations or ignoring lawful orders of the fire code official.

**[A] 109.3.4 Unauthorized tampering.** Signs, tags or seals posted or affixed by the *fire code official* shall not be mutilated, destroyed or tampered with, or removed, without authorization from the *fire code official*.

- ❖ This section states that tampering with signs, seals or tags posted at the property is a violation of the code. The safety of occupants may depend on warning signs posted by the fire code official remaining in place.

**[A] 109.4 Violation penalties.** Persons who shall violate a provision of this code or shall fail to comply with any of the requirements thereof or who shall erect, install, alter, repair or do work in violation of the *approved construction documents* or directive of the *fire code official*, or of a permit or certificate used under provisions of this code, shall be guilty of a **[SPECIFY OFFENSE]**, punishable by a fine of not more than **[AMOUNT]** dollars or by imprisonment not exceeding **[NUMBER OF DAYS]**, or both such fine and imprisonment. Each day that a violation continues after due notice has been served shall be deemed a separate offense.

- ❖ Penalties for code violations must be established in adopting legislation. The offense, dollar amount for the fine and maximum number of days of imprisonment are to be specific in the adopting ordinance of the jurisdiction. A sample adoption ordinance is on page xxi of the code.

The code does not establish penalties for violations. The jurisdiction's judicial and legislative bodies should work with the fire code official to establish reasonable and equitable penalties for violators. The penalties set for individual violations should be representative of the severity of the act committed and the culpability of the violator. Once served with a violation notice, the violator becomes guilty of a separate offense for each day the violation continues to exist; however, most prosecutors and courts are reluctant to impose this penalty for days during the compliance period. Many violators wrongly assume that the Seventh Amendment of the U.S. Constitution, which offers protection against double jeopardy, exempts them from compliance once they have paid or served their sentence for a previous fire code violation. This is certainly not the case. Most courts reinforce the compliance requirement in such cases by making compliance a condition for completing the sentence.

Failure to comply with the judge's order mandating compliance may result in a contempt of court charge.

**[A] 109.4.1 Abatement of violation.** In addition to the imposition of the penalties herein described, the *fire code official* is authorized to institute appropriate action to prevent unlawful construction or to restrain, correct or abate a violation; or to prevent illegal occupancy of a structure or premises; or to stop an illegal act, conduct of business or occupancy of a structure on or about any premises.

- ❖ Even though the person who violated the code has paid any fine and served any sentence that may be imposed for the jurisdiction under Section 109.4, the fire code official has the right to require that the code violation be removed. If the violation is not abated, the fire code official has the right to prevent occupancy until the violation is addressed. Usually, the court will require that the violation be corrected as part of the sentence of noncompliance prior to the occupancy of the building.

## SECTION 110 UNSAFE BUILDINGS

**[A] 110.1 General.** If during the inspection of a premises, a building or structure, or any building system, in whole or in part, constitutes a clear and inimical threat to human life, safety or health, the *fire code official* shall issue such notice or orders to remove or remedy the conditions as shall be deemed necessary in accordance with this section, and shall refer the building to the building department for any repairs, *alterations*, remodeling, removing or demolition required.

- ❖ The fire code official is required to order the correction or abatement of hazardous conditions within the scope of the code and to refer the building to the building department for those operations that are within the scope of that department. The conditions listed in Section 110.1.1 represent many of the most common hazardous conditions encountered. Specific requirements supporting each of these objectives are found throughout the code.

**[A] 110.1.1 Unsafe conditions.** Structures or existing equipment that are or hereafter become unsafe or deficient because of inadequate *means of egress* or which constitute a fire hazard, or are otherwise dangerous to human life or the public welfare, or which involve illegal or improper occupancy or inadequate maintenance, shall be deemed an unsafe condition. A vacant structure that is not secured against unauthorized entry as required by Section 311 shall be deemed unsafe.

- ❖ Courts have continually upheld the right of states and their authorized subdivisions to abate public nuisances, even by demolition, and bill or assess the property owner through a tax lien for their expenses. However, care must be exercised to maintain compliance with the due process and equal protection doctrines of the Fourth and Fourteenth Amendments of the U.S. Constitution. Jurisdictions should consult legal counsel and adopt appropriate guidelines

before engaging in a nuisance abatement program.

Uninhabited or abandoned buildings that are not secured against unauthorized entry as required by Section 311 have a very high probability of intentionally set fires. When fires occur in these buildings, they present a host of unusual hazards to fire fighters. Since the buildings are uninhabited, fires may develop for significant periods of time before they are detected and reported. Accordingly, such unsecured buildings are declared by this section to be unsafe and therefore subject to remediation as provided in Section 110 (see commentary, Section 311).

**[A] 110.1.2 Structural hazards.** Where an apparent structural hazard is caused by the faulty installation, operation or malfunction of any of the items or devices governed by this code, the *fire code official* shall immediately notify the building code official in accordance with Section 110.1.

❖ The fire code official is required to report structurally unsafe buildings to the building official to secure abatement of unsafe conditions. Courts have continually upheld the right of states and their authorized subdivisions to abate public nuisances, even by demolition, and bill or assess the property owner through a tax lien for their expenses. However, care must be exercised to maintain compliance with the due process and equal protection doctrines of the Fourth and Fourteenth Amendments of the U.S. Constitution.

**[A] 110.2 Evacuation.** The *fire code official* or the fire department official in charge of an incident shall be authorized to order the immediate evacuation of any occupied building deemed unsafe where such building has hazardous conditions that present imminent danger to building occupants. Persons so notified shall immediately leave the structure or premises and shall not enter or re-enter until authorized to do so by the *fire code official* or the fire department official in charge of the incident.

❖ The fire code official must immediately order the evacuation of any premises posing a clear and imminent threat to life or property. Building occupants who are warned must comply with the evacuation order without delay. Upon leaving the building, occupants may not reenter until authorization is given by the fire code official. Severe and immediate danger anticipated in this section dictates such extreme measures to protect public health, safety and welfare.

**[A] 110.3 Summary abatement.** Where conditions exist that are deemed hazardous to life and property, the *fire code official* or fire department official in charge of the incident is authorized to abate summarily such hazardous conditions that are in violation of this code.

❖ As indicated in the commentary to Section 110.1.1, the fire code official is authorized to seek abatement action by the building department and bill the owner for abatement costs. Obviously, this is an extreme measure and should be done only when the owner, operator or occupant does not take such measures under the requirements of Section 110.4.

**[A] 110.4 Abatement.** The *owner*, the owner's authorized agent, operator or occupant of a building or premises deemed unsafe by the *fire code official* shall abate or cause to be abated or corrected such unsafe conditions either by repair, rehabilitation, demolition or other *approved* corrective action.

❖ This section describes the usual circumstance in which a building has such critical violations that it is declared unsafe by the fire code official. The owner, owner's authorized agent, operator or occupant should take abatement measures to correct the unsafe condition. If this is not done promptly, the fire code official has the authority to directly abate the unsafe conditions and bill the owner for the abatement work in accordance with Sections 110.1.1 and 110.3.

## SECTION 111 STOP WORK ORDER

**[A] 111.1 Order.** Where the *fire code official* finds any work regulated by this code being performed in a manner contrary to the provisions of this code, or in a dangerous or unsafe manner, the *fire code official* is authorized to issue a stop work order.

❖ The fire code official is authorized to issue a stop work order when the work does not comply with the code. Obviously, this is an extreme and costly measure that should be reserved for situations in which the violation is a serious safety hazard.

**[A] 111.2 Issuance.** A stop work order shall be in writing and shall be given to the *owner* of the property, or to the *owner's* authorized agent, or to the person doing the work. Upon issuance of a stop work order, the cited work shall immediately cease. The stop work order shall state the reason for the order, and the conditions under which the cited work is authorized to resume.

❖ The stop work order is to be in writing and must cite the reason for issuing the order.

Upon receipt of a violation notice from the fire code official, all construction activities identified in the notice must immediately cease, except as expressly permitted to correct the violation.

Construction activities that are outside of the scope of the issue involved with the stop work order are not affected and need not stop; thus, the scope of the order must be clearly stated.

**[A] 111.3 Emergencies.** Where an emergency exists, the *fire code official* shall not be required to give a written notice prior to stopping the work.

❖ This section gives the fire code official the authority to stop the work in dispute immediately when, in his or her opinion, there is an unsafe emergency condition that has been created by the work. The need for the written notice is suspended for this situation so that the work can be stopped immediately. After the work is stopped, immediate measures should be taken to correct the work at issue.

[A] **111.4 Failure to comply.** Any person who shall continue any work after having been served with a stop work order, except such work as that person is directed to perform to remove a violation or unsafe condition, shall be liable to a fine of not less than [AMOUNT] dollars or more than [AMOUNT] dollars.

- ❖ The local jurisdiction is to designate the fine that is to apply to any person who continues work that is at issue, other than abatement work. The dollar amounts for the minimum and maximum fines are to be specified in the adopting ordinance. A sample adoption ordinance is on page xxi of the code.

## SECTION 112 SERVICE UTILITIES

[A] **112.1 Authority to disconnect service utilities.** The *fire code official* shall have the authority to authorize disconnection of utility service to the building, structure or system in order to safely execute emergency operations or to eliminate an immediate hazard. The *fire code official* shall notify the serving utility and, where possible, the *owner* or the owner's authorized agent and the occupant of the building, structure or service system of the decision to disconnect prior to taking such action. If not notified prior to disconnection, then the *owner*, the owner's authorized agent or occupant of the building, structure or service system shall be notified in writing as soon as practical thereafter.

- ❖ This section authorizes the fire code official to order the disconnection of building utilities that interfere with emergency operations or contribute to a public safety hazard. This section also provides that such an action must be preceded by written notice to the utility and the owner or owner's authorized agent and occupants of the building. When the hazard to the public health, safety or welfare is so imminent as to mandate immediate disconnection, this section makes it clear that the fire code official has the authority and even the obligation to cause disconnection without notice.

## SECTION 113 FEES

[A] **113.1 Fees.** A permit shall not be issued until the fees have been paid, nor shall an amendment to a permit be released until the additional fee, if any, has been paid.

- ❖ The code anticipates that jurisdictions will establish their own fee schedules. It is the intent that the fees collected by the department for permit issuance, plan review and inspection be adequate to cover the costs to the department in these areas. If the department has additional duties, then its budget will need to be supplemented from the general fund. This section requires that all fees be paid prior to permit issuance or release of an amendment to a permit. Since department operations are intended to be supported by fees paid by the user of department activities, it is

important that these fees are received before incurring any expense. This philosophy has resulted in some departments having fees paid prior to the performance of two areas of work: plan review and inspection.

[A] **113.2 Schedule of permit fees.** A fee for each permit shall be paid as required, in accordance with the schedule as established by the applicable governing authority.

- ❖ The jurisdiction is responsible for promulgating a schedule of fees to be charged for operational or construction permits. Permit fees should be established by law, such as in an ordinance adopting the code, a separate ordinance or a legally promulgated regulation, as required by state or local law. Fee schedules for operational permits should be based on an analysis of the amount of time and resources to be expended by the jurisdiction in administering the permit. Fee schedules for construction permits are often based on a valuation of the work to be performed. This concept is based on the proposition that the valuation of a project is related to the amount of work to be expended in plan review, inspections and administering the permit, plus an excess to cover the department overhead.

[A] **113.3 Work commencing before permit issuance.** A person who commences any work, activity or operation regulated by this code before obtaining the necessary permits shall be subject to an additional fee established by the applicable governing authority, which shall be in addition to the required permit fees.

- ❖ The fire code official will incur certain costs (i.e., inspection time and administrative) when investigating and citing a person who has commenced work, activity or operation without having obtained a permit. The fire code official is, therefore, entitled to recover these costs by establishing a fee, in addition to that collected when the required permit is issued, to be imposed on the responsible party. Note that this is not a penalty, as described in Section 109.4, for which the person can also be liable.

[A] **113.4 Related fees.** The payment of the fee for the construction, *alteration*, removal or demolition of work done in connection to or concurrently with the work or activity authorized by a permit shall not relieve the applicant or holder of the permit from the payment of other fees that are prescribed by law.

- ❖ The fees for a permit may be in addition to other fees required by the jurisdiction or others for related items, such as sewer connections, water service taps, driveways and signs and others. It cannot be construed that the fire code permit fee includes these other items.

[A] **113.5 Refunds.** The applicable governing authority is authorized to establish a refund policy.

- ❖ This section allows for a refund of fees, which may be full or partial, typically resulting from the revocation, abandonment or discontinuance of a project or oper-

## SCOPE AND ADMINISTRATION

ation for which a permit has been issued and fees have been collected. The refund of fees should be related to the cost of enforcement services not provided because of the termination of the project or operation. The fire code official, when authorizing a fee refund, is authorizing the disbursement of public funds; therefore, the request for a refund should be in writing and for good cause.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

*2009 International Code Interpretations*. Washington, DC: International Code Council, 2009.

*Complete Revision History to the 2015 I-Codes*. Washington, DC: International Code Council, 2014.

NFPA 550—07, *Fire Safety Concepts Tree*. Quincy, MA: National Fire Protection Association, 2007.

Robertson, J. C. and W.E. Koffel, Jr. *Fire Prevention Organization and Management. Course Guide*. Emmitsburg, MD: Executive Office of the President, U.S. Federal Emergency Management Agency, U.S. Fire Administration, National Fire Academy and Open Learning Fire Service Program, 1990.

Rosenbauer, D. L. *Introduction to Fire Protection Law*. Quincy, MA: National Fire Protection Association, 1978.

# Chapter 2: Definitions

## General Comments

All terms used in the code and their definitions are listed alphabetically in Chapter 2. While a defined term may be used in one chapter or another, the meaning provided in Chapter 2 is applicable throughout the code.

Where understanding of a term's definition is especially key to or necessary for understanding of a particular code provision, the term is shown in italics wherever it appears in the code. This is true only for those terms that have a meaning that is unique to the code. In other words, the generally understood meaning of a term or phrase might not be sufficient or consistent with the meaning prescribed by the code; therefore, it is essential that the code-defined meaning be known.

Guidance regarding tense, gender and plurality of defined terms as well as terms not defined in the code is also provided.

## Purpose

Codes by their very nature are technical documents. Every word, term and punctuation mark can alter a sentence's meaning and, if misused, muddy its intent.

Further, the code, with its broad scope of applicability, includes terms that have a different meaning than the generally accepted meaning of the term. Additionally, these terms can have multiple meanings depending on the context or discipline in which they are being used.

For these reasons, maintaining a consensus on the specific meaning of terms contained in the code is essential. Chapter 2 performs this function by stating clearly what specific terms mean for the purpose of the code.

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## SECTION 201 GENERAL

**201.1 Scope.** Unless otherwise expressly stated, the following words and terms shall, for the purposes of this code, have the meanings shown in this chapter.

❖ This section contains the definitions for application of the code and the use of the words and terms is governed by the provisions of this section. This includes code-defined terms as well as those terms that are not.

**201.2 Interchangeability.** Words used in the present tense include the future; words stated in the masculine gender include the feminine and neuter; the singular number includes the plural and the plural, the singular.

❖ While the definitions are to be taken literally, gender and tense are to be considered interchangeable.

**201.3 Terms defined in other codes.** Where terms are not defined in this code and are defined in the *International Building Code*, *International Fuel Gas Code*, *International Mechanical Code* or *International Plumbing Code*, such terms shall have the meanings ascribed to them as in those codes.

❖ This section states that when a term is not defined in the code but is defined in another volume of the *International Code*<sup>®</sup> family, the meaning found in those

codes can be used. This adds consistency to the application of the codes.

**201.4 Terms not defined.** Where terms are not defined through the methods authorized by this section, such terms shall have ordinarily accepted meanings such as the context implies. *Merriam Webster's Collegiate Dictionary, 11th Edition*, shall be considered as providing ordinarily accepted meanings.

❖ Another resource for defining words or terms not defined within the code or other *International Codes*<sup>®</sup> (I-Codes<sup>®</sup>) is simply their "ordinarily accepted meaning." With some words, a dictionary definition may be sufficient, if the definition is applied within an appropriate context. Not all dictionaries, however, define words the same and not all parts of this country apply the same meanings to all words. The dictionary referenced in this section provides a standardized resource for defining terms and establishing "ordinarily accepted" meanings of words, thus reducing the likelihood of inconsistent enforcement of the code.

Some terms used throughout the code may not be defined in Chapter 2 or in a dictionary. In those cases, the user should first turn to the definitions contained in the referenced standards (see Chapter 80) and then refer to published textbooks on the subject in question.

## SECTION 202 GENERAL DEFINITIONS

**[BG] 24-HOUR BASIS.** The actual time that a person is an occupant within a facility for the purpose of receiving care. It shall not include a facility that is open for 24 hours and is capable of providing care to someone visiting the facility during any segment of the 24 hours.

❖ Care offered over a 24-hour basis is used to differentiate groups and levels of protection between institutional facilities that typically house patients for more than a day, such as hospitals, detoxification facilities, foster care and nursing homes, from other care facilities that keep patients for only part of a day, such as day cares, clinics, day surgery centers and outpatient facilities. To better understand how these concepts work together, see the definitions for “Ambulatory care facility,” “Custodial care,” “Medical care,” “Personal care service” and “Incapable of self-preservation.” Facilities that have patients/residents/customers that typically stay for 24 hours or more are considered to be providing care on a 24-hour care basis. However, a facility such as a day care or an urgent care facility, that operates 24 hours a day, would not be considered as providing care on a 24-hour basis if the clients did not stay 24 hours, but instead were in and out of the facility similar to one that closed for the night.

**[BE] ACCESSIBLE MEANS OF EGRESS.** A continuous and unobstructed way of egress travel from any *accessible* point in a building or facility to a *public way*.

❖ Accessible means of egress requirements are needed to provide those persons with physical disabilities or mobility impairments a means of egress to exit the building. Because of physical limitations, some occupants may need assistance to exit a building. See Section 1009 for requirements establishing areas where people can safely wait for assisted rescue. Chapter 4 also includes requirements in the fire safety and evacuation plans for specific planning to address occupants who may need assistance in evacuation during emergencies. In addition, Chapter 9 of the code includes requirements for emergency evacuation notification for persons with hearing and vision disabilities.

The accessible means of egress requirements may not be the same route as that required for ingress into the building [see Sections 1104 and 1105 of the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>)]. For example, a two-story building requires one accessible route to connect all accessible spaces within the building. The accessible route to the second level is typically by an elevator. During a fire emergency, persons with mobility impairments on the second level would be moving to the exit stairways for assisted rescue, not back the way they came in, via the elevator.

**[BE] ACCESSIBLE ROUTE.** A continuous, unobstructed path that complies with Chapter 11 of the *International Building Code*.

❖ There are typically more physical barriers in the built environment to people with a mobility impairment than in any other category of disability. An accessible route enables a person with a mobility impairment to approach and utilize a facility’s accessible fixtures and features. While there are a variety of mobility devices, the design and construction of an accessible route is based predominantly on provisions necessary for accessibility to a person using a wheelchair. Accessible routes are required for both ingress and egress (see Sections 1009 and 1104).

An accessible route must also be safe and usable by people with other disabilities and those without disabilities; therefore, requirements are set forth in consideration of those needs. For example, there are restrictions on objects that protrude into a circulation path in consideration not only of a person with a visual impairment but also the possibility of smoke limiting visibility during an emergency.

**AEROSOL.** A product that is dispensed from an aerosol container by a propellant.

Aerosol products shall be classified by means of the calculation of their chemical heats of combustion and shall be designated Level 1, Level 2 or Level 3.

**Level 1 aerosol products.** Those with a total chemical heat of combustion that is less than or equal to 8,600 British thermal units per pound (Btu/lb) (20 kJ/g).

**Level 2 aerosol products.** Those with a total chemical heat of combustion that is greater than 8,600 Btu/lb (20 kJ/g), but less than or equal to 13,000 Btu/lb (30 kJ/g).

**Level 3 aerosol products.** Those with a total chemical heat of combustion that is greater than 13,000 Btu/lb (30 kJ/g).

❖ The intent of the code is to regulate those aerosols that contain a flammable propellant, such as butane, isobutane or propane and cannot be protected easily. An aerosol product such as whipped cream is a water-based material with a nonflammable propellant (nitrous oxide) and would, therefore, not be regulated as a hazardous material. Many aerosols are water based and, while containing some flammable material, do not produce a threat to standard commodity protection scenarios. The contents of the aerosol container may be dispensed in the form of a mist, spray, foam, gel or aerated powder.

Because of the wide range of flammability of aerosol products, a classification system was established to determine the required level of fire protection. Categories are defined according to the aerosol’s chemical heat of combustion expressed in Btus per pound (Btu/lb). Aerosol category classifications of Levels 1,

2 and 3 are used to avoid confusion with flammable liquid classifications.

Examples of Level 1 aerosol products are air fresheners, shaving gel and whipped cream. Level 1 aerosols are not regulated as a hazardous material and are essentially exempt from the requirements of Sections 307 and 414 of the IBC. Examples of Level 2 aerosols include some hair sprays and insect repellents. Level 3 aerosols include carburetor cleaner and other petroleum-based aerosols.

While aerosols are defined as hazardous materials, note that they are not listed in Table 5003.1.1(1) or 5003.1.1(2) [IBC Table 307.1(1) or 307.1(2)] as having a maximum allowable quantity per control area. As stated in Section 307.1, Exception 11 of the IBC, a building or structure used for aerosol storage is classified as Group S-1, provided the requirements of Chapter 51 of the code are satisfied; therefore, the Group H classification is not utilized since the design must satisfy Chapter 51 of the code in order to be in compliance.

It is important to note that, in dealing with aerosols, the designation of “flammable” on an aerosol can is strictly a consumer warning labeling and must not be confused with the aerosol level printed on the carton. This is important because there are instances where a Level 3 aerosol product requiring the highest level of sprinkler protection will not be flammable for consumer use, and conversely there are instances where a flammable aerosol may be a Level 1 aerosol product and could require only Class III commodity protection in accordance with NFPA 13.

**AEROSOL CONTAINER.** A metal can, or a glass or plastic bottle designed to dispense an aerosol.

- ❖ All design criteria for the aerosol container, including the maximum size and minimum strength, are set by the U.S. Department of Transportation (DOTn 49 CFR) and addressed in Section 5104. These container regulations are necessary for the safe transportation of aerosol products.

**AEROSOL WAREHOUSE.** A building used for warehousing aerosol products.

- ❖ Any building used primarily for storing large quantities of aerosol products would be considered an aerosol warehouse and would be subject to fire safety requirements that are consistent with the types of aerosol products stored and their known hazards. Commodities other than aerosol products are allowed to be stored in an aerosol warehouse in accordance with Chapter 51 (see Section 5104.4).

**AGENCY.** Any emergency responder department within the jurisdiction that utilizes radio frequencies for communication. This could include, but not be limited to, various public safety agencies such as fire departments, emergency medical services and law enforcement.

- ❖ This definition provides clarification as to the primary emergency responders that are intended to be included in the term, but does not rule out other

responders who might also need the use of the emergency responders radio coverage system (ERRCS), based on the needs and policies of the adopting jurisdiction.

**AGENT.** A person who shall have charge, care or control of any structure as *owner*, or agent of the *owner*, or as executor, executrix, administrator, administratrix, trustee or guardian of the estate of the *owner*. Any such person representing the actual *owner* shall be bound to comply with the provisions of this code to the same extent as if that person was the *owner*.

- ❖ An agent, for purposes of the code, is a person who has full authority under the law to act for or represent the owner of a building subject to the provisions of the code. An agent acts by the authority of the person he or she represents and generally has the same powers as the person represented. It is commonplace for building owners to retain the services of management agents to conduct all affairs pertinent to their building, including code compliance.

**[BG] AGRICULTURAL BUILDING.** A structure designed and constructed to house farm implements, hay, grain, poultry, livestock or other horticultural products. This structure shall not be a place of human habitation or a place of employment where agricultural products are processed, treated or packaged, nor shall it be a place used by the public.

- ❖ This definition is needed for the proper application of the utility and miscellaneous occupancy group provisions. The use of the building is quite restricted such that buildings that include habitable or public spaces are not agricultural buildings by definition.

**AGRO-INDUSTRIAL.** A facility, or portion thereof, housing operations involving the transforming of raw agricultural products into intermediate or consumable products.

- ❖ This definition coordinates with the requirements in Chapter 28 that have been scoped to address facilities addressing the creation of these products. Providing this definition helps to understand what types of facilities are regulated by Sections 2808 and 2809.

**[BG] AIR-INFLATED STRUCTURE.** A structure that uses air-pressurized membrane beams, arches or other elements to enclose space. Occupants of such a structure do not occupy the pressurized areas used to support the structure.

- ❖ This type of membrane structure is characterized by multiple layers arranged such that air-pressurized membrane beams, arches or similar elements are formed. These elements are pressurized with air and form the membrane structure. Note that the occupants of the structure are not subjected to the pressurized areas, because the pressurization is in the structural elements, not within the space used by the occupants. This type of structure is generally much smaller than an air-supported structure and differs in that it depends for support on the inflation of balloon-like sections over, under or around the occupants. The occupants normally are found within a surrounding structure consisting of these inflated sections. Possibly the most common example of this kind of

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structure is the “Moonwalk” children’s entertainment structure, which has an inflated floor structure for children to play on and also inflated columns that support an overhead canopy and plastic mesh walls. Commentary Figure 202-A1 illustrates an air-inflated structure.

**[BG] AIR-SUPPORTED STRUCTURE.** A structure wherein the shape of the structure is attained by air pressure, and occupants of the structure are within the elevated pressure area. Air supported structures are of two basic types:

❖ An air-supported structure identifies those membrane structures that are completely pressurized for the purposes of supporting the membrane covering. Most “domed” sports arenas use air pressure within the structure to support the membrane covering. The membrane covering can consist of one layer or multi-

ple layers; thus, air-supported structures are classified as either “single skin” or “double skin.” Commentary Figure 202-A2 illustrates an air-supported structure.

**Double skin.** Similar to a single skin, but with an attached liner that is separated from the outer skin and provides an airspace which serves for insulation, acoustic, aesthetic or similar purposes.

❖ A double-skin, air-supported structure contains multiple layers of membrane sheathing. The membranes are usually separated by enough distance to allow for pressurized air or other materials to be inserted between the plies. The pressurized air or other materials usually serve to increase the insulating and acoustical properties.



**Figure 202-A1**  
**EXAMPLE OF AIR-INFLATED MEMBRANE STRUCTURE**



**Figure 202-A2**  
**AIR-SUPPORTED MEMBRANE STRUCTURE—SWIMMING POOL COVER**

**Single skin.** Where there is only the single outer skin and the air pressure is directly against that skin.

- ❖ A single-skin, air-supported structure consists of just one membrane covering that is directly supported by the interior pressurized air. No other membranes are provided for insulating or acoustical purposes. If the membrane covering consists of several laminated plies, such an arrangement is still considered a single-skin, air-supported structure.

**AIRCRAFT MOTOR-VEHICLE FUEL-DISPENSING FACILITY.** That portion of property where flammable or *combustible liquids* or gases used as motor fuels are stored and dispensed from fixed automotive-type equipment into the fuel tanks of aircraft.

- ❖ Since the first edition of the code, Sections 2003.5 and 2006.1 have required that aircraft motor-vehicle fuel-dispensing facilities comply with Chapter 23. This definition, in addition to the scope statement in Section 2301.1, provides correlation with Chapter 20, making it clear that Chapter 23 does, in fact, apply to aircraft motor-vehicle fuel-dispensing facilities. While the text does not specify limitations on the types of aircraft involved, the typical aircraft that might be brought to a fixed fueling station that uses equipment similar to that used at automotive service stations, rather than fueling from hydrants or fuel tanker trucks that are used on larger aircraft, would likely be small general aviation-type aircraft.

**AIRCRAFT OPERATION AREA (AOA).** Any area used or intended for use for the parking, taxiing, takeoff, landing or other ground-based aircraft activity.

- ❖ Any area involving aircraft, whether moving or stationary, is known as the aircraft operating area. This area has special operating procedures and hazards.

**AIRPORT.** An area of land or structural surface that is used, or intended for use, for the landing and taking off of aircraft with an overall length greater than 39 feet (11 887 mm) and an overall exterior fuselage width greater than 6.6 feet (2012 mm), and any appurtenant areas that are used or intended for use for airport buildings and other airport facilities.

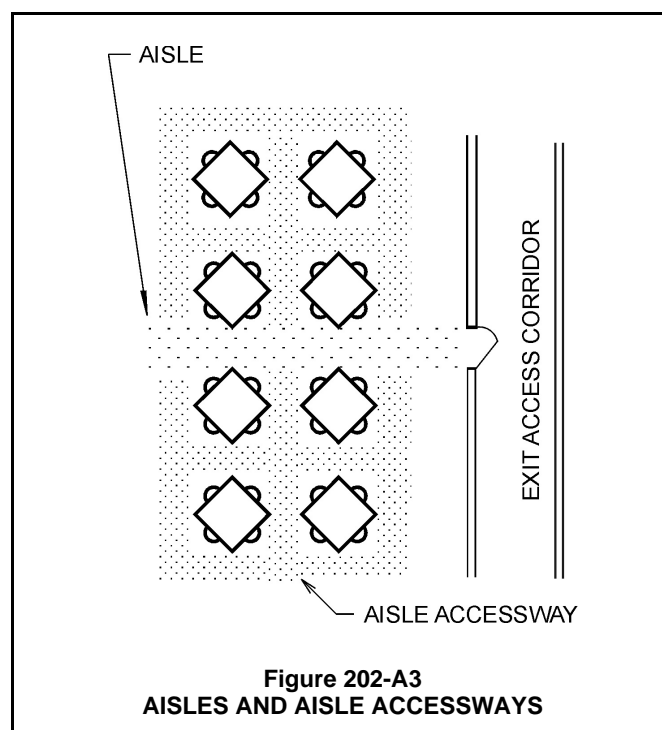
- ❖ Those structures and operations included in an airport are terminal buildings; maintenance hangars; runways; taxiways; loading and unloading of passengers, luggage and freight; and control towers with all the land involved in performing these functions.

**[BE] AISLE.** An unenclosed *exit access* component that defines and provides a path of egress travel.

- ❖ Aisles and aisle accessways are both utilized as part of the means of egress in facilities where tables, seats, displays or other furniture may limit the path of travel. The aisle accessways lead to the main aisles that lead to the exits from the space and building (see Commentary Figure 202-A3). While both may result in a confined path of travel, an aisle is an unenclosed component, while a corridor would be an enclosed component of the means of egress. See Sections 1018 and 1029 for requirements for aisles.

**[BE] AISLE ACCESSWAY.** That portion of an *exit access* that leads to an *aisle*.

- ❖ As illustrated in Commentary Figure 202-A3, an aisle accessway is intended for one-way travel or limited two-way travel. The space between tables, seats, displays or other furniture (i.e., aisle accessway) utilized for means of egress will lead to a main aisle. See Sections 1018 and 1029 for requirements for aisle accessways.



**Figure 202-A3  
AISLES AND AISLE ACCESSWAYS**

**ALARM, NUISANCE.** See “Nuisance alarm.”

**ALARM DEVICE, MULTIPLE STATION.** See “Multiple-station alarm device.”

**ALARM NOTIFICATION APPLIANCE.** A fire alarm system component such as a bell, horn, speaker, light or text display that provides audible, tactile or visible outputs, or any combination thereof. See also “Audible alarm notification appliance” or “Visible alarm notification appliance.”

- ❖ The code requires that fire alarm systems be equipped with approved alarm notification appliances so that in an emergency, the fire alarm system will notify the occupants of the need for evacuation or implementation of the fire emergency plan. Alarm notification devices required by the code are of two general types: visible and audible. Except for emergency voice/alarm communication systems, once the fire alarm system has been activated, all visible and audible communication alarms are required to activate. Emergency voice/alarm communication systems are special signaling systems that are activated selectively in response to specific emergency conditions but have the capability to be activated throughout the building if necessary.

## DEFINITIONS

**ALARM SIGNAL.** A signal indicating an emergency requiring immediate action, such as a signal indicative of fire.

❖ This is a general term for all types of supervisory and trouble signals. An example would be a supervisory (tamper) switch on a sprinkler control valve. It could also be the response to a specific device that is not part of the alarm notification system but causes a specific function, such as a smoke detector for elevator recall. The activation of the device does not necessarily indicate that there is a fire; however, the level of protection may have been compromised (see also the definitions of “Fire alarm signal” and “Supervisory signal”).

**ALARM VERIFICATION FEATURE.** A feature of automatic fire detection and alarm systems to reduce unwanted alarms wherein smoke detectors report alarm conditions for a minimum period of time, or confirm alarm conditions within a given time period, after being automatically reset, in order to be accepted as a valid alarm-initiation signal.

❖ False fire (evacuation) alarms are a nuisance. For this reason the code specifies that alarms activated by smoke detectors are not to be sounded until the alarm signal is verified by cross-zoned detectors in a single protected area or by system features that will retard the alarm until the signal is determined to be valid. Valid alarm initiation signals can be determined by detectors that report alarm conditions for a minimum period of time or that, after being reset, continue to report an alarm condition. The alarm verification feature may not retard signal activation for a period of more than 60 seconds and must not apply to alarm-initiating devices other than smoke detectors (which may be connected to the same circuit). Alarm verification is not the same as presignal features that delay an alarm signal for more than 1 minute and that are allowed only where specifically permitted by the authority having jurisdiction.

**ALCOHOL-BASED HAND RUB.** An alcohol-containing preparation designed for application to the hands for reducing the number of viable microorganisms on the hands and containing ethanol or isopropanol in an amount not exceeding 95-percent by volume.

❖ Alcohol-based hand rub solutions are typically packaged in pump bottles or nonrefillable soft bladders for insertion into a wall-mounted pump dispenser. They are typically closed to the atmosphere with no mixing or refilling of containers, which makes the ignition of fugitive vapors very unlikely. See the commentary to Sections 5705.5 and 5705.5.1 for further information.

As part of ongoing research to control the outbreak of multiple-drug resistant bacteria, such as methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant *Enterococcus* (VRE) and similar “super bugs,” which are highly resistant to antibiotics, the U.S. Centers for Disease Control (CDC) and Food and Drug Administration (FDA) have continued to study the performance of alcohol-based hand rubs. As a result of their research, both agencies now rec-

ommend that the concentration of ethanol or isopropanol in alcohol-based hand rubs be increased to 95 percent by volume. The research found that a higher alcohol concentration offers much more virucidal activity when compared to alcohol-based hand rubs formulated with 70-percent alcohol by volume. To help protect health care workers, hospital patients and long-term care residents against health care-acquired infections, the definition of 11 alcohol-based hand rubs has been revised in the 2012 edition of the code to increase the permissible volume of ethyl or isopropyl alcohol from 70 to 95 percent. It should be noted that alcohol-based hand rubs formulated at this concentration are classified as Class IB flammable liquids.

Because of the increased volume of alcohol in alcohol-based hand rubs and to supplement the original fire test and modeling findings, the heat release rate and burning time of 95-percent ethanol were calculated using formulae found in the *SFPE Handbook of Fire Protection Engineering* and compared to weaker solutions found in older alcohol-based hand rubs. The calculations confirmed that 95-percent ethanol will exhibit the highest heat release (282 kW) when compared to more dilute ethanol/water solutions (146-240 kW) but exhibited the shortest duration pool fire (83 seconds versus 95 to 119 seconds) because the lack of water allowed quicker volatilization of the fuel.

**ALCOHOL-BLENDED FUELS.** Flammable liquids consisting of 10-percent or greater, by volume, ethanol or other alcohols blended with gasoline.

❖ Alcohols are polar compounds that exhibit increased moisture absorption, water solubility, polar solvency and solution conductivity relative to gasoline. Alcohol-gasoline blended fuels have unique properties that may affect dispensing equipment and hardware material compatibility and fire response. The most common alcohol blended fuel is E85, which consists of nominally 85-percent ethanol and 15-percent unleaded gasoline. The blending is usually done at the processing plant, or may be accomplished filling the delivery tanker with the designated percentage of each fuel required to achieve the desired percentage. In cold climates, the fuel blend may include more gasoline to improve vehicle performance. The properties of E85 are listed in Commentary Figure 202-A4. Ethanol is a flammable, colorless liquid with a faint alcohol odor. The color of ethanol fuel blends depends on the color of the gasoline in the blend. Blends may also have a gasoline-like odor. See the commentary to Section 2306.8 for a more detailed discussion of the hazards presented by these alternative fuels.

**[A] ALTERATION.** Any construction or renovation to an existing structure other than a repair or addition.

❖ The code utilizes this term to reflect construction operations intended for an existing building but not within the scope of an addition or repair [see the defi-

nitions of “Addition” and “Repair” in the IEBC). (see IBC Section 101.4.7 for a reference to the *International Existing Building Code*® (IEBC®))

**[BE] ALTERNATING TREAD DEVICE.** A device that has a series of steps between 50 and 70 degrees (0.87 and 1.22 rad) from horizontal, usually attached to a center support rail in an alternating manner so that the user does not have both feet on the same level at the same time.

❖ An alternating tread device is commonly used in areas that would otherwise be provided with a ladder where there is not adequate space for a full stairway. Where these devices are permitted is specifically listed (e.g., Section 1006.2.2.1). The device is used extensively in industrial facilities for worker access to platforms or equipment. Requirements are found in Section 1011.

**[BG] AMBULATORY CARE FACILITY.** Buildings or portions thereof used to provide medical, surgical, psychiatric, nursing or similar care on a less-than-24-hour basis to persons who are rendered incapable of self-preservation by the services provided.

❖ The code provides different requirements for outpatient clinics, ambulatory care facilities and hospitals. Ambulatory care facilities, while still classified as a Group B occupancy, have additional standards above those of an outpatient clinic primarily due to the fact that patients are temporarily unable to respond to emergencies because of the treatment processes (see commentary, Section 422 of the IBC). Ambulatory care facilities include day surgery centers and

similar facilities where patients may receive fairly intensive treatment, but do not stay at the facility more than a few hours. If patients are receiving care on a 24-hour basis, such facilities would be defined as hospitals. (See definition of “24-hour basis.”)

**AMMONIUM NITRATE.** A chemical compound represented by the formula NH<sub>4</sub>NO<sub>3</sub>.

❖ Ammonium nitrate is a fairly simple compound (NH<sub>4</sub>NO<sub>3</sub>) but one that has an extremely complex set of reactions in a fire. The history of ammonium nitrate has been marked by major fires and explosions. Certain characteristics have caused or contributed to these fires and explosions. The following properties of ammonium nitrate are similar to those of other nitrates: (1) it is an oxidizing agent—it contains available oxygen that can make ignition easier and cause a fire to burn with surprising intensity; (2) it is hygroscopic—absorbing moisture from the air or from substances it touches and (3) it is deliquescent—as it absorbs moisture, a portion will liquefy and nearby combustibles can become impregnated with an oxidizing salt.

**ANNUNCIATOR.** A unit containing one or more indicator lamps, alphanumeric displays or other equivalent means in which each indication provides status information about a circuit, condition or location.

❖ This refers to the panel that displays the status of the monitored fire protection systems and devices. It is not the fire alarm control unit; however, the control panel may function as an annunciator.

Vapor density	Ethanol vapor, like gasoline vapor, is denser than air and tends to settle in low areas. However, ethanol vapor disperses rapidly.
Solubility in water	Fuel ethanol will mix with water, but at high enough concentrations of water, the ethanol will separate from the water.
Energy content	For identical volumes, ethanol contains less energy than gasoline. On an energy basis, 1.0 gallon of E85 is equivalent to 0.72 gallons of gasoline.
Flame visibility	A fuel ethanol flame is less bright than a gasoline flame but is easily visible in daylight.
Specific gravity	Pure ethanol and ethanol blends are heavier than gasoline.
Conductivity	Ethanol and ethanol blends conduct electricity. Gasoline, by contrast, is an electrical insulator.
Toxicity	Ethanol is less toxic than gasoline or methanol. Carcinogenic compounds are not present in pure ethanol; however, because gasoline is used in the blend, E85 is considered to be potentially carcinogenic.
Flammability	At low temperatures, the vapor concentration in an E85 tank can fall into the flammable range. The temperature for flammable E85 vapors depends on the E85 volatility. Although less likely than with E85, gasoline tanks can also contain flammable vapors at extremely low temperature.
Fire fighting	Fuel ethanol fires, like all fires, should be taken seriously. An E85 fire should be handled like a gasoline fire. Use a CO <sub>2</sub> or dry chemical extinguisher that is marked B, BC or ABC. An alcohol-type or alcohol-resistant (ARF) foam may be used to effectively combat fuel ethanol fires. Never use water to control a fire involving high-concentration fuel ethanol such as E85.

For SI: 1 gallon = 3.785 L.

**Figure 202-A4  
PROPERTIES OF FUEL ETHANOL**

## DEFINITIONS

[A] **APPROVED.** Acceptable to the *fire code official*.

❖ As related to the process of acceptance of building installations, including materials, equipment and construction systems, this definition identifies where the ultimate authority rests. Whenever this term is used, it intends that only the enforcing authority can accept a specific installation or component as complying with the code. For the IBC and *International Residential Code*® (IRC®), the “building official” is identified as the person responsible for administering its provisions. For the *International Fire Code*® (IFC®), the “fire code official” is identified as the person responsible for administering IFC provisions. For the *International Energy Conservation Code*® (IECC®), *International Fuel Gas Code*® (IFGC®), *International Green Construction Code*® (IgCC®), *International Mechanical Code*® (IMC®), *International Plumbing Code*® (IPC®), *International Property Maintenance Code*® (IPMC®), *International Swimming Pool and Spa Code*® (ISPSA®) and *International Wildfire-Urban Interface Code*® (IWUIC®), the “code official” is identified as the person responsible.

[BG] **AREA, BUILDING.** The area included within surrounding *exterior walls* (or *exterior walls* and *fire walls*) exclusive of vent shafts and *courts*. Areas of the building not provided with surrounding walls shall be included in the building area if such areas are included within the horizontal projection of the roof or floor above.

❖ Allowable building areas (as established by the provisions of Chapter 5 and Table 506.2 of the IBC) are a function of the potential fire hazard and the level of fire endurance of the building's structural elements, as defined by the types of construction in Chapter 6 of the IBC. A building area is the “footprint” of the building; that is, the area measured within the perimeter formed by the inside surface of the exterior walls. This excludes spaces that are inside this perimeter and open to the outside atmosphere at the top, such as open shafts and courts (see Section 1206 of the IBC). When a portion of the building has no exterior walls, the area regulated by Chapter 5 of the IBC is defined by the projection of the roof or floor above [see IBC Commentary Figure 202(5)]. The roof overhang on portions of a building where there are exterior enclosure walls does not add to the building area because the area is defined by exterior walls.

[BE] **AREA OF REFUGE.** An area where persons unable to use *stairways* can remain temporarily to await instructions or assistance during emergency evacuation.

❖ The area of refuge is a temporary waiting area used during emergency evacuations for persons who are unable to exit the building using the stairways. The fire safety plans (in accordance with Section 404) include the locations of areas of refuge so that the fire department will know where people may be waiting for rescue assistance. See Section 1009 for where

areas of refuge are required at stairways and elevators. Areas of refuge have requirements for separation, size, signage, instructional information and two-way communication systems.

**ARRAY.** The configuration of storage. Characteristics considered in defining an array include the type of packaging, flue spaces, height of storage and compactness of storage.

❖ This term defines the configuration of storage, with its essential components being the manner in which the commodity is packaged (stored either in piled formation or on a rack storage system); the amount of flue space between formations of the commodity; height, width and length of any one array and compactness.

**ARRAY, CLOSED.** A storage configuration having a 6-inch (152 mm) or smaller width vertical flue space that restricts air movement through the stored commodity.

❖ The term “closed array” was effectively defined as the result of a number of fire tests. These tests were conducted with the sample test assembly array employing 6-inch-wide (152 mm) longitudinal flues and no transverse flues.

[BG] **ATRIUM.** An opening connecting two or more stories other than enclosed *stairways*, elevators, hoistways, escalators, plumbing, electrical, air-conditioning or other equipment, which is closed at the top and not defined as a mall. Stories, as used in this definition, do not include balconies within assembly groups or mezzanines that comply with Section 505 of the *International Building Code*.

❖ The definition identifies that an atrium is a floor opening or a series of floor openings that connect the environments of adjacent stories. The definition of “Atrium” excludes enclosed stairways, elevators, hoistways and other similar openings in order to clarify that those elements would not fall under the purview as to what is considered an atrium and, therefore, the associated requirements found in Section 404 of the IBC would not apply. What this does not preclude is the inclusion of elevators and open stairways within atriums. Such elements would need to be entirely within the atrium to meet the separation requirements found in Section 404.6 of the IBC. Building features, such as stairways, elevators, hoistways, escalators, plumbing, electrical, air conditioning or other equipment openings, are required to be enclosed in fire-resistance-rated shafts in accordance with Sections 712 and 713 of the IBC. Atriums are specified in Section 712.1.7 of the IBC to address openings in horizontal assemblies. An atrium is not defined by size or use. A series of floor openings that are enclosed with exterior walls, yet open at the roof, would be considered a court and would be exempt from the requirements of Section 404 of the IBC. Balconies associated with assembly occupancies and mezzanines are not considered individual stories that would contribute to the classification of a space as an atrium.

**[BG] ATTIC.** The space between the ceiling beams of the top story and the roof rafters.

❖ The definition of “Attic” identifies the specific portion of a building or structure for the purposes of determining the applicability of requirements that are specific to attics, such as ventilation (see Section 1203 of the IBC) and draftstopping (see Section 718 of the IBC). Additionally, the IBC has access requirements (see Section 1209 of the IBC) and uniformly distributed live load requirements (see Table 1607.1 of the IBC) for attics. An attic is considered the space or area located immediately below the roof sheathing within the roof framing system of a building. Pitched roof systems, such as gabled, hip, sawtoothed or curved roofs, all create spaces between the roof sheathing and ceiling membrane, which are considered attics.

**AUDIBLE ALARM NOTIFICATION APPLIANCE.** A notification appliance that alerts by the sense of hearing.

❖ Audible alarms that are part of a fire alarm system must be loud enough to be heard in every occupied space of a building. Section 907.5.2.1.1 prescribes the minimum sound pressure level for all audible alarm notification appliances depending on the occupancy of the building and the function of the space.

**AUTOMATED RACK STORAGE.** Automated rack storage is a stocking method whereby the movement of pallets, products, apparatus or systems are automatically controlled by mechanical or electronic devices.

❖ This definition for automated rack storage systems applies to storage and retrieval systems designed for movement of palletized loads commonly used in warehouses containing extra-high-rack storage of Class I-IV commodities over 40 feet (12 192 mm) in height or high-hazard commodities over 30 feet (9144 mm) in height. Conventional material handling equipment such as forklifts generally cannot be used above this height to safely retrieve or store palletized loads. It is not uncommon for these systems to be used in buildings with roof heights over 100 feet (30 480 mm). NFPA 13 has no limit on the height of storage racks. See also the commentary to Section 3209.4.

**AUTOMATIC.** As applied to fire protection devices, a device or system providing an emergency function without the necessity for human intervention and activated as a result of a predetermined temperature rise, rate of temperature rise or combustion products.

❖ This term, when used in conjunction with fire protection systems or devices, means that the system or device will perform its intended function without a person being present or performing any task in its control or operation. The device or system has the inherent capability to detect a developing fire condition and perform some predetermined function. Automatic devices and systems operate completely without human presence or intervention.

**AUTOMATIC FIRE-EXTINGUISHING SYSTEM.** An *approved* system of devices and equipment which automatically detects a fire and discharges an *approved* fire-extinguishing agent onto or in the area of a fire.

❖ This term is the generic name for all types of automatic fire-extinguishing systems, including the most common type—the automatic sprinkler system. See Section 904 for requirements for particular alternative automatic fire-extinguishing systems, such as wet-chemical, dry-chemical, foam, carbon dioxide, Halon, clean-agent systems and automatic water mist.

**AUTOMATIC SMOKE DETECTION SYSTEM.** A fire alarm system that has initiation devices that utilize smoke detectors for protection of an area such as a room or space with detectors to provide early warning of fire.

❖ Chapter 9 provides requirements for various automatic fire protection systems including automatic fire detection system, automatic sprinkler system, automatic fire alarm system, and automatic smoke detection system. Automatic smoke detection systems are required for various occupancies as specified in Section 907. They are required to increase the likelihood that fire is detected and occupants of the building are given an early warning of danger.

**AUTOMATIC SPRINKLER SYSTEM.** An *automatic sprinkler system*, for fire protection purposes, is an integrated system of underground and overhead piping designed in accordance with fire protection engineering standards. The system includes a suitable water supply. The portion of the system above the ground is a network of specially sized or hydraulically designed piping installed in a structure or area, generally overhead, and to which automatic sprinklers are connected in a systematic pattern. The system is usually activated by heat from a fire and discharges water over the fire area.

❖ An automatic sprinkler system is one type of automatic fire-extinguishing system. Automatic sprinkler systems are the most common, and their life safety attributes are widely recognized. The code specifies three types of automatic sprinkler systems: one installed in accordance with NFPA 13, one in accordance with NFPA 13R and the other in accordance with NFPA 13D. To be considered for most code design alternatives, a building automatic sprinkler system must be installed throughout in accordance with NFPA 13 (see Section 903.3.1.1).

In a fire, sprinklers automatically open and discharge water onto the fire in a spray pattern that is designed to contain or extinguish the fire. Originally, automatic sprinkler systems were developed just for the protection of buildings and their contents. Because of the development and improvements in sprinkler head response time and water distribution, however, automatic sprinkler systems are now also considered a life safety system. Proper operation of an automatic sprinkler system requires careful selection of the sprinkler heads so that water in sufficient quantity at adequate pressure and properly distrib-

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uted will be available to suppress the fire. Note that the context of the use of the term “fire area” in the last sentence of the definition is to refer to the area in which the fire is occurring, not in the context of the defined term “fire area.”

There are many different types of automatic sprinkler systems—wet pipe, dry pipe, preaction, anti-freeze and various combinations. Sprinklers can be pendant, upright or sidewall and can be designed for standard or extended coverage. Additional information can be found in NFPA 13.

**AUTOMATIC WATER MIST SYSTEM.** A system consisting of a water supply, a pressure source and a distribution piping system with attached nozzles which, at or above a minimum operating pressure, defined by its listing, discharges water in fine droplets meeting the requirements of NFPA 750 for the purpose of the control, suppression or extinguishment of a fire. Such systems include wet-pipe, dry-pipe and pre-action types. The systems are designed as engineered, preengineered, local-application or total flooding systems.

❖ The code recognizes water mist systems as an alternative extinguishing system to automatic sprinkler systems. However, no exceptions, reductions or tradeoffs for water mist systems are granted or permitted by the code because such systems are not considered to be equivalent to automatic sprinkler systems. Automatic water mist systems have been approved by FM Global for occupancies similar to a Light Hazard Group (as defined by NFPA 13) and listed by UL for occupancies similar to Ordinary Hazard Group I (as defined by NFPA 13). These listings permit automatic water mist systems to be installed as the primary suppression systems in a variety of occupancy classifications.

Water mist systems are used for special applications where creating a heat absorbent vapor consisting of water droplets with a size of less than 1,000 microns at the discharge nozzle is the primary extinguishing method. These systems are typically used where water damage may be an issue or where water supplies are limited. The droplet size can be controlled by adjusting the discharge pressure through the nozzle. Creating a mist and an equal volume of water will create a larger total service area exposed to the fire and thus better facilitate the absorption of heat, allowing more water droplets to turn to steam more quickly and thus more effectively cool the room.

**AUTOMOTIVE MOTOR FUEL-DISPENSING FACILITY.** That portion of property where flammable or *combustible liquids* or gases used as motor fuels are stored and dispensed from fixed equipment into the fuel tanks of motor vehicles.

❖ Automotive motor fuel-dispensing facilities may be attended or unattended and they may take the form of the conventional motor fuel-dispensing facility,

convenience store or other location that transfers fuel from a storage tank to the fuel tank of some type of motorized equipment. Motor fuel-dispensing facilities are classified in occupancy Group M by the IBC.

**AVERAGE AMBIENT SOUND LEVEL.** The root mean square, A-weighted sound pressure level measured over a 24-hour period, or the time any person is present, whichever time period is less.

❖ The ambient noise that can be expected depends on the occupancy of the building. To attract the attention of the occupants, the audible alarm devices must be heard above the ambient noise in the space. For this reason, the alarm devices must have minimum sound pressure levels above the average ambient sound level. Section 907.5.2.1.1 prescribes the minimum sound pressure levels for the audible alarm notification appliances for all occupancy conditions.

Although it is possible to measure the ambient sound within an occupied space, the alarm notification devices are usually designed and installed before buildings are occupied, thus it is typically a careful analysis of the types of uses within a space that will determine the average ambient sound level. If, after the building is occupied, the alarm notification devices are below expected audibility, a field measurement may be necessary to determine whether or not the design assumptions are correct.

**[BG] AWNING.** An architectural projection that provides weather protection, identity or decoration and is partially or wholly supported by the building to which it is attached. An awning is comprised of a lightweight frame structure over which a covering is attached.

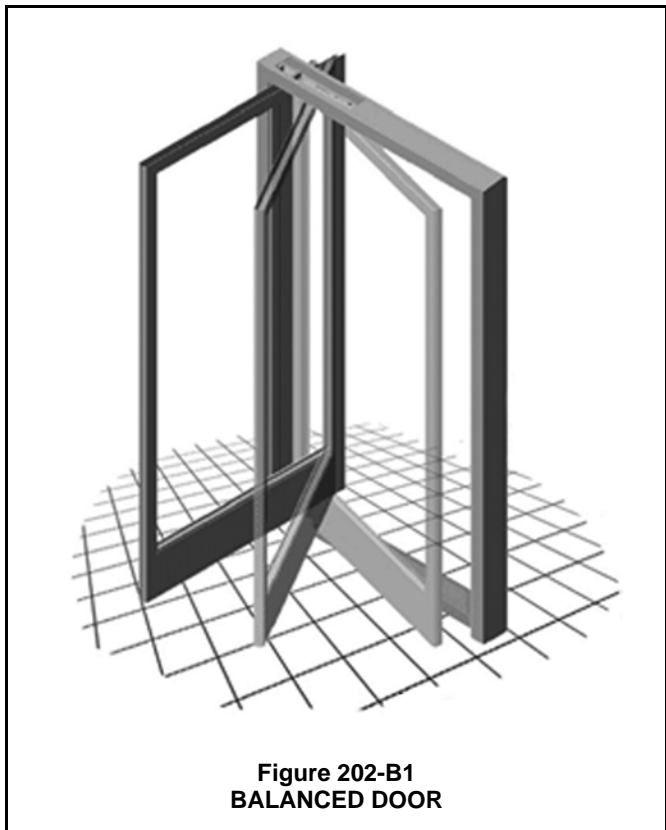
❖ Similar to a canopy, an awning typically provides weather protection, signage or decoration. Its distinguishing characteristic is the lightweight frame structure. It is also supported, at least in part, by the building from which it projects. See Section 3105 of the IBC for general requirements and Section 3202 of the IBC for encroachment requirements. This definition helps to clarify the applicability of roof loads in Section 1607.12.4 of the IBC. Also see the definitions of “Retractable awning,” “Canopy” and “Marquee” in the IBC.

**[BE] BALANCED DOOR.** A door equipped with double-pivoted hardware so designed as to cause a semicounter balanced swing action when opening.

❖ Balanced doors are commonly used to decrease the force necessary to open the door or to reduce the length of the door swing. Balanced doors typically reduce the clear opening width more than normally hinged doors (see Commentary Figure 202-B1 and Section 1010.1.10.2).

**BALED COTTON.** See “Cotton.”

**BALED COTTON, DENSELY PACKED.** See “Cotton.”



**Figure 202-B1  
BALANCED DOOR**

**BARRICADE.** A structure that consists of a combination of walls, floor and roof, which is designed to withstand the rapid release of energy in an explosion and which is fully confined, partially vented or fully vented; or other effective method of shielding from *explosive materials* by a natural or artificial barrier.

❖ Barricade means effectively screening a building containing explosives by means of a natural or artificial barrier from a magazine, another building, a railway or a highway.

**Artificial barricade.** An artificial mound or revetment with a minimum thickness of 3 feet (914 mm).

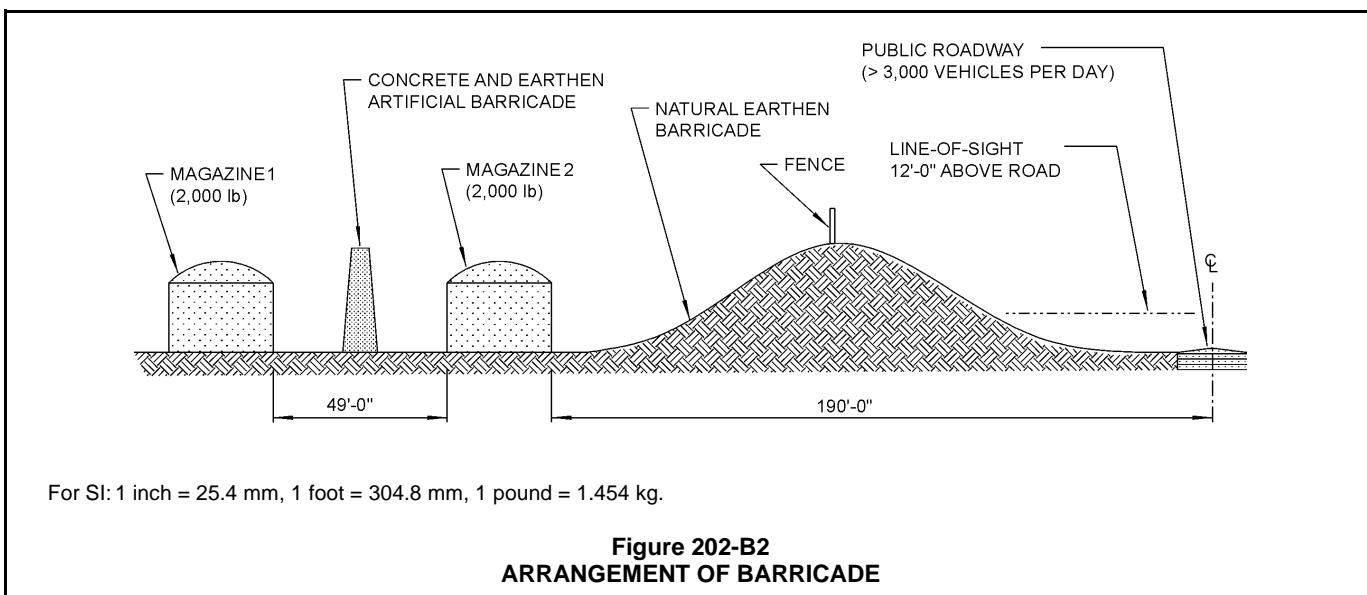
❖ Barricade means effectively screening a building containing explosives by means of a natural or artificial barrier from a magazine, another building, a railway or a highway.

**Natural barricade.** Natural features of the ground, such as hills, or timber of sufficient density that the surrounding exposures that require protection cannot be seen from the magazine or building containing *explosives* when the trees are bare of leaves.

❖ Native land features capable of protecting adjacent buildings, people and property from blast effects if an explosion in a magazine occurs may qualify as reduced separation distances permitted by Table 5604.5.2(2). Trees and other ground cover must be thick enough for effective visual screening for the magazine when the branches are bare of leaves or other seasonal foliage.

**BARRICADED.** The effective screening of a building containing *explosive materials* from the magazine or other building, railway or highway by a natural or an artificial barrier. A straight line from the top of any sidewall of the building containing *explosive materials* to the eave line of any magazine or other building or to a point 12 feet (3658 mm) above the center of a railway or highway shall pass through such barrier.

❖ Natural or artificial barriers must exist or be constructed to qualify for the separation distance reductions allowed in Table 5604.5.2(2). These barriers are intended to provide protection for people and property equivalent to the larger separation distances by absorbing or deflecting blast effects and debris from explosions involving magazines. Commentary Figure 202-B2 illustrates the arrangement of natural and artificial barricades for protection from two 2,000-pound (908 kg) Type 1 magazines.



**Figure 202-B2  
ARRANGEMENT OF BARRICADE**

## DEFINITIONS

**[BG] BASEMENT.** A story that is not a story above grade plane.

❖ Unlike previous editions of the I-Codes where a story would be defined as a basement if any portion of the story was below grade, a basement is now defined as a story that has its floor surface below the adjoining ground level and that does not qualify as a story above grade plane (see the commentary to the definition of “Story above grade plane”). IBC Commentary Figure 202.2(7) illustrates the application of the definition of “Story above grade plane.” Since a basement is not a story above grade, it does not contribute to the height of the building for the purpose of applying the allowable building height in stories from Table 504.4 of the IBC.

**BATTERY SYSTEM, STATIONARY LEAD ACID.** A system which consists of three interconnected subsystems:

1. A lead-acid battery.
2. A battery charger.
3. A collection of rectifiers, inverters, converters and associated electrical equipment as required for a particular application.

❖ The definition describes the completed battery system, consisting of all the components needed to make a functioning battery power system (see commentary, Section 608).

### BATTERY TYPES.

**Lithium-ion battery.** A storage battery that consists of lithium ions embedded in a carbon graphite or nickel metal-oxide substrate. The electrolyte is a carbonate mixture or a gelled polymer. The lithium ions are the charge carriers of the battery.

❖ This definition describes a specific type of sealed, nonventing, recombinant storage batteries similar to nickel-metal hydride batteries, although they are not as durable. Lithium-ion batteries, also commonly known as “Li-ion” batteries, are typically lighter than other comparably sized types of rechargeable batteries which makes them a popular choice for portable devices and automotive applications. They hold their charge well, are generally durable and may be recharged many times. Like other types of sealed batteries with a high-viscosity, immobilized electrolyte, Li-ion batteries have the advantage of not requiring spill control safeguards and also pose a reduced fugitive gas hazard. Lithium-ion batteries, when exposed to prolonged hot conditions with inadequate ventilation, can rupture, ignite, or explode. In recent history, Li-ion batteries were the subject of a massive battery recall initiative by several computer and cell phone manufacturers due to the Li-ion batteries used in their products overheating from internal contamination defects and causing fires or burn injuries.

**Lithium metal polymer battery.** A storage battery that is comprised of nonaqueous liquid or polymerized electrolytes, which provide ionic conductivity between lithiated

positive active material electrically separated from metallic lithium or lithiated negative active material.

❖ This definition describes lithium metal polymer (LMP) batteries, a specific type of sealed, nonventing storage battery similar to lithium-ion batteries and which are undergoing evaluation for use as stationary battery back-up systems to replace the currently used lead-acid and valve-regulated lead acid (VRLA) batteries. The LMP battery is similar to the Lithium-ion type in its characteristics (light, energy-dense, no liquid electrolyte, etc.). This technology is becoming more popular for deployment in outdoor cabinets and in buildings as well. Like lithium-ion batteries, LMP batteries use Lithium ions as the charge carrier. However, LMP batteries have more lithium because their anode is a solid thin foil of pure lithium encased in a plastic-like polymer that serves as the electrolyte. A significant advantage of LMP batteries is that they store more energy per unit of weight when compared to other batteries using nickel or lead anodes. Lithium is also an extremely lightweight metal when compared to other cathode or anode materials which results in a rechargeable battery with a high-energy density.

Even though LMP batteries should be recycled, they don't pose as much of an environmental hazard as lead-acid or Ni-Cad technologies if they are simply disposed. LMP batteries do not produce or liberate hydrogen or oxygen during their charging cycles and are, therefore, not classified as being recombinant or nonrecombinant. Since gases are not liberated from LMP batteries, the requirement in Section 608.2 for either vented caps or self-resealing flame arresting caps are not applicable. Because LMP batteries do not off-gas flammable or oxidizing gases while being charged, Section 608.6.1 does not require a mechanical ventilation system.

LMP batteries are constructed with an internal means of thermal runaway management which is required by Section 608.3. Each battery is equipped with an internal heating system that is located within the electrochemical stack of anodes and cathodes. This heating element ensures that the battery temperature limits are not exceeded when the battery is being charged or discharged.

These batteries contain no liquid electrolytes or electrolytes suspended in a gel or similar liquids. The electrolyte is a solid lithium-ion that is normally mixed with a rubber polymer that is located between the cathode and anode. Since these batteries do not contain any liquid, the code does not require spill control or a means of neutralization.

While LMP batteries do not have the potential for spills or discharging of hydrogen or oxygen, they still present a potential fire threat if they are somehow overheated and can be a threat to fire fighters because they will be connected to an energized circuit. Accordingly, Table 608.1 requires that the area housing these batteries be provided with signs com-

plying with Section 608.7 and a means of smoke detection complying with Section 608.9. Section 606.8 also requires batteries installed inside of buildings within seismically active areas be appropriately braced and anchored in accordance with the IBC.

**Nickel cadmium (Ni-Cd) battery.** An alkaline storage battery in which the positive active material is nickel oxide, the negative contains cadmium and the electrolyte is potassium hydroxide.

- ❖ This definition describes a specific type of nonrecombinant storage battery. Nickel-cadmium (Ni-Cd) batteries are durable and may be recharged many times. One of the hazards of storage batteries is overcharging and, in the case of Ni-Cd batteries, overcharging can produce either hydrogen gas or oxygen that could result in a rupture of the cell casing. Ni-Cd cells are, therefore, provided with safety venting caps to allow the generated gas to escape from inside the cell. See the commentary to Section 608.2 for further discussion of vents.

**Nonrecombinant battery.** A storage battery in which, under conditions of normal use, hydrogen and oxygen gases created by electrolysis are vented into the air outside of the battery.

- ❖ Nonrecombinant batteries, also called flooded cell batteries, are those where the electrodes/plates are immersed in electrolyte, and the gases (hydrogen and oxygen) created during charging are vented to the atmosphere. These batteries require maintenance in the form of distilled water occasionally being added to the cells to bring the electrolyte back to its required level. The most familiar example of a flooded lead-acid cell is the 12-V automobile battery (see also the commentary to the definition of “Recombinant battery”).

**Recombinant battery.** A storage battery in which, under conditions of normal use, hydrogen and oxygen gases created by electrolysis are converted back into water inside the battery instead of venting into the air outside of the battery.

- ❖ Recombinant batteries are designed so that the oxygen generated during charging is captured and recombined in the battery. This is called an oxygen recombination cycle and works well as long as the charge rate is not too high. An overly high charge rate could result in cell case rupture, thermal runaway or internal mechanical damage.

The VRLA battery is the most common type of recombinant battery. It was developed for stationary and telecommunication battery applications. These types of sealed batteries have a spring-controlled valve that vents gases at a predetermined pressure. Typical pressure thresholds are from 2 to 5 pounds per square inch gauge (psig) (14 to 34 kPa), depending on the battery design. Although the term “valve-regulated” is often used synonymously with describing sealed lead-acid batteries, not all sealed batteries are valve-regulated. Some battery designs employ

replaceable vent plugs or other mechanisms to relieve excess pressure. Sealed batteries were developed to reduce the maintenance required for batteries in active service. Since electrolyte levels are preserved by trapping and recombining off-gases, there should not be any need to add distilled water over the life of the battery. These batteries are often misnamed “maintenance free.” In fact, all maintenance practices applicable to unsealed-type batteries are applicable to sealed-type batteries. The only exception is that electrolyte levels cannot, and should not, need to be maintained.

**Stationary storage battery.** A group of electrochemical cells interconnected to supply a nominal voltage of DC power to a suitably connected electrical load, designed for service in a permanent location. The number of cells connected in a series determines the nominal voltage rating of the battery. The size of the cells determines the discharge capacity of the entire battery. After discharge, it may be restored to a fully charged condition by an electric current flowing in a direction opposite to the flow of current when the battery is discharged.

- ❖ The term “stationary storage battery” applies to all battery types made up of multiple electrochemical cells interconnected to supply a nominal voltage of direct current (DC) power. The batteries consist of a positive and a negative lead plate immersed in an electrolyte solution, which is considered a corrosive liquid. The definition includes both the vented type, in which hydrogen and oxygen are produced and vented, and the valve-regulated type, which is sealed to prevent the venting of the generated gases.

Stationary storage batteries come in a wide variety of designs for different applications. They are used for applications where power is necessary only on a standby or emergency basis. Stationary batteries are infrequently discharged. Stationary batteries remain on a continuous float charge so that they can be used on demand. The largest types of stationary batteries are those used for electrical load leveling. Load-leveling batteries store electrical energy for times of peak power demand and are taken off-line during times of low power demand. Such batteries are typically used for uninterrupted power supply (UPS) systems, emergency power or standby power applications and are manufactured in a variety of plate designs.

**Valve-regulated lead-acid (VRLA) battery.** A lead-acid battery consisting of sealed cells furnished with a valve that opens to vent the battery whenever the internal pressure of the battery exceeds the ambient pressure by a set amount. In VRLA batteries, the liquid electrolyte in the cells is immobilized in an absorptive glass mat (AGM cells or batteries) or by the addition of a gelling agent (gel cells or gelled batteries).

- ❖ Valve-regulated lead-acid (VRLA) batteries (sometimes referred to as “gel cells”) differ substantially from flooded batteries in design, operation and potential hazard. VRLA-type batteries are uniquely different from the traditional liquid electrolyte lead-acid batter-

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ies in that they have no liquid electrolyte to flow from the container if it were to break. Also, the VRLA batteries do not vent their off-gases to the atmosphere but rather implement an oxygen recombination cycle that minimizes the emissions of gas from the batteries during overcharging. Though these batteries are considered sealed, their design includes spring-controlled valves that vent gases at a pressure threshold of 2 to 5 psig (14 to 34 kPa). These batteries are sometimes mistakenly called “maintenance free”; however, they should be maintained in accordance with the manufacturer's instructions as with any other building system.

**Vented (flooded) lead-acid battery.** A lead-acid battery consisting of cells that have electrodes immersed in liquid electrolyte. Flooded lead-acid batteries have a provision for the user to add water to the cell and are equipped with a flame-arresting vent which permits the escape of hydrogen and oxygen gas from the cell in a diffused manner such that a spark, or other ignition source, outside the cell will not ignite the gases inside the cell.

- ❖ There are basically two types of lead-acid storage batteries, which are based on how they are constructed and vented: they are either vented (flooded) or sealed. Vented (flooded) and sealed batteries differ in how they dispose of the hydrogen (explosive in air at 4 percent by volume) and oxygen produced by electrolysis during their recharging (off-gassing). In a vented (flooded) battery, these gases are allowed to escape to the atmosphere. In a sealed battery, the gases are contained within the battery cell(s) and recombined with the electrolyte. Because the gases created during battery charging are vented to the atmosphere, distilled water must be added by the owner periodically to bring the electrolyte level back to that required by the battery specifications. One of the most common types of vented (flooded) lead-acid batteries is the automobile battery.

**BIN BOX.** A five-sided container with the open side facing an aisle. Bin boxes are self-supporting or supported by a structure designed so that little or no horizontal or vertical space exists around the boxes.

- ❖ Proprietary storage systems, such as bin box storage, are common in warehousing and manufacturing industries, such as automotive assembly plants and mail-order mercantile operations. Many bin box systems rely on the rigidity of adjacent bins and interlocking design for stability. Provisions for fastening the self-supporting units together to permit higher stacking are typical in most designs. Other bin box systems are designed in conjunction with a supporting rack system to minimize unusable space between bins. Bin boxes can be constructed of combustible materials, such as wood or cardboard, or of noncombustible materials such as metal.

**BIOMASS.** Plant- or animal-based material of biological origin excluding material embedded in geologic formations or transformed into fossils.

- ❖ This term is provided to coordinate with the requirements in Chapter 28 and the inclusion of these materials in the commodity classifications for high-piled combustible storage found in Chapter 32. These materials are becoming more prevalent and guidance is needed in terms of the hazards they pose and how they should be regulated.

**BLAST AREA.** The area including the blast site and the immediate adjacent area within the influence of flying rock, missiles and concussion.

- ❖ The area of a blast is affected by flying rock missiles, gases and concussion and also includes the blast site and the immediately adjacent area that is owned, leased or controlled by the blast operator.

**BLAST SITE.** The area in which *explosive materials* are being or have been loaded and which includes all holes loaded or to be loaded for the same blast and a distance of 50 feet (15 240 mm) in all directions.

- ❖ The area where explosive material is handled during loading, which includes 50 feet (15 240 mm) in all directions from loaded blast holes or holes to be loaded.

**BLASTER.** A person qualified in accordance with Section 3301.4 to be in charge of and responsible for the loading and firing of a blast.

- ❖ In general, the blaster should be qualified, experienced and of sound judgment when performing the duties of blasting. This person is authorized to use explosives for blasting purposes. The blaster is trained and experienced in the use of explosives and licensed by the department.

**BLASTING AGENT.** A material or mixture consisting of fuel and oxidizer, intended for blasting provided that the finished product, as mixed for use or shipment, cannot be detonated by means of a No. 8 test detonator when unconfined. Blasting agents are labeled and placarded as Class 1.5 material by US DOTn.

- ❖ This definition is derived from federal explosive regulations and is intended to distinguish blasting agents from more dangerous explosive materials on the basis of their propensity to mass detonate by initiation using a standard device.

**[BE] BLEACHERS.** Tiered seating supported on a dedicated structural system and two or more rows high and is not a building element (see “*Grandstand*”).

- ❖ Bleachers, folding and telescopic seating and grandstands are essentially unique forms of tiered seating that are supported on a dedicated structural system. All types are addressed in ICC 300, *Standard on*

*Bleachers, Folding and Telescopic Seating and Grandstands*, the safety standard for these types of seating arrangements (see Section 1029.1.1). Bleachers can have backrests or just seatboards. The term “building element” used in Section 1029.1.1 is a defined term in the IBC, which is primarily used in conjunction with the structural elements regulated in Table 601 of the IBC. Bleachers have a separate structural system and are not considered a building element of the building or structure in which they are located. An individual bench seat directly attached to a floor system is not a bleacher. The terms “bleacher” and “grandstand” are basically interchangeable. There is no cut-off in size or number of seats that separates bleachers and grandstands.

**[BG] BOARDING HOUSE.** A building arranged or used for lodging for compensation, with or without meals, and not occupied as a single-family unit.

- ❖ A boarding house is a structure where the occupants are provided sleeping accommodations or meals and accommodations for a fee. The individual rooms used usually do not contain all of the permanent living provisions of a dwelling unit (e.g., permanent cooking facilities). Most often, the term “boarding house” describes a facility that is primarily for transient occupants; however, these facilities might also be used for nontransient purposes. Depending on the extent of transiency, a boarding house could be classified as Group R-1 when an occupant typically stays for not more than 30 days or Group R-2 when the length of stay is greater than 30 days. Boarding houses are distinct from lodging houses. Lodging houses allow transient guests within a residence that is also occupied by the owner or primary residents of the dwelling unit. Lodging houses are classified as Group R-3 occupancies.

**BOILING POINT.** The temperature at which the vapor pressure of a liquid equals the atmospheric pressure of 14.7 pounds per square inch absolute (psia) (101 kPa) or 760 mm of mercury. Where an accurate boiling point is unavailable for the material in question, or for mixtures which do not have a constant boiling point, for the purposes of this classification, the 20-percent evaporated point of a distillation performed in accordance with ASTM D 86 shall be used as the boiling point of the liquid.

- ❖ The purpose of the boiling point is to assist in classifying flammable liquids. The classification of flammable liquids is based on the flash point and the boiling point. When one compares a Class IA liquid and a Class IB liquid, the only difference in their definitions is the boiling point. The lower the boiling point of a flammable liquid, the greater the hazard due to increased vapor pressure at NTP. This information will be found in the material safety data sheet (MSDS) and must be evaluated by the fire code official.

**BONFIRE.** An outdoor fire utilized for ceremonial purposes.

- ❖ Bonfires are usually very large and are associated with a crowd activity. Failure to follow good safety

practices with these fires can lead to serious injuries and property damage.

**[BE] BREAKOUT.** For revolving doors, a process whereby wings or door panels can be pushed open manually for *means of egress* travel.

- ❖ In addition to the swinging doors in the immediate area, revolving doors have a breakout feature as an additional safety requirement. The panels in the door can be operated manually to collapse or fold in the direction of egress during an emergency. This should increase the number of people that could exit per minute when not using the revolving door in the standard manner.

**BRITISH THERMAL UNIT (BTU).** The heat necessary to raise the temperature of 1 pound (0.454 kg) of water by 1°F (0.5565°C).

- ❖ This definition describes the English unit of heat used throughout the document. A British thermal unit (Btu) is used as a way to describe the heat content of combustibles. The metric equivalent of a Btu is a joule. This term should not be confused with heat release rate. Heat release rate would be described as Btu per second (joule per second = watt).

**[A] BUILDING.** Any structure used or intended for supporting or sheltering any use or occupancy.

- ❖ The code uses this term to identify those structures that provide shelter for a function or activity. See the definition for “Area, building” for situations when a single structure may be two or more “Buildings” created by fire walls.

**BUILDING AREA.** See “Area, building.”

**BUILDING HEIGHT.** See “Height, building.”

**[A] BUILDING OFFICIAL.** The officer or other designated authority charged with the administration and enforcement of the *International Building Code*, or a duly authorized representative.

- ❖ The statutory power to enforce the building code is normally vested in a building department of a state, county or municipality that has a designated enforcement officer termed the “building official” (see Section 103.1 of the IBC).

**BULK OXYGEN SYSTEM.** An assembly of equipment, such as oxygen storage containers, pressure regulators, safety devices, vaporizers, manifolds and interconnecting piping, that has a storage capacity of more than 20,000 cubic feet (566 m<sup>3</sup>) of oxygen at *normal temperature and pressure (NTP)* including unconnected reserves on hand at the site. The bulk oxygen system terminates at the point where oxygen at service pressure first enters the supply line. The oxygen containers can be stationary or movable, and the oxygen can be stored as a gas or liquid.

- ❖ As indicated in Section 6301.1, NFPA 55 contains installation and maintenance requirements for bulk oxygen systems. NFPA 55 also has the requirements for the protection of bulk oxygen systems from potential fire exposures. Oxygen storage systems with less

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than the capacities indicated in the definition are not required to comply with NFPA 55, but are regulated by this chapter.

**BULK PLANT OR TERMINAL.** That portion of a property where flammable or *combustible liquids* are received by tank vessel, pipelines, tank car or tank vehicle and are stored or blended in bulk for the purpose of distributing such liquids by tank vessel, pipeline, tank car, tank vehicle, portable tank or container.

❖ All of us have seen the large storage tanks surrounded by containment berms that constitute what is commonly called a “tank farm.” A facility of this kind may consist of one tank or several tanks and typically receives, stores and dispenses anywhere from thousands of gallons to hundreds of thousands of gallons of flammable or combustible liquids daily.

**BULK TRANSFER.** The loading or unloading of flammable or *combustible liquids* from or between tank vehicles, tank cars or storage tanks.

❖ This term refers to the loading or unloading of a flammable or combustible liquid from or between storage tanks, tank vehicles or tank cars or any combination thereof. See also the definition of “Process transfer” and Section 5706.5. This transfer is for the storage or transportation of flammable or combustible liquids.

**BULLET RESISTANT.** Constructed so as to resist penetration of a bullet of 150-grain M2 ball ammunition having a nominal muzzle velocity of 2,700 feet per second (fps) (824 mps) when fired from a 30-caliber rifle at a distance of 100 feet (30 480 mm), measured perpendicular to the target.

❖ Tests to determine bullet resistance are to be conducted on test panels or empty magazines. The panels or magazines are to resist a penetration of five out of five shots placed independently of each other in an area at least 3 feet by 3 feet (0.9 m by 0.9 m). If hardwood or softwood is used, its water content is not to exceed 15 percent.

Where a magazine roof or ceiling is required to be bullet resistant, it must be constructed of materials comparable to the sidewalls or of other materials that can withstand the penetration of bullets fired at an angle of 45 degrees (0.79 rad) from perpendicular.

**CANOPY.** A structure or architectural projection of rigid construction over which a covering is attached that provides weather protection, identity or decoration, and may be structurally independent or supported by attachment to a building on one end and by not less than one stanchion on the outer end.

❖ A canopy can be either an architectural projection from a building, or it can be an independent structure. An example of the former is typically found covering an entrance walkway in front of a hotel or apartment

building or perhaps a restaurant. An example of the latter is a canopy built over fuel pumps at a motor fuel-dispensing facility. This definition distinguishes a canopy from an awning which consists of a light-weight frame that is supported by the building from which it projects. In doing so, the definition clarifies the applicability of roof loads in Section 1607.12.4 of the IBC. See Section 3105 of the IBC for general requirements and Section 3202 of the IBC for encroachment requirements. Commentary Figures 202-C1, 202-C2 and 202-C3 illustrate types of canopies.



**Figure 202-C1**  
**EXAMPLE OF A FREE-STANDING**  
**MEMBRANE-COVERED CANOPY**



**Figure 202-C2**  
**EXAMPLE OF A CANOPY SUPPORTED**  
**BY A BUILDING AND STANCHION**



**Figure 202-C3**  
**EXAMPLE OF A FREE-STANDING**  
**MOTOR FUEL-DISPENSING FACILITY CANOPY**

**CARBON DIOXIDE EXTINGUISHING SYSTEM.** A system supplying carbon dioxide (CO<sub>2</sub>) from a pressurized vessel through fixed pipes and nozzles. The system includes a manual- or automatic-actuating mechanism.

❖ Carbon dioxide (CO<sub>2</sub>) extinguishing systems are useful in extinguishing fires in specific hazards or equipment in occupancies where an inert electrically nonconductive medium is essential or desirable and where cleanup of other extinguishing agents, such as dry-chemical residue, presents a problem. The system works by displacing the oxygen in an enclosed area by flooding the space with carbon dioxide. To effectively flood the enclosure, automatic door and window closers and control dampers for the mechanical ventilation system must be installed.

These types of gaseous extinguishing systems have some inherent disadvantages that should be considered before selection. Because the oxygen is being displaced, occupants should not be in the space for a period after discharge, depending on the concentration of CO<sub>2</sub> to be achieved. Additionally, the discharge rate can result in a rapid increase in pressure within the space where the system is discharged. However, where water is not a desired means of suppression carbon dioxide and other gaseous suppression systems can be very effective. NFPA 12 contains minimum requirements for the design, installation, testing, inspection, approval, operation and maintenance of carbon dioxide extinguishing systems.

**[BG] CARE SUITE.** In Group I-2 occupancies, a group of treatment rooms, care recipient sleeping rooms and the support rooms or spaces and circulation space within the suite where staff are in attendance for supervision of all care recipients within the suite, and the suite is in compliance with the requirements of Section 407.4.4 of the *International Building Code*.

❖ Care suites are designed to allow for a group of rooms to function as a unit in the treatment and care of patients. Suites are recognized to be an effective tool to provide flexibility in reaching an exit access due to functional considerations. Suites are particu-

larly useful in intensive care units and emergency department in-patient treatment areas. Suites allow staff to have clear and unobstructed supervision of patients/care recipients in specific treatment and sleeping rooms through the elimination of corridor width or rating requirements. The term is not intended to apply to day rooms or business sections of the hospital. This term is only applicable to suites of patient rooms in Group I-2 occupancies, and should not be confused with similar layouts in other parts of the hospital or within other occupancies that may be referred to as a "suite." Care suites are to meet the requirements of Section 407 of the IBC.

**CARTON.** A cardboard or fiberboard box enclosing a product.

❖ This term is commonly used when applying the high-piled storage requirements of Chapter 32 and also for packaging of aerosols in Chapter 51. This definition provides a consistent understanding of a word often used to describe packaging.

**CEILING LIMIT.** The maximum concentration of an airborne contaminant to which one may be exposed. The ceiling limits utilized are those published in DOL 29 CFR Part 1910.1000. The ceiling Recommended Exposure Limit (REL-C) concentrations published by the U.S. National Institute for Occupational Safety and Health (NIOSH), Threshold Limit Value-Ceiling (TLV-C) concentrations published by the American Conference of Governmental Industrial Hygienists (ACGIH), Ceiling Workplace Environmental Exposure Level (WEEL-Ceiling) Guides published by the American Industrial Hygiene Association (AIHA), and other *approved*, consistent measures are allowed as surrogates for hazardous substances not listed in DOL 29 CFR Part 1910.1000.

❖ This limit is the concentration at which immediate irritation to skin, respiratory system or both will occur. This is an important level for emergency personnel and workers to be aware of. Mechanical ventilation may be used to assist in keeping the working environment below these levels.

**[A] CHANGE OF OCCUPANCY.** A change in the use of a building or a portion of a building. A change of occupancy shall include any change of occupancy classification, any change from one group to another group within an occupancy classification or any change in use within a group for a specific occupancy classification.

❖ This term describes the condition when an existing building or structure is used for a different use or the same use with an increase in the level of activity (see Section 101.4.7 for a reference to the IEBC). This term is only applicable to existing buildings, never new ones. For example, Group B includes both beauty parlors and post offices. If a beauty shop moved into an old post office, while remaining a Group B building, there would be a change in the level of activity; therefore, this would be considered a change of occupancy.

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**CHEMICAL.** An element, chemical compound or mixture of elements or compounds or both.

- ❖ Chemicals may be hazardous, in which case the buildings, processes and storage that use them are regulated, or they may be nonhazardous, in which case their storage is regulated. These regulations are typically found in the IBC, IMC, IPC, IFGC and the code.

**CHEMICAL NAME.** The scientific designation of a chemical in accordance with the nomenclature system developed by the International Union of Pure and Applied Chemistry, the Chemical Abstracts Service rules of nomenclature, or a name which will clearly identify a chemical for the purpose of conducting an evaluation.

- ❖ This name can be used to research the product in resource manuals to determine the hazard characteristics of the product. Some examples of resources are: National Toxicology Program (NTP), Chemical Hazards Response Information System (CHRIS) manual, Emergency Response Guidebook (ERG), MSDS, etc.

**[M] CHIMNEY.** A primarily vertical structure containing one or more flues for the purpose of carrying gaseous products of combustion and air from a fuel-burning appliance to the outdoor atmosphere.

- ❖ The IFGC and the IMC address the installation of chimneys and venting systems that are required to convey products of combustion from fuel-burning appliances to the atmosphere. The code regulates the maintenance of masonry chimneys in Section 603.6.1. Chimneys differ from metal vents in the materials from which they are constructed and the type of appliance they are designed to serve. Chimneys can vent much hotter flue gases than metal vents.

**Factory-built chimney.** A listed and labeled chimney composed of factory-made components, assembled in the field in accordance with manufacturer's instructions and the conditions of the listing.

- ❖ A factory-built chimney is a manufactured listed and labeled chimney that has been tested by an approved agency to determine its performance characteristics. Factory-built chimneys are manufactured in two basic designs: either a double-wall insulated design or a triple-wall air-cooled design. Both designs use stainless steel inner liners to resist the corrosive effects of combustion products.

**Masonry chimney.** A field-constructed chimney composed of solid masonry units, bricks, stones, or concrete.

- ❖ Masonry chimneys can have one or more flues within them, and are field constructed of brick, stone, concrete or fire-clay materials. Masonry chimneys can stand alone or be part of a masonry fireplace.

**Metal chimney.** A field-constructed chimney of metal.

- ❖ A metal chimney is an unlisted chimney constructed and installed in accordance with NFPA 211 and is sometimes referred to as a "smokestack." Metal chimneys are typically field constructed and installed in industrial structures.

**CLEAN AGENT.** Electrically nonconducting, volatile or gaseous fire extinguishant that does not leave a residue upon evaporation.

- ❖ The two categories of clean agents are halocarbon compounds and inert gas agents. Halocarbon compounds include bromine, carbon, chloride, fluorine, hydrogen and iodine. Halocarbon compounds suppress the fire through a combination of breaking the chemical chain reaction of the fire, reducing the ambient oxygen supporting the fire and reducing the ambient temperature of the fire origin to reduce the propagation of fire. The clean agents that are inert gas agents contain primary components consisting of helium, neon or argon, or a combination of all three. Inert gases work by reducing the oxygen concentration around the fire origin to a level that does not support combustion (see commentary, Section 904.10).

**[BG] CLINIC, OUTPATIENT.** Buildings or portions thereof used to provide medical care on a less-than-24-hour basis to persons who are not rendered incapable of self-preservation by the services provided.

- ❖ Outpatient clinics generally consist of doctors' offices where various medical services can be provided. These clinics typically function during normal business hours (i.e., less than 24 hours) and, unlike ambulatory care facilities, the patients are generally ambulatory and capable of self-preservation. This definition clarifies the difference between ambulatory surgery centers (ambulatory care facilities) and the typical doctor's office. In many cities, outpatient clinics are open at all hours to be available to people who work a variety of shifts. The term "urgent care" is often used to describe such facilities. An outpatient facility that is open 24/7 may still be classified as a Group B occupancy, provided all patients are outpatients and individual patients are not treated for periods in excess of 24 hours. The latter would describe a Group I-2 hospital. See the commentaries for Sections 407 and 422 of the IBC.

**CLOSED CONTAINER.** A container sealed by means of a lid or other device such that liquid, vapor or dusts will not escape from it under ordinary conditions of use or handling.

- ❖ A closed container is one that is sealed so that no vapors or dust can escape. The important difference in dealing with an open container and a closed container is that the open container is more dangerous and calls for more safety requirements. The fire tetrahedron is made up of fuel, heat, oxygen and a chain

reaction. In a closed container there is only the fuel part of the tetrahedron; in an open container, there is the fuel and oxygen sides of the tetrahedron. In this case, a closed container is less hazardous than an open container unless there is a leak.

**CLOSED SYSTEM.** The use of a solid or liquid hazardous material involving a closed vessel or system that remains closed during normal operations where vapors emitted by the product are not liberated outside of the vessel or system and the product is not exposed to the atmosphere during normal operations; and all uses of *compressed gases*. Examples of closed systems for solids and liquids include product conveyed through a piping system into a closed vessel, system or piece of equipment.

❖ This definition is used primarily with regard to hazardous materials. The difference between a closed system and an open system is whether the hazardous material involved in the process is exposed to the atmosphere. A closed system is inherently less hazardous than an open system due to the fact that vapors, dusts or similar materials are not normally released from closed systems. Because closed systems are less hazardous than open systems, credit is typically given to increase the maximum allowable quantities (MAQ) when systems are considered closed. Materials in closed or open systems are assumed to be “in use” as opposed to “in storage.” Gases are always assumed to be in closed systems since they would be immediately dispersed in an open system if exposed to the atmosphere without some means of containment (see the definition of “Open system”).

**COLD DECK.** A pile of unfinished cut logs.

❖ A cold deck is a pile of ranked logs that have different lengths. The lengths are usually greater than 8 feet (2438 mm) and up to 50 feet (15 240 mm) long.

**COMBUSTIBLE DUST.** Finely divided solid material which is 420 microns or less in diameter and which, when dispersed in air in the proper proportions, could be ignited by a flame, spark or other source of ignition. Combustible dust will pass through a U.S. No. 40 standard sieve.

❖ Combustible dusts are combustible solids in a finely divided state that are suspended in the air. An explosion hazard exists when the concentration of the combustible dust is within the explosive limits and exposed to an ignition source of sufficient energy and duration to initiate self-sustained combustion. A review of the occupancy classification for Group H-2 in Chapter 2 (based on IBC Section 307.4) indicates that combustible dusts are classified in that occupancy group. The intent of that section is that when combustible dust is determined by an engineering analysis to meet the definition parameter that, in a given occupancy, it is dispersed in air in the proper proportions so as to be ignitable by an ignition source, then the deflagration hazard is sufficient to classify the occupancy in Group H-2. Combustible dust, as a material, that does not rise to that defined

level of hazard in a particular building would not cause the building or portion thereof housing the hazard to be classified in Group H-2, but rather in the group that is most appropriate for the particular operation.

The original tabular MAQ per control area for combustible dust, included in the legacy building and fire codes, was deleted because of its questionable value, given the complexities of dust explosion hazards. In the 2012 edition of the code, a row for combustible dust was added to Table 5003.1.1(1) along with a new Note q. The note reinforces the fact that determining a theoretical MAQ of combustible dust and the potential for a dust explosion requires a thorough evaluation and technical report based on the provisions of Section 104.7.2 of the code. Such determination is complex and requires evaluation far beyond the simple 1 pound per 1,000 cubic feet (16 g/m<sup>3</sup>) MAQ previously used by the legacy codes. Critical factors, such as particle size, material density, humidity and oxygen concentration, play a major role in the evaluation of the dust hazard and are much too complex to be simply addressed.

**COMBUSTIBLE FIBERS.** Readily ignitable and free-burning materials in a fibrous or shredded form, such as cocoa fiber, cloth, cotton, excelsior, hay, hemp, henequen, istle, jute, kapok, oakum, rags, sisal, Spanish moss, straw, tow, wastepaper, certain synthetic fibers or other like materials. This definition does not include densely packed baled cotton.

❖ The basic component of all textiles is fibers. Fibers may be either natural or man-made. Cellulosic, protein and mineral fibers are considered natural fibers. Fibers produced by chemical processes (nylon, rayon, Orlon, etc.) are considered man-made. The definition clarifies that densely packed baled cotton is not to be considered a hazardous material. The density and packaging arrangements of cotton fibers meeting the definition of “Baled cotton, densely packed” in this section reduce the hazard of the material such that the hazardous materials provisions of the code need no longer apply.

**COMBUSTIBLE GAS DETECTOR.** An instrument that samples the local atmosphere and indicates the presence of ignitable vapors or gases within the flammable or explosive range expressed as a volume percent in air.

❖ This definition coordinates with the requirements in Section 3510 that provide procedures for undertaking hot work on tanks that have contained flammable or combustible liquids. One of the procedures required is the use of a combustible gas detector to evaluate the conditions of the space while hot work is occurring.

**COMBUSTIBLE LIQUID.** A liquid having a closed cup flash point at or above 100°F (38°C). Combustible liquids shall be subdivided as follows:

**Class II.** Liquids having a closed cup flash point at or above 100°F (38°C) and below 140°F (60°C).

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**Class IIIA.** Liquids having a closed cup flash point at or above 140°F (60°C) and below 200°F (93°C).

**Class IIIB.** Liquids having closed cup *flash points* at or above 200°F (93°C).

The category of combustible liquids does not include *compressed gases* or *cryogenic fluids*.

❖ Combustible liquids differ from flammable liquids in that the closed-cup flash point of all combustible liquids is at or above 100°F (38°C) (see the definition of “Flash point”). There are three categories of combustible liquids. The range of their closed-cup flash point dictates the class of combustible liquid. The flash point range of 100°F (38°C) to 140°F (60°C) for Class II liquids was based on a possible indoor ambient temperature exceeding 100°F (38°C). Only a moderate degree of heating would be required to bring the liquid to its flash point at this temperature. Class III liquids, which have flash points higher than 140°F (60°C), would require a significant heat source above ambient temperature to reach their flash point (see the definition of “Flammable liquid”). Class IIIA has a closed-cup flash point range of 140°F (60°C) to 200°F (93°C). Class IIIB has a closed-cup flash point at or above 200°F (93°C). The term “combustible liquid” does not include liquefied compressed gases or cryogenic fluids. Compressed gases are regulated in Chapter 53 and cryogenic fluids are regulated in Chapter 55.

**[M] COMMERCIAL COOKING APPLIANCES.** Appliances used in a commercial food service establishment for heating or cooking food and which produce grease vapors, steam, fumes, smoke or odors that are required to be removed through a local exhaust ventilation system. Such appliances include deep fat fryers, upright broilers, griddles, broilers, steam-jacketed kettles, hot-top ranges, under-fired broilers (charbroilers), ovens, barbecues, rotisseries, and similar appliances. For the purpose of this definition, a food service establishment shall include any building or a portion thereof used for the preparation and serving of food.

❖ This definition is important in the application of Section 609, which requires a commercial kitchen hood above commercial cooking appliances. A definition of “Food service establishment” is included within this definition. “Food service” includes operations, such as preparing, handling, cleaning, cooking and packaging food items of any kind.

**COMMERCIAL MOTOR VEHICLE.** A motor vehicle used to transport passengers or property where the motor vehicle:

1. Has a gross vehicle weight rating of 10,000 pounds (454 kg) or more; or
2. Is designed to transport 16 or more passengers, including the driver.

❖ This definition clarifies what constitutes a “commercial vehicle.” This term has often been misinterpreted in previous editions. These criteria are from the DOT

49 CFR; Part 390.5, and correlate with IBC Section 1607.7. Where vehicles of this size are present in buildings greater than 5,000 square feet (464 m<sup>2</sup>) in area, the code requires an automatic sprinkler system be provided in repair garages, commercial parking garages and in Group S-1 storage occupancies (see Section 903.2).

**COMMODITY.** A combination of products, packing materials and containers.

❖ Commodity is a term used to identify the product being stored, its container or housing and the type of stackable mechanism (with or without pallet). Commodities and their containers are generally identified as classes, with each classification identifying the combustibility (potential fire hazard). The quantity and locations of each type of commodity will define the type of general and special fire protection and life safety requirements necessary for the building or structure. See the commentary for the various commodities in Section 3203.

**[BE] COMMON PATH OF EGRESS TRAVEL.** That portion of the *exit access* travel distance measured from the most remote point within a story to that point where the occupants have separate and distinct access to two *exits* or *exit access* doorways.

❖ The common path of egress travel is a concept used to refine travel distance criteria. A common path of travel is the route an occupant will travel where the one way in is also the one way out, similar to a dead-end corridor or single exit suite. Once occupants reach a point where two different routes are available, and the two different routes continue to two separate exits, then common path of travel is finished. The length of a common path of egress travel is limited so that the means of egress path of travel provides a choice before the occupant has traveled an excessive distance (see Section 1006). This reduces the possibility that, although the exits are remote from one another, a single fire condition will render both paths unavailable. The common path of egress travel is part of the overall exit access travel distance. To be compliant, the path of egress must meet criteria for both common path of egress travel and exit access travel distance.

**[BE] COMMON USE.** Interior or exterior circulation paths, rooms, spaces or elements that are not for public use and are made available for the shared use of two or more people.

❖ Some buildings include areas that are restricted to employees only or where public access is limited. Common-use spaces may be part of employee work areas but do not include public-use spaces. Any space that is shared by two or more persons, such as copy areas, break rooms, toilet rooms or circulation paths, are common use areas. A grade school classroom would be another example of a common-use space (see also the commentary for the definition of “Public-use areas” and “Employee work area”).

**COMPRESSED GAS.** A material, or mixture of materials that:

1. Is a gas at 68°F (20°C) or less at 14.7 psia (101 kPa) of pressure; and
2. Has a *boiling point* of 68°F (20°C) or less at 14.7 psia (101 kPa) which is either liquefied, nonliquefied or in solution, except those gases which have no other health- or physical-hazard properties are not considered to be compressed until the pressure in the packaging exceeds 41 psia (282 kPa) at 68°F (20°C).

The states of a compressed gas are categorized as follows:

1. Nonliquefied compressed gases are gases, other than those in solution, which are in a packaging under the charged pressure and are entirely gaseous at a temperature of 68°F (20°C).
  2. Liquefied compressed gases are gases that, in a packaging under the charged pressure, are partially liquid at a temperature of 68°F (20°C).
  3. Compressed gases in solution are nonliquefied gases that are dissolved in a solvent.
  4. Compressed gas mixtures consist of a mixture of two or more compressed gases contained in a packaging, the hazard properties of which are represented by the properties of the mixture as a whole.
- ❖ This term refers to all types of gases that are under pressure at normal room or outdoor temperatures inside their containers, including, but not limited to, flammable, nonflammable, highly toxic, toxic, cryogenic and liquefied gases. The vapor pressure limitations provide the distinction between a liquid and a gas.

**COMPRESSED GAS CONTAINER.** A pressure vessel designed to hold *compressed gases* at pressures greater than one atmosphere at 68°F (20°C) and includes cylinders, containers and tanks.

- ❖ Containers covered by this definition range from the small compressed air tanks carried by some road service trucks to the very large storage tanks mounted on permanent bases at industrial plants. Designs vary considerably depending on the gases they are intended to hold, whether they are designed for upright or horizontal mounting and the environment they will be used in.

**COMPRESSED GAS SYSTEM.** An assembly of equipment designed to contain, distribute or transport *compressed gases*. It can consist of a *compressed gas* container or containers, reactors and appurtenances, including pumps, compressors and connecting piping and tubing.

- ❖ This definition is intended to include every component used to convey the gas to or from manufacturing, storage and use facilities. System designs will vary widely depending on their intended use.

**[BG] CONGREGATE LIVING FACILITIES.** A building or part thereof that contains sleeping units where residents share bathroom and/or kitchen facilities.

- ❖ Congregate living facilities are those pertaining to group housing (i.e., dormitories, fraternities, convents) that combine individual sleeping quarters with communal facilities for food, care, sanitation and recreation. The number of occupants in the facility determines the appropriate occupancy classification. There are two thresholds: 10 and 16. A congregate living facility with 16 or fewer nontransient residents falls in the R-3 classification—for above 16 nontransient residents the classification is R-2. For transient residents, if there are 10 or fewer in the facility, it is also in the R-3 classification. If over 10 transient residents, it is an R-1 occupancy.

**CONSTANTLY ATTENDED LOCATION.** A designated location at a facility staffed by trained personnel on a continuous basis where alarm or supervisory signals are monitored and facilities are provided for notification of the fire department or other emergency services.

- ❖ These locations are intended to receive trouble, supervisory and fire alarm signals transmitted by the fire protection equipment installed within a protected facility. It is the intent of the code to have both an approved location and personnel who are acceptable to the fire code official responsible for actions taken when the fire protection system requires attention. The term “constantly attended” implies 24-hour surveillance of the system, at the designated location.

**[A] CONSTRUCTION DOCUMENTS.** The written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of the project necessary for obtaining a permit.

- ❖ To determine whether proposed construction is in compliance with code requirements, sufficient information must be submitted to the fire code official for review. This definition describes in general which items are to be included in that documentation. This typically will include drawings (floor plans, elevations, sections, details, etc.), specifications and product information describing the proposed work. In the past, these documents were referred to as “plans and specifications.” Those terms are not broad enough to include all information, such as calculations or graphs.

**CONTAINER.** A vessel of 60 gallons (227 L) or less in capacity used for transporting or storing hazardous materials. Pipes, piping systems, engines and engine fuel tanks are not considered to be containers.

- ❖ This definition establishes the intended capacity of the container to avoid confusion with portable or stationary tanks. A container could include typical 55-gallon (208 L) drums or 2-ounce (59 ml) cans. It is

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important to note the size difference between a drum and a barrel. A drum has a capacity of 55 U.S. gallons (208 L) and a barrel has a capacity of 42 U.S. gallons (158 L). These terms are sometimes reported incorrectly when determining the amount of storage in a facility.

**CONTAINMENT SYSTEM.** A gas-tight recovery system comprised of equipment or devices which can be placed over a leak in a *compressed gas* container, thereby stopping or controlling the escape of gas from the leaking container.

❖ A containment system consists of various components that will capture gases from a leaking container by being placed at the source of the leak.

**CONTAINMENT VESSEL.** A gas-tight recovery vessel designed so that a leaking *compressed gas* container can be placed within its confines thereby encapsulating the leaking container.

❖ A containment vessel is a closed unit that a leaking container can be placed in that will fully contain any unwanted release.

**CONTINUOUS GAS DETECTION SYSTEM.** A gas detection system where the analytical instrument is maintained in continuous operation and sampling is performed without interruption. Analysis is allowed to be performed on a cyclical basis at intervals not to exceed 30 minutes.

❖ This term refers to a system that is capable of constantly monitoring the presence of highly toxic or toxic compressed gases at or below the permissible exposure limit (PEL) for the gas. A continuous gas detection system will provide notification of a leak or rupture in a compressed gas cylinder or tank in a storage or use condition.

Numerous techniques exist for detecting and measuring gases. Two of the most common types of detection methods are briefly described below:

*Colorimetric Detection (Chemcassette Detection):* Colorimetric detection involves a circuit that is usually completed by the presence of an electrolyte within the cell itself. A carefully prepared reel of porous paper tape is impregnated with a chemical that will change color in the presence of the target gas—this reaction can be very specific to particular gases of interest. This tape is then positioned so that the sample of air or gas passes through a section of the tape. Color changes are measured optically and converted to a direct concentration value of the target gas.

*Electrochemical Detection:* Electrochemical cells work on the fuel-cell principle. As the target gas enters the cell, it reacts at the active electrode and generates a very small current, which flows through an external measuring circuit back to the counter electrode.

**CONTROL AREA.** Spaces within a building where quantities of hazardous materials not exceeding the *maximum allowable quantities per control area* are stored, dispensed,

used or handled. See also the definition of “Outdoor control area.”

❖ The use of control areas allows for the use and storage of hazardous materials without classifying the building or structure as a high-hazard Group H occupancy when the total quantity of hazardous materials in the entire building might exceed the MAQ. This concept is based on regulating the allowable quantities of hazardous materials in each control area by giving credit for further compartmentation through the use of fire barriers having a minimum fire-resistance rating of 1 hour. Maximum quantities of hazardous materials within each control area cannot exceed the MAQ for a given material. Thus, the quantities in each control area will be less than the MAQ, while the overall quantity in the entire building could exceed the MAQ (see commentary, Section 5003.8.3).

**[BE] CORRIDOR.** An enclosed *exit access* component that defines and provides a path of egress travel.

❖ Corridors are regulated in the code because they serve as principal elements of travel in many means of egress systems within buildings. Typically, corridors have walls that extend from the floor to the ceiling. They need not extend above the ceiling or have doors in their openings unless a fire-resistance rating is required (see Section 1020).

While both aisles and corridors may result in a confined path of travel, an aisle is an unenclosed component, while a corridor would be an enclosed component of the means of egress. The enclosed character of the corridor restricts the sensory perception of the user. A fire located on the other side of the corridor wall, for example, may not be as readily seen, heard or smelled by the occupants traveling through the egress corridor. The code does not specifically state what is considered “enclosed” when corridors are not fire-resistance rated. When an egress path is bounded by partial-height walls, such as work-station partitions in an office, issues would be if the walls provided a confined path of travel and limited fire recognition in adjacent spaces by restricting line of sight, hearing and smell.

**CORRIDOR, OPEN-ENDED.** See “Open-ended corridor.”

**CORROSIVE.** A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the point of contact. A chemical shall be considered corrosive if, when tested on the intact skin of albino rabbits by the method described in DOTn 49 CFR 173.137, such chemical destroys or changes irreversibly the structure of the tissue at the point of contact following an exposure period of 4 hours. This term does not refer to action on inanimate surfaces.

❖ This definition is derived from DOT 49 CFR; Part 173. While corrosive materials may not pose a fire, explosion or reactivity hazard, they do pose a handling and storage problem. Corrosive materials, therefore, are

primarily considered a health hazard, and an occupancy containing such materials in excess of the maximum allowable quantity per control area (MAQ) is classified in Group H-4. It should be noted that many corrosive chemicals are also strong oxidizing agents that would require review as a multiple-hazard material in accordance with Section 5001.1.

## COTTON.

**Baled cotton.** A natural seed fiber wrapped in and secured with industry-accepted materials, usually consisting of burlap, woven polypropylene, polyethylene or cotton or sheet polyethylene, and secured with steel, synthetic or wire bands, or wire; also includes linters (lint removed from the cottonseed) and motes (residual materials from the ginning process).

- ❖ Since Section 3705 deals with baled fibers, this definition of standard “Baled cotton” is being included only to distinguish it from “Baled cotton, densely packed” (see commentary to the definition of “Baled cotton, densely packed”). The Joint Cotton Industry Bale Packaging Committee (JCIBPC) is a committee that represents all parts of the cotton industry and sets standards and specifications for packaging of cotton bales that include bale density. The JCIBPC specifications for baling of cotton require that all cotton bales be secured with fixed length wire bands, polyester plastic strapping or cold-rolled high tensile steel strapping and then covered in fully coated woven polyolefin, polyethylene film or burlap.

**Baled cotton, densely packed.** Cotton, made into banded bales, with a packing density of not less than 22 pounds per cubic foot (360 kg/m<sup>3</sup>), and dimensions complying with the following: a length of 55 inches (1397 mm), a width of 21 inches (533.4 mm) and a height of 27.6 to 35.4 inches (701 to 899 mm).

- ❖ Currently, over 99 percent of all U.S. cotton is pressed and stored as densely packed baled cotton, with bales meeting the weight and dimension requirements of ISO 8115. One reason that the cotton industry has chosen to use mostly such bales is because the bales are very difficult to ignite, which allows the industry to transport them without being labeled as “flammable solids” or “dangerous goods” by the national or international transport authorities. This definition should be used to distinguish such bales from other combustible fibers.

In order to counteract some erroneous information regarding the combustibility characteristics of densely packed cotton bales, flammability research was conducted on baled cotton. The research demonstrated that densely packed baled cotton meeting the size and weight requirements of ISO 8115 is not a hazardous material. In view of that data, the U.S. Department of Transportation (DOT) (U.S. Coast Guard), the United Nations (U.N.) and the International Maritime Organization (IMO) have all removed baled cotton from the list of hazardous materials and

flammable solids, provided the cotton bales are the densely packed type that meet the standard noted above. The research conclusions were:

1. Standard cotton fiber “passed” the DOT spontaneous combustion test: the cotton did not exceed the oven temperature and was not classified as self-heating.
2. Cotton, as densely packed baled cotton, did not cause sustained smoldering propagation: an electric heater placed within the bale was unable to cause sustained smoldering propagation, due to the lack of oxygen inside the densely packed bale.
3. Cotton, as densely packed baled cotton, was exposed to ignition from a cigarette and a match and performed very well: no propagating combustion with either.
4. Cotton, as densely packed baled cotton, was exposed to ignition from the gas burner source in ASTM E1590 (also known as California Technical Bulletin 129) of 12 L/min of propane gas for 180 seconds and passed all the criteria, including mass loss of less than 1.36 kg (3 pounds), heat release rate less than 100 kW and total heat release of less than 25 MJ in the first 10 minutes of the test.

**Seed cotton.** Perishable raw agricultural commodity consisting of cotton fiber (lint) attached to the seed of the cotton plant, which requires ginning to become a commercial product.

- ❖ Before cotton can be spun into yarn or thread and woven into cloth, the fibers must be separated from their seeds by a cotton gin (short for “cotton engine”) in a process called “cotton ginning,” which takes seed cotton and converts it into cotton fibers that are then stored in bales. Thus, seed cotton is a perishable raw material without commercial value that is not stored, but exists simply as a step on the way from the cotton field to the gin plant. Seed cotton is held in modules on the way from the harvest to the ginning factory, and is neither a loose cotton fiber (it has not been converted into fibers yet) nor densely packed baled cotton. As such, it is still a perishable agricultural product.

In the typical harvesting process (for example, grain harvesting), threshing machines are used to separate the raw agricultural product into a product that can then be stored and marketed, such as use as food or animal feed, and a byproduct that is usually left in the field. The cotton ginning process is essentially the same as the grain harvesting process in that a raw agricultural product (seed cotton) is converted by specially designed equipment into products with commercial value. These products are: cotton fiber (that exits the ginning process packaged as densely packed cotton bales and is either stored in a cotton warehouse or shipped to a textile mill) and cotton-

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seeds (that go either to cottonseed oil mills or are fed directly to dairy cattle).

**[BG] COURT.** An open, uncovered space, unobstructed to the sky, bounded on three or more sides by exterior building walls or other enclosing devices.

❖ Though not specifically identified in the definition, the provisions in the code for courts (Section 1206 of the IBC) are only applicable to those areas created by the arrangement of exterior walls and used to provide natural light or ventilation (see Section 1206.1 of the IBC and the definition of “Yard.” See also the definition of “Egress court” for courts that are utilized for exit discharge.)

**[BG] COVERED MALL BUILDING.** A single building enclosing a number of tenants and occupants such as retail stores, drinking and dining establishments, entertainment and amusement facilities, passenger transportation terminals, offices, and other similar uses wherein two or more tenants have a main entrance into one or more malls. Anchor buildings shall not be considered as a part of the covered mall building. The term “covered mall building” shall include open mall buildings as defined below.

❖ The covered mall building is the entire area of the building (area of mall plus gross leasable area), excluding the anchor buildings. Passenger transportation terminals frequently are developed as wide concourses with small shops along the sides. For this reason, passenger transportation facilities are included. Transportation facilities used for freight or other purposes are not to be considered a covered mall building.

**Mall.** A roofed or covered common pedestrian area within a covered mall building that serves as access for two or more tenants and not to exceed three levels that are open to each other. The term “mall” shall include open malls as defined below.

❖ A mall is an interior, climate-controlled pedestrian way that is open to the tenant spaces within the mall building and typically connects to the anchor buildings. The term “mall” also includes open mall. Unless noted otherwise, an open mall must comply with all the provisions for a mall.

**Open mall.** An unroofed common pedestrian way serving a number of tenants not exceeding three levels. Circulation at levels above grade shall be permitted to include open exterior balconies leading to *exits* discharging at grade.

❖ A mall is an interior, climate-controlled pedestrian way that is open to the tenant spaces within the mall building and typically connects to the anchor buildings. The term “mall” also includes open mall. Unless noted otherwise, an open mall must comply with all the provisions for a mall.

**Open mall building.** Several structures housing a number of tenants such as retail stores, drinking and dining establishments, entertainment and amusement facilities, offices, and other similar uses wherein two or more tenants have a

main entrance into one or more open malls. Anchor buildings are not considered as a part of the open mall building.

❖ An open mall building includes all of the buildings housing a number of tenants wherein two or more tenants have a main entrance into one or more open malls. Because the open mall is characterized by there not being a roof connecting one side of the pedestrian mall to the other, the covered mall “building” may actually be a collection of separate buildings which all rely on a shared pedestrian concourse for egress. Similar to the covered mall building, the open mall “building” does not include the anchor buildings. Unless noted otherwise, open mall buildings must comply with all the provisions for covered mall buildings.

**CRITICAL CIRCUIT.** A circuit that requires continuous operation to ensure safety of the structure and occupants.

❖ The purpose of this definition is to clarify the applicability of the provisions of Section 604.3 of the code. Critical circuits are those electrical circuits supplying power to systems and equipment that are vital to the safety of building occupants and to the operational continuity of safety systems such as fire alarm systems, security systems, emergency communication systems and similar systems identified throughout the code, most notably in sections pertaining to emergency power. Although the term “critical circuit” is used widely throughout many industry standards, there is no specific definition for the term. As such, this definition was created based on definitions found in NFPA 70 and is similar to the definition of “Critical Operations Power Systems (COPS)” in that standard (see the commentary to Section 604.3).

**CRYOGENIC CONTAINER.** A cryogenic vessel of any size used for the transportation, handling or storage of *cryogenic fluids*.

❖ This definition is necessary to differentiate containers that hold cryogenic fluids from those that are used for ordinary compressed gases as addressed in Chapter 53, flammable and combustible liquids as addressed in Chapter 57 or other liquid or gaseous hazardous materials. Because of the extreme pressures and temperatures, these containers are unique in construction (see also commentary for the definition of “Container”).

**CRYOGENIC FLUID.** A fluid having a *boiling point* lower than -130°F (-89.9°C) at 14.7 pounds per square inch atmosphere (psia) (an absolute pressure of 101.3 kPa).

❖ This definition contains the criteria for determining whether Chapter 55 is applicable. If a fluid falls outside of these criteria, it would likely be treated as a compressed gas and addressed within Chapter 53 (see also the definition for “Compressed gas”).

**CRYOGENIC VESSEL.** A pressure vessel, low-pressure tank or atmospheric tank designed to contain a *cryogenic fluid* on which venting, insulation, refrigeration or a combina-

tion of these is used in order to maintain the operating pressure within the design pressure and the contents in a liquid phase.

- ❖ Cryogenic vessels differ from basic containers in that they are designed for use as either a pressure vessel, a low-pressure tank or an atmospheric tank that regulates the operating pressure to maintain the fluid as a liquid. Such vessels not only contain the fluids but also play an active role in regulating the state of the fluids.

**[BG] CUSTODIAL CARE.** Assistance with day-to-day living tasks; such as assistance with cooking, taking medication, bathing, using toilet facilities and other tasks of daily living. Custodial care includes persons receiving care who have the ability to respond to emergency situations and evacuate at a slower rate and/or who have mental and psychiatric complications.

- ❖ Care facilities encompass a full spectrum of occupant acuity and support services and span a wide range of occupancy types, including Groups E, I, and R. There are three types of care defined in the IBC and IFC: personal, custodial, and medical.

- Personal care is on one end of the care spectrum. It occurs in Group E occupancies for child day care services for persons over 2<sup>1</sup>/<sub>2</sub> years of age. Occupants are supervised but do not need custodial or medical care.
- Custodial care occurs in Groups I-1, I-4 and R4, where occupants may be elderly or impaired, or require adult or child day care of any age. Care recipients may need daily living assistance such as cooking, cleaning, bathing or help with taking medications. Persons who receive custodial care may or may not require assistance with evacuation depending on the occupancy and the “condition” in the occupancy. See also the commentary to the definitions of Groups I-1, I-4 and R4.
- Medical care occurs in Group I-2 occupancies on the opposite end of the spectrum, where care recipients are incapable of self-preservation. They may be completely bedridden, meaning bed movement may be required during emergencies, and may be dependent on life support systems such as medical gases and emergency power to maintain life. This level of acuity is not allowed in custodial care or personal care.

There are two other key defining aspects of custodial care that also differentiate it from medical care. The first is the evacuation capability of custodial care recipients. Custodial care recipients’ evacuation capabilities are limited by the occupancy classification criteria or the occupancy condition in which care occurs. Group I-1 Condition 1 and Group R-4 Condition 1 only includes occupants with the ability to self-evacuate. Group I-1 Condition 2 and Group R-4 Condition 2 includes limited assistance

with evacuation. Group I-4 also assumes that the occupants may not be able to respond on their own during emergencies. The second differentiating aspect is that Group I-1 and R-4 custodial care recipients also participate in fire drills in accordance with the code, versus Group I-2 medical care that implements defend-in-place strategies during emergencies.

The level of care provided describes the condition and capabilities of an occupant which then indicates the appropriate standards for protection systems, both active and passive. See also the definitions of “24-hour basis,” “Ambulatory care facility,” “Detoxification facilities,” “Foster care facilities,” “Group home,” “Hospitals and psychiatric hospitals,” “Incapable of self-preservation,” “Medical care,” “Nursing homes” and “Personal care service.”

**CYLINDER.** A pressure vessel designed for pressures higher than 40 psia (275.6 kPa) and having a circular cross section. It does not include a portable tank, multiunit tank car tank, cargo tank or tank car.

- ❖ As referenced in the code, cylinders are vessels containing flammable or nonflammable compressed gases. Gas cylinders are fabricated to comply with regulations specified by DOTn and are generally limited to a capacity equivalent to the volume of 1,000 pounds (454 kg) of water.

**DAMPER.** See “Fire damper” and “Smoke damper.”

**DAY BOX.** A portable magazine designed to hold *explosive* materials and constructed in accordance with the requirements for a Type 3 magazine as defined and classified in Chapter 56.

- ❖ Day boxes are basically Type 3 magazines used to isolate in-process material from a workstation as a means to minimize the potential for involvement should an event occur within the immediate vicinity of the work area. See the commentary to Section 5604.5.1.3 for a more complete discussion of the use of day boxes.

**DECORATIVE MATERIALS.** All materials applied over the building interior finish for decorative, acoustical or other effect including, but not limited to, curtains, draperies, fabrics, streamers and all other materials utilized for decorative effect including, but not limited to, bulletin boards, artwork, posters, photographs, paintings, batting, cloth, cotton, hay, stalks, straw, vines, leaves, trees, moss and similar items, foam plastics and materials containing foam plastics. Decorative materials do not include wall coverings, ceiling coverings, floor coverings, ordinary window shades, interior finish and materials 0.025 inch (0.64 mm) or less in thickness applied directly to and adhering tightly to a substrate.

- ❖ Decorative materials have historically been characterized by easily ignitable materials that burn very rapidly and contribute to fire spread. In order to properly classify decorative materials, it is important to define the term and this definition captures the essential elements. The significance of this definition is to provide information as to what is not regulated as

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decorative materials in the application of code requirements. While any dictionary would define floor coverings, window shades and wallpaper as being “decorative” in a building interior, they are not considered decorative materials for the flame-resistance testing to which the code requirements are intended to apply (see Section 807).

**DEFLAGRATION.** An exothermic reaction, such as the extremely rapid oxidation of a flammable dust or vapor in air, in which the reaction progresses through the unburned material at a rate less than the velocity of sound. A deflagration can have an explosive effect.

❖ Materials posing a deflagration hazard usually burn very quickly with an energy release from a chemical reaction in the form of intense heat. Confined deflagration hazards under pressure can result in an explosion. Most hazardous materials posing a severe deflagration hazard are classified as Group H-2.

**DELUGE SYSTEM.** A sprinkler system employing open sprinklers attached to a piping system connected to a water supply through a valve that is opened by the operation of a detection system installed in the same area as the sprinklers. When this valve opens, water flows into the piping system and discharges from all sprinklers attached thereto.

❖ A deluge system applies large quantities of water or foam throughout the protected area by means of a system of open sprinklers. In a fire, the system is activated by a fire detection system that makes it possible to apply water to a fire more quickly and to cover a larger area than with a conventional automatic sprinkler system, which depends on sprinklers being activated individually as the fire spreads. As the definition indicates, the sprinklers are open. There is no fusible link so when water is admitted into the system by the fire detection system, it flows through the piping and is immediately discharged through the sprinkler heads.

Deluge systems are particularly beneficial in hazardous areas where the fuel loads (combustible contents) are of such a nature that fire may grow with exceptional rapidity and possibly flash ahead of the operations of conventional automatic sprinklers.

**DESIGN PRESSURE.** The maximum gauge pressure that a pressure vessel, device, component or system is designed to withstand safely under the temperature and conditions of use expected.

❖ A container that is subjected to an internal pressure higher than its design pressure faces a high failure rate. If the container is used to store flammable liquids or gases, a boiling liquid expanding vapor explosion (BLEVE), which is a form of pressure-releasing explosion, may occur.

**DETACHED BUILDING.** A separate single-story building, without a *basement* or crawl space, used for the storage or use

of hazardous materials and located an *approved* distance from all structures.

❖ This term refers to the type of structure that the code recognizes for using and storing Group H materials exceeding MAQ. A detached storage building is required only for Group H, as indicated in Table 5003.8.2 of the code or Table 415.6.2 of the IBC, and as may be required in Chapters 50 through 67 of the code.

**DETEARING.** A process for rapidly removing excess wet coating material from a dipped or coated object or material by passing it through an electrostatic field.

❖ Detearing applies to dip tank operations. It is the process of rapidly removing excess wet coating materials from an object.

**DETECTOR, HEAT.** A fire detector that senses heat, either abnormally high temperature or rate of rise, or both.

❖ In a fire, heat is released that causes the temperature in a room or space to increase. Automatic fire detectors that sense abnormally high temperature or rate of temperature rise are known as heat detectors. These include fixed temperature detectors, rate compensation detectors and rate-of-rise detectors. The code requires all automatic fire detectors to be smoke detectors, except that heat detectors tested and approved in accordance with NFPA 72 may be used as an alternative to smoke detectors in rooms and spaces where, during normal operation, products of combustion are present in sufficient quantity to actuate a smoke detector.

**DETONATING CORD.** A flexible cord containing a center core of high *explosive* used to initiate other *explosives*.

❖ Outwardly, detonating cord, or primacord, is somewhat similar to a safety fuse in size and appearance. But instead of being filled with black powder, detonating cord generally contains pentaerythritol tetranitrate (PETN). Like other explosives, primacord is generally set off by a blasting cap. It propagates a detonation at a rate of 9,000 yards per second (8.23 km/s), a little over 5 miles per hour (8.05 km/h). A length of detonating cord stretching from San Francisco to New York will explode over its entire length of 3,000 miles (4828.03 km) in about 10 minutes.

**DETONATION.** An exothermic reaction characterized by the presence of a shock wave in the material which establishes and maintains the reaction. The reaction zone progresses through the material at a rate greater than the velocity of sound. The principal heating mechanism is one of shock compression. *Detonations* have an *explosive* effect.

❖ Detonations are distinguished from deflagrations, which are produced by explosive gases, dusts, vapors and mists, by the speed with which they propagate a blast effect. Both detonations and deflagra-

tions may produce explosive results when they occur in a confined space.

**DETONATOR.** A device containing any initiating or primary *explosive* that is used for initiating *detonation*. A detonator shall not contain more than 154.32 grains (10 grams) of total *explosives* by weight, excluding ignition or delay charges. The term includes, but is not limited to, electric blasting caps of instantaneous and delay types, blasting caps for use with safety fuses, detonating cord delay connectors, and noninstantaneous and delay blasting caps which use detonating cord, shock tube or any other replacement for electric leg wires. All types of detonators in strengths through No. 8 cap should be rated at 1½ pounds (0.68 kg) of explosives per 1,000 caps. For strengths higher than No. 8 cap, consult the manufacturer.

❖ These devices contain a primary explosive charge and are used to initiate other explosives. Detonators include, but are not limited to:

1. Electric detonators of instantaneous and delay types.
2. Detonators for use with safety fuses, detonating cord delay connectors and nonelectric instantaneous delay detonators that use detonating cord, shock tube or any other replacement for electric leg wires.

**[BG] DETOXIFICATION FACILITIES.** Facilities that provide treatment for substance abuse serving care recipients who are incapable of self-preservation or who are harmful to themselves or others.

❖ Persons in detoxification facilities may be physically incapable of self-preservation, or they may be confined within an area of a building for care or security

purposes. See the commentary for the definition of “Occupancy Group I-2” and Section 407 of the IBC.

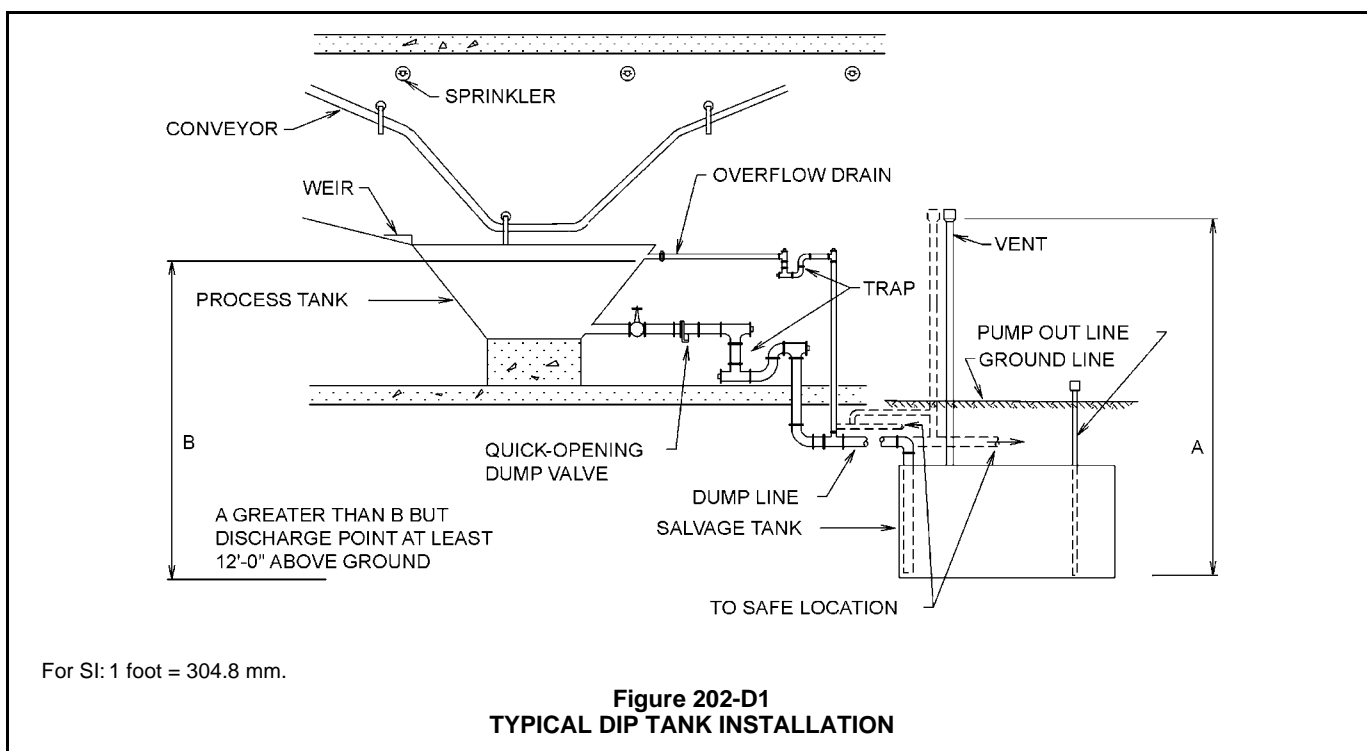
Care facilities encompass a full spectrum of acuity and support services and span a wide range of occupancy types including Groups B, E, I and R. The level of care provided describes the condition and capabilities of an occupant which, in turn, indicates appropriate standards for protection systems, both passive and active. See also the definitions for “24-hour basis,” “Ambulatory care facility,” “Group home,” “Hospitals and psychiatric hospitals,” “Incapable of self-preservation,” “Medical care,” “Nursing homes” and “Personal care service.”

**DIP TANK.** A tank, vat or container of flammable or combustible liquid in which articles or materials are immersed for the purpose of coating, finishing, treating and similar processes.

❖ Dip tanks can be almost any size, depending on the size of the work pieces to be immersed. They may be equipped with a fire suppression system, as well as overflow and drain pipes, all of which are based on the tank size. Regardless of size, dip tanks must be constructed of noncombustible materials, equipped with an approved self-closing cover and properly ventilated (see Commentary Figure 202-D1).

**DISCHARGE SITE.** The immediate area surrounding the fireworks mortars used for an outdoor fireworks display.

❖ The area selected for the discharge of aerial shells must be located so that the trajectory of the shells does not come within 25 feet (7620 mm) of any overhead object. Ground display pieces must be located a minimum distance of 75 feet (22 860 mm) from spectator viewing areas and parking areas.



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**DISPENSING.** The pouring or transferring of any material from a container, tank or similar vessel, whereby vapors, dusts, fumes, mists or gases are liberated to the atmosphere.

- ❖ This term refers to any transfer of a hazardous material from one container to another that is open to the atmosphere where liberation of the material in the forms listed in the definition occurs. See also the definitions for “Closed system” and “Handling.”

**DISPENSING DEVICE, OVERHEAD TYPE.** A dispensing device that consists of one or more individual units intended for installation in conjunction with each other, mounted above a dispensing area typically within the motor fuel-dispensing facility canopy structure, and characterized by the use of an overhead hose reel.

- ❖ Dispensing devices are approved pieces of fixed equipment that control the dispensing of fuel through the dispensing hose connected to them. An overhead-type dispensing device is not to be confused with the conventional dispenser, often referred to as a “high-hose” dispenser, that is equipped with a dispensing hose connected at the top of the dispenser frame. The intent of this provision is to identify the overhead hose reel that has special requirements for the classification of electrical equipment in the vicinity of the reel in accordance with Chapter 8 of NFPA 30A.

**DISPLAY SITE.** The immediate area where a fireworks display is conducted. The display area includes the discharge site, the fallout area and the required separation distance from the mortars to spectator viewing areas. The display area does not include spectator viewing areas or vehicle parking areas.

- ❖ Where added safety precautions have been taken, or particularly favorable conditions exist, the fire code official can decrease the required separation distances upon demonstration that the hazard has been reduced or the risk has been properly protected. Where unusual or safety-threatening conditions exist, he or she can also increase the required separation distances as he or she deems necessary.

**DOOR, BALANCED.** See “Balanced door.”

- ❖ See the commentary to definition of “Balanced door.”

**DOOR, DUTCH.** See “Dutch door.”

- ❖ See the commentary to definition of “Dutch door.”

**DOOR, LOW ENERGY POWER-OPERATED.** See “Low energy power-operated door.”

- ❖ See the commentary to definition of “Low energy power-operated door.”

**DOOR, POWER-ASSISTED.** See “Power-assisted door.”

- ❖ See the commentary to definition of “Power-assisted door.”

**DOOR, POWER-OPERATED.** See “Power-operated door.”

- ❖ See the commentary to definition of “Power-operated door.”

**DOORWAY, EXIT ACCESS.** See “Exit access doorway.”

- ❖ See the commentary to definition of “Exit access doorway.”

**[BG] DORMITORY.** A space in a building where group sleeping accommodations are provided in one room, or in a series of closely associated rooms, for persons not members of the same family group, under joint occupancy and single management, as in college dormitories or fraternity houses.

- ❖ Dormitories typically consist of a large room serving as a community sleeping room or many smaller rooms grouped together and serving as private or semiprivate sleeping rooms (sleeping units). A typical setting for dormitories is on college campuses; however, sleeping areas of a fire station and similar lodging facilities for occupants not of the same family group are also considered dormitories. Dormitories most often are not the permanent residence of the occupants. They are typically occupied only for a designated period of time, such as a school year. Though limited, the period of occupancy is usually more than 30 days, which provides the occupant with a familiarity of the structure such that the occupancy is not considered transient. A dormitory is classified as Group R-2 (see the commentary to the definition of “Occupancy Group R-2”).

Structures containing a dormitory often have a cafeteria or central eating area and common recreational areas. When such conditions exist, the structure must comply with the mixed occupancy provisions of Section 508 of the IBC.

**DRAFT CURTAIN.** A structure arranged to limit the spread of smoke and heat along the underside of the ceiling or roof.

- ❖ A draft curtain restricts the passage of smoke at roof or ceiling level. Located at the roof or ceiling, draft curtains are designed to compartmentalize the roof or ceiling area in order to limit the passage of smoke to a defined area and hinder its spread throughout the entire storage area. It has also been argued that such curtains help the activation of smoke and heat vents. They are not intended to have a fire-resistance rating. Draft curtains are often termed “curtain boards.”

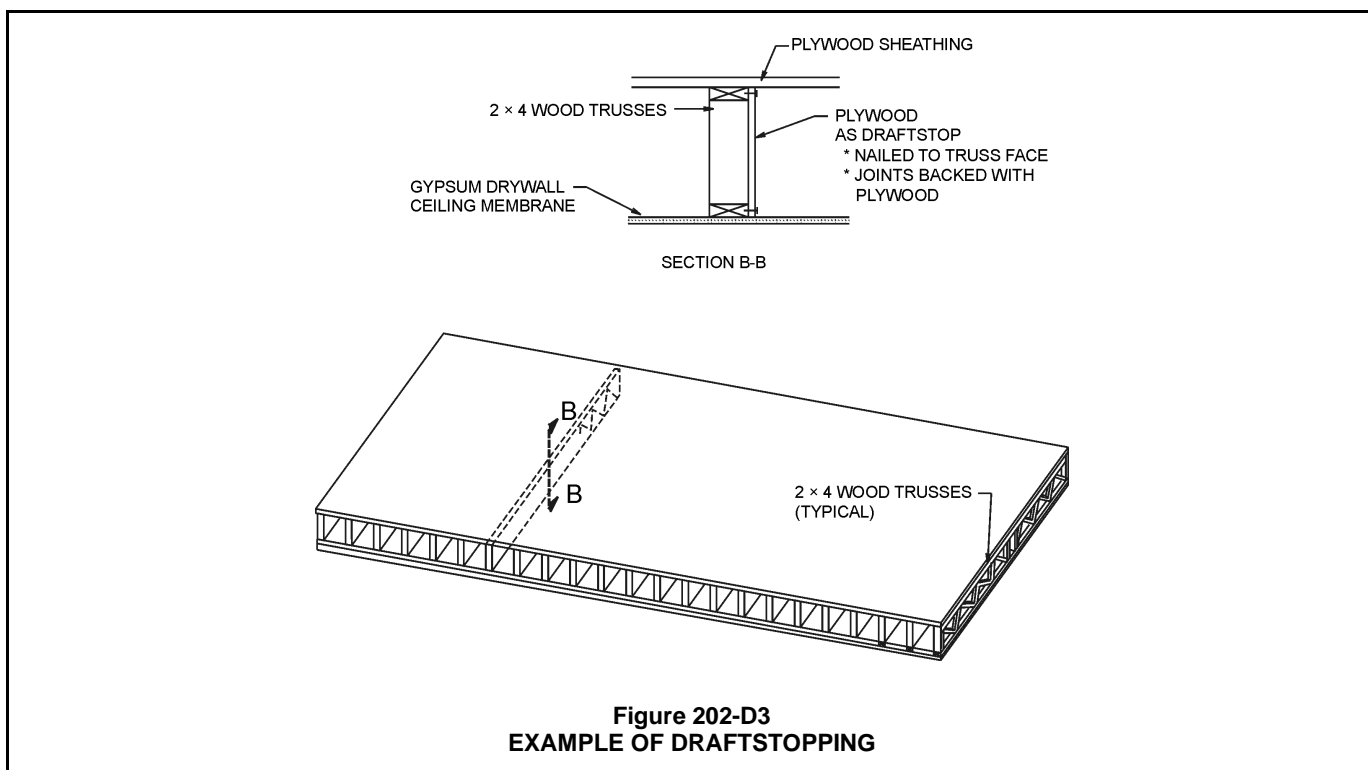
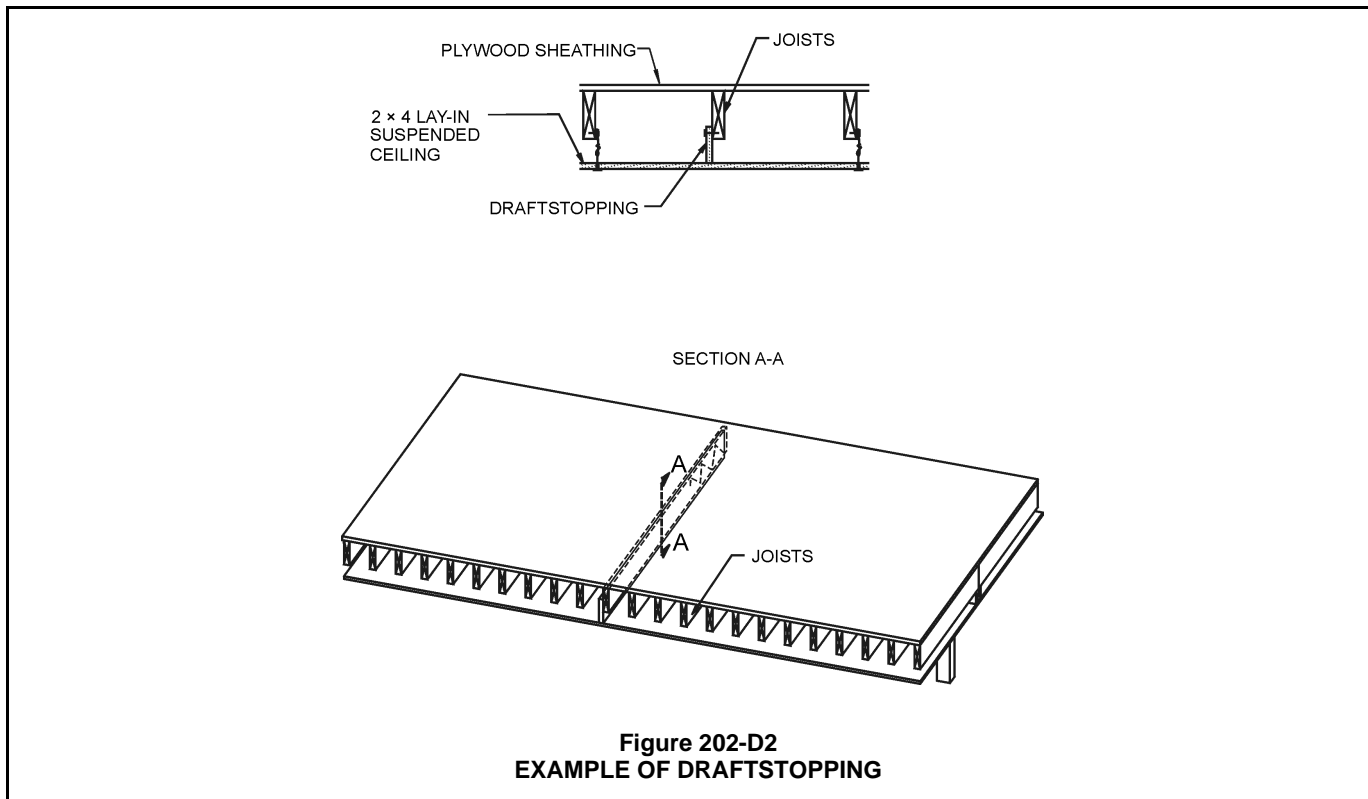
**[BF] DRAFTSTOP.** A material, device or construction installed to restrict the movement of air within open spaces of concealed areas of building components such as crawl spaces, floor/ceiling assemblies, roof/ceiling assemblies and attics.

- ❖ Draftstopping is required in concealed combustible spaces to limit the movement of air, smoke and other products of combustion. Draftstopping materials are permitted to be combustible based on the rationale that a large and thick enough combustible material will act as a hindrance against the free movement of air, flame/fire and products of combustion [see Commentary Figures 202-D2 and 202-D3 for typical draftstopping applications (also see Section 718 of the IBC)].

Although the term “draftstopping” would seem to imply that its primary purpose is to hinder the circula-

tion of air within the space, its intended purpose is to stop the movement of fire and products of combustion, as evidenced by the fact that draftstopping can be omitted in some cases when appropriate automatic sprinkler protection is installed (see Sections 718.3.2, 718.3.3, 718.4.2 and 718.4.3 of the IBC).

**DRY-CHEMICAL EXTINGUISHING AGENT.** A powder composed of small particles, usually of sodium bicarbonate, potassium bicarbonate, urea-potassium-based bicarbonate, potassium chloride or monoammonium phosphate, with added particulate material supplemented by special treatment



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to provide resistance to packing, resistance to moisture absorption (caking) and the proper flow capabilities.

- ❖ A dry-chemical system extinguishes a fire by placing a chemical barrier between the fire and oxygen, which acts to smother a fire. This system is best known for protection for commercial ranges, commercial fryers and exhaust hoods. Wet-chemical extinguishing systems, however, are more commonly used for new installations in commercial cooking equipment.

The type of dry chemical to be used in the extinguishing system is a function of the hazard expected. The type of dry chemical used in a system must not be changed, unless it has been proven changeable by a testing laboratory; is recommended by the manufacturer of the equipment and is acceptable to the fire code official for the hazard expected. Additional guidance on the use of various dry-chemical agents can be found in NFPA 17, which gives minimum requirements for the design, installation, testing, inspection, approval, operation and maintenance of dry-chemical extinguishing systems.

**DRY CLEANING.** The process of removing dirt, grease, paints and other stains from such items as wearing apparel, textiles, fabrics and rugs by use of nonaqueous liquids (solvents).

- ❖ Dry cleaning is the process of cleaning textile-based items in a closed machine using solvents that are not water based; hence, the term “dry.” This process generally consists of a “wash cycle” in which the item or items to be cleaned are placed in the machine with the dry cleaning solvent and tumbled for a predetermined length of time, followed by an “extraction cycle” in which the solvent is centrifugally removed from the clean items, not unlike the “spin” cycle of a washing machine. Recovery of remaining solvent and solvent vapors in the cleaned articles is accomplished in a “reclamation cycle,” which involves heating the cleaned articles to vaporize the remaining solvent, which is then collected and condensed. Finally, an “aeration” or drying cycle occurs where warm air dries and deodorizes the cleaned articles. The dry cleaning process can also include the manual application of solvent and spotting compounds prior to the main cleaning process. See also the definitions of “Dry cleaning plant” and “Solvent or liquid classifications.”

**DRY CLEANING PLANT.** A facility in which dry cleaning and associated operations are conducted, including the office, receiving area and storage rooms.

- ❖ The type of construction, occupancy group classification and other building requirements are determined by the type of solvent and machinery used in the cleaning process. The main hazards in a dry cleaning plant are the fire hazards of the flammable and combustible solvents and the health hazards of the chlorinated hydrocarbon solvents. See also the definitions

of “Dry cleaning” and “Solvent or liquid classifications.”

**DRY CLEANING ROOM.** An occupiable space within a building used for performing dry cleaning operations, the installation of solvent-handling equipment or the storage of dry cleaning solvents.

- ❖ The IBC defines an occupiable space as “a room or enclosed space designed for human occupancy....in which occupants are engaged at labor....” Within the context of Chapter 21, a dry cleaning room is primarily the room or space in which the actual dry cleaning process is conducted. Depending on the scope of the dry cleaning establishment, it could be a room or space within a large plant or could encompass the entire plant in smaller operations. Note that the focus of the term is on the presence of the dry cleaning solvent, whether it is in the cleaning process, being stored for future use within the room or space, or being transferred from storage containers to the dry cleaning machines. See also the definitions of “Dry cleaning,” “Dry cleaning plant” and “Solvent or liquid classifications.”

**DRY CLEANING SYSTEM.** Machinery or equipment in which textiles are immersed or agitated in solvent or in which dry cleaning solvent is extracted from textiles.

- ❖ This term focuses on the actual dry cleaning machines and solvent extractors that use or recover dry cleaning solvent. Systems are classified according to the hazards of the solvent they use. See the commentary to Sections 2103.2 and 2105 for additional discussion of dry cleaning system classification and operation, respectively. See also the definition of “Solvent or liquid classifications.”

**DUTCH DOOR.** A door divided horizontally so that the top can be operated independently from the bottom.

- ❖ This definition is associated with the requirements in Section 1105.4.4.2.3 for existing Group I-2 occupancies. Dutch doors have been used in health care facilities for many years for various necessary operational reasons. Existing language in the IBC does not specifically address dutch doors. Their use is not prohibited, but if used, they must meet the requirements contained in IBC Section 407.3, including positive latching and limiting the transfer of smoke. The definition is provided for additional clarity as to what is considered a “dutch door.”

**[BG] DWELLING.** A building that contains one or two *dwelling units* used, intended or designed to be used, rented, leased, let or hired out to be occupied for living purposes.

- ❖ Dwellings are buildings intended to serve as residences for one or two families. Dwellings can be owner-occupied or rented. The term “dwelling,” which refers to the building itself, is defined to distinguish it from the term “dwelling unit,” which is a single living

unit within a building. See also the definition for “Townhouse.”

**[BG] DWELLING UNIT.** A single unit providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation.

❖ A dwelling unit, as stated, is a residential unit that contains all of the necessary facilities for independent living. This provides a single, independent unit that serves a single family or single group of individuals. This terminology is used throughout the code for the determination of the application of various provisions. A dwelling unit is also distinguished from a sleeping unit which does not have all of the features of a dwelling unit and must comply with a different set of requirements (see the definition for “Sleeping unit”). A building containing one or more dwelling units is a “dwelling” (see the definitions for “Dwelling” and “Townhouse”). A building containing three or more dwelling units is regulated as a Group R-2 occupancy. The most common term used for such a building is an apartment house or condominium. To be considered a Group R-3, the structure must have one or two dwelling units, or be subdivided by fire walls between every unit or every two units.

**EARLY SUPPRESSION FAST-RESPONSE (ESFR) SPRINKLER.** A sprinkler *listed* for early suppression fast-response performance.

❖ The early suppression fast-response (ESFR) sprinkler head was originally designed to provide fire suppression for heat and fire situations that required a lower thermal response to activate the sprinkler head earlier than the standard sprinkler head. The ESFR sprinkler heads have a response time index (RTI) of 50 (meters-seconds)  $\frac{1}{2}$  or less, compared to a standard sprinkler head, which has an RTI of 80 (meters-seconds)  $\frac{1}{2}$  or more. ESFR sprinkler design requires the same concepts of sprinkler system design for it to react and suppress a fire when needed. The important difference is that ESFR systems are specifically designed to suppress a high-challenge fire versus simply controlling its growth.

**[BE] EGRESS COURT.** A court or *yard* which provides access to a *public way* for one or more *exits*.

❖ The egress court requirements address situations where the exit discharge portion of the means of egress passes through confined areas near the building and therefore faces a hazard not normally found in the exit discharge (see Section 1028.4).

**ELECTROSTATIC FLUIDIZED BED.** A container holding powder coating material that is aerated from below so as to form an air-supported expanded cloud of such material that is electrically charged with a charge opposite to that of the object to be coated. Such object is transported through the

container immediately above the charged and aerated materials in order to be coated.

❖ Because the powder used in the electrostatic fluidized bed is not as finely divided as that used in electrostatic spray methods, it is not likely to create a dust explosion potential. Electrostatic fluidized beds allow for the coating of materials that then must be cured in a baking oven (see also Chapter 30). This method of coating is typically used for small pieces [dimensions less than 4 inches (102 mm)].

**ELEVATOR GROUP.** A grouping of elevators in a building located adjacent or directly across from one another that respond to a common hall call button(s).

❖ This definition clarifies the application of the emergency voice/alarm communication system requirements in Section 907.5.2.2 as to the locations, called “paging zones,” where system speakers are required (see commentary, Section 907.5.2.2).

**EMERGENCY ALARM SYSTEM.** A system to provide indication and warning of emergency situations involving hazardous materials.

❖ Because of the potentially volatile nature of hazardous materials, an emergency alarm system is required outside of interior building rooms or areas containing hazardous materials in excess of the maximum allowable quantities permitted in Tables 5003.1.1(1) and 5003.1.1(2). The intent of the emergency alarm, upon actuation by an alarm-initiating device, is to alert the occupants to an emergency condition involving hazardous materials. The initiation of the emergency alarm can be by manual or automatic means depending on the hazard and the specific requirements for the type of hazard (see commentary, Sections 908, 5004.9 and 5005.4.4).

**EMERGENCY CONTROL STATION.** An *approved* location on the premises where signals from emergency equipment are received and which is staffed by trained personnel.

❖ This definition identifies the room or area located in the HPM facility that is used to receive various alarms and signals. The smoke detectors located in the building’s recirculation ventilation ducts, the gas-monitoring/detection system and the telephone/fire protective signaling systems located outside of HPM storage rooms must all be connected to the emergency control station. The location of this station must be approved by the fire code official. An approved location should be based on personnel being able to adequately monitor the necessary alarms and signals and on the fire department being able to gain access quickly when responding to emergency situations. Additionally, the room must be occupied by persons who are trained to respond to the various alarms and signals.

**[BE] EMERGENCY ESCAPE AND RESCUE OPENING.** An operable window, door or other similar device that

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provides for a means of escape and access for rescue in the event of an emergency.

❖ These are commonly windows that are sized and located such that they can be used to exit a building directly from a basement or bedroom during an emergency condition. The openings are also used by emergency personnel to rescue the occupants in a building (see Section 1030). Windows are never considered to be exit or exit access components for purposes of meeting minimum number of exit requirements. An emergency escape and rescue opening could be a type of door, such as a basement door with direct access to an exterior stairway or a door to a balcony. Bulkhead-style cellar doors could also be evaluated as possible emergency escape and rescue openings.

**EMERGENCY EVACUATION DRILL.** An exercise performed to train staff and occupants and to evaluate their efficiency and effectiveness in carrying out emergency evacuation procedures.

❖ This definition provides a consistent explanation of the purpose and extent of such activities. Without drilling the staff and occupants in the emergency procedures for which they have been trained, neither management nor the staff or occupants can adequately gauge their readiness to perform in a crisis mode.

**EMERGENCY POWER SYSTEM.** A source of automatic electric power of a required capacity and duration to operate required life safety, fire alarm, detection and ventilation systems in the event of a failure of the primary power. Emergency power systems are required for electrical loads where interruption of the primary power could result in loss of human life or serious injuries.

❖ This definition is intended to provide clarity for the fire code official as to exactly what systems are considered to be emergency power systems and is consistent with the definitions in NFPA 110 and NFPA 111. However, since the list of systems in the definition is not exhaustive, reference must be made to Section 604 of the code which provides the “where required” provisions. When the normal power supply to any of the indicated systems, or other systems designated by the code, fails, the emergency power system is to provide a specified degree and duration of illumination or power for systems and equipment that are essential for life safety. See the commentary to Section 604 for more detailed discussion on the difference between standby and emergency power.

**EMERGENCY SHUTOFF VALVE.** A valve designed to shut off the flow of gases or liquids.

❖ See the commentary following the definition of “Emergency shutoff valve, manual.”

**EMERGENCY SHUTOFF VALVE, AUTOMATIC.** A fail-safe automatic-closing valve designed to shut off the

flow of gases or liquids initiated by a control system that is activated by automatic means.

❖ See the commentary following the definition of “Emergency shutoff valve, manual.”

**EMERGENCY SHUTOFF VALVE, MANUAL.** A manually operated valve designed to shut off the flow of gases or liquids.

❖ The term “emergency shutoff valve” has historically been used inconsistently throughout various sections in the code. There are fundamentally two types of shutoff valves commonly employed: manually operated or automatically operated. Those that are automatic can either fail open or fail closed. A valve that fails in the closed position is said to be “fail-safe.” Automatic valves are actuated by a control system that may activate the valves either automatically or manually. The code requires the manual activation of controls that are used to operate automatic valves.

Three definitions are now provided for emergency valves to include the function of the valve itself and the two subsets that describe the two types encountered (e.g., manual or automatic). See also the commentary to the definitions of “Fail-safe” and “Remotely located, manually activated shutdown control.”

**EMERGENCY VOICE/ALARM COMMUNICATIONS.** Dedicated manual or automatic facilities for originating and distributing voice instructions, as well as alert and evacuation signals pertaining to a fire emergency, to the occupants of a building.

❖ An emergency voice/alarm communication system is a special feature of fire alarm systems in buildings with special evacuation considerations, such as a high-rise building or a large assembly space. Emergency voice/alarm communication systems automatically communicate a fire emergency message to all occupants of a building on a general or selective basis. Such systems also enable the fire service to manually transmit voice instructions to the building occupants about a fire emergency condition and the action to be taken for evacuation or movement to another area of the building. Although most systems use prerecorded messages, some now use computer synthesized voices to communicate customized messages that are unique to the facility.

**[BG] EMPLOYEE WORK AREA.** All or any portion of a space used only by employees and only for work. *Corridors, toilet rooms, kitchenettes and break rooms are not employee work areas.*

❖ An employee work area is different in an office versus on a factory line. An employee work area will most likely expand past the station or desk where an employee performs his or her job. An employee work area could include common use spaces, but not public use spaces. Depending on the duties of the

employee, it may also include copy areas, stock rooms, filing areas, an assembly line, etc. (see also the commentary for the definitions of “Common use” and “Public-use areas”).

Note that not all employee-only areas are considered part of employee work areas (i.e., bathrooms, corridors, breakrooms).

**[BG] EQUIPMENT PLATFORM.** An unoccupied, elevated platform used exclusively for mechanical systems or industrial process equipment, including the associated elevated walkways, *stairways*, *alternating tread devices* and ladders necessary to access the platform (see Section 505.3 of the *International Building Code*).

❖ A distinction is made between equipment platforms and mezzanines by way of this definition. Equipment platforms, covered in Section 505.3 of the IBC, are unoccupied and used exclusively for housing equipment and providing access thereto, and are not subject to the requirements for mezzanines. Their purpose could also be to allow access for maintenance, repair or modification of elevated or very large equipment. Equipment platforms allow efficient use of high bay areas by locating infrequently accessed equipment or processes overhead without the occupant load or increasing the hazard to occupants in the room. Elevated floor areas that do not meet this definition would be subject to the requirements for mezzanines.

**EXCESS FLOW CONTROL.** A fail-safe system or other *approved* means designed to shut off flow caused by a rupture in pressurized piping systems.

❖ This refers to a fail-safe valve or other approved device that is required on pressurized piping systems to prevent the uncontrolled release of excess quantities of hazardous liquids and gases if piping or valve failure occurs. To safeguard as much piping as practical, the device must be installed as close to the supply container as possible.

**EXCESS FLOW VALVE.** A valve inserted into a *compressed gas* cylinder, portable tank or stationary tank that is designed to positively shut off the flow of gas in the event that its predetermined flow is exceeded.

❖ Such a valve has the ability to shut down flow when the intended flow rate has been exceeded. Quite often, when the predetermined flow has been exceeded, a failure will occur.

**EXHAUSTED ENCLOSURE.** An appliance or piece of equipment which consists of a top, a back and two sides providing a means of local exhaust for capturing gases, fumes, vapors and mists. Such enclosures include laboratory hoods, exhaust fume hoods and similar appliances and equipment used to retain and exhaust locally the gases, fumes, vapors and mists that could be released. Rooms or areas provided with general ventilation, in themselves, are not exhausted enclosures.

❖ When a hazardous chemical is being dispensed or used, an exhausted enclosure can be used to reduce

the exposure of personnel to a toxic or hazardous atmosphere. These enclosures have special requirements for protection (see Section 5003.8.5).

**EXISTING.** Buildings, facilities or conditions that are already in existence, constructed or officially authorized prior to the adoption of this code.

❖ This term is specifically defined to reduce any confusion regarding the application of the code to existing buildings, facilities and conditions. This definition would include anything that has already been in use, is already constructed or has been approved by the jurisdiction prior to the adoption of the code. If an occupancy changes use significantly, it may be considered new in some cases.

**[BE] EXIT.** That portion of a *means of egress* system between the *exit access* and the *exit discharge* or *public way*. Exit components include exterior exit doors at the *level of exit discharge*, *interior exit stairways* and *ramps*, *exit passageways*, *exterior exit stairways* and *ramps* and *horizontal exits*.

❖ Exits are the critical element of the means of egress system that the building occupants travel through to reach the exterior at the level of exit discharge. Exit stairways and ramps from upper and lower stories must be separated from adjacent areas with fire-resistance-rated construction. The fire-resistance-rated construction serves as a barrier between the fire and the means of egress and protects the occupants while they travel through the exit. Separation by fire-resistance-rated construction is not required, however, where the exit leads directly to the exterior at the level of exit discharge (e.g., exterior door at grade). Commentary Figure 202-E1 illustrates three different types of exits: interior exit stairway, exterior exit stairway and exterior exit door.

A horizontal exit, while not discharging to the outside, does discharge to another building or refuge area. The door to the refuge area is through a fire wall or fire barrier (see the definition for “Horizontal exit” and Section 1026).

**[BE] EXIT ACCESS.** That portion of a *means of egress* system that leads from any occupied portion of a building or structure to an *exit*.

❖ The exit access portion of the means of egress consists of all floor areas that lead from usable spaces within the building to the exit or exits serving that floor area. Crawl spaces and concealed attic and roof spaces are not considered to be part of the exit access. As shown in Commentary Figure 202-E2, the exit access begins at the furthest points within each room or space and ends at the entrance to the exit.

**[BE] EXIT ACCESS DOORWAY.** A door or access point along the path of egress travel from an occupied room, area or space where the path of egress enters an intervening room, *corridor*, *exit access stairway* or *ramp*.

❖ Exit access doorways are used to design many critical aspects of the means of egress including arrangement, number, separation, opening protection and

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exit sign placement. The term “doorway” has traditionally been limited to those situations where an actual opening, either with or without a door, is present. With “access point,” the term “exit access doorway” is inclusive of specific points in the means of egress which may not include a “door” such as when an unenclosed exit access stairway is used in the egress path.

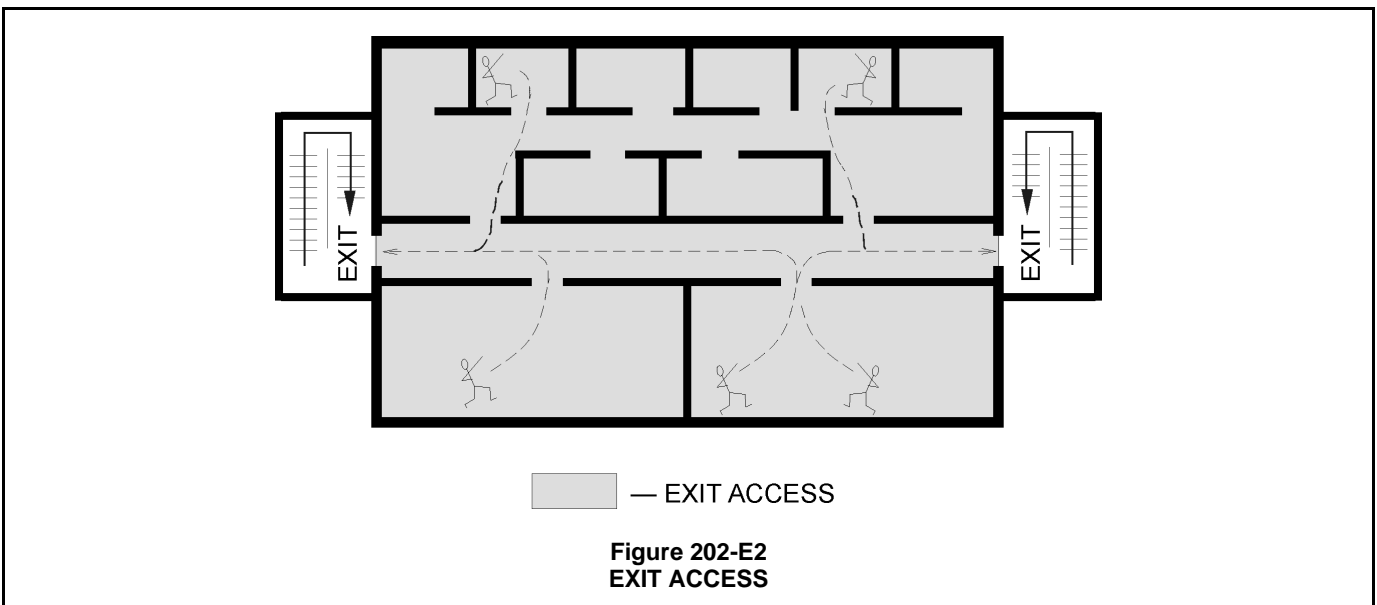
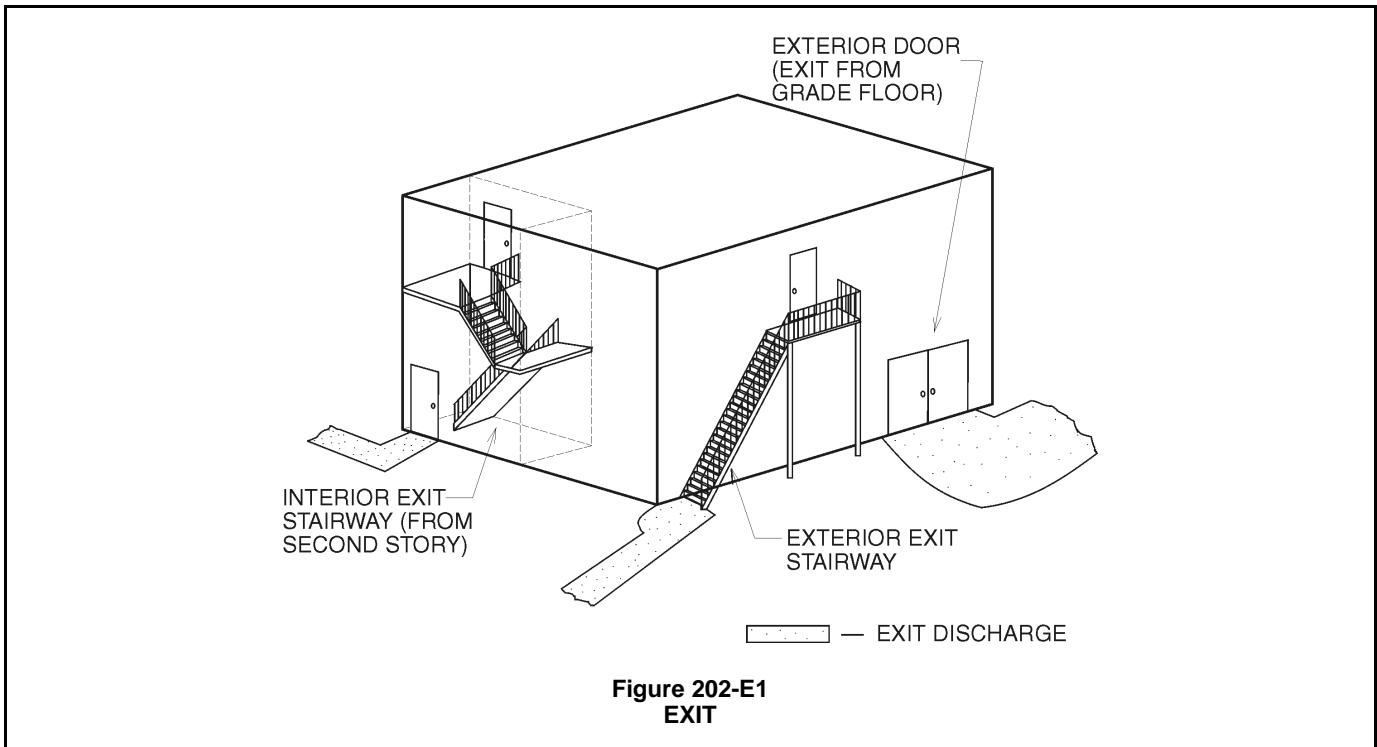
**[BE] EXIT ACCESS RAMP.** A ramp within the exit access portion of the means of egress system.

- ❖ Unenclosed ramps may serve as part of the route for exit access when floor levels have changes in elevation.

tion. For the limited situations where exit access ramps can be used between stories, see Sections 1006.3 and 1019. Exit access elements are included in the travel distance requirements unless specifically exempted (i.e., open parking garages, outdoor facilities) (see Section 1017.3.1).

**[BE] EXIT ACCESS STAIRWAY.** A stairway within the exit access portion of the means of egress system.

- ❖ Unenclosed steps and stairways may serve as part of the route for exit access when floor levels have changes in elevation. For the limited situations where exit access stairways can be used between stories,



see Sections 1006.3 and 1019. Exit access elements are included in the travel distance requirements unless specifically exempted (i.e., open parking garages, outdoor facilities) (see Section 1017.3.1).

**[BE] EXIT DISCHARGE.** That portion of a *means of egress* system between the termination of an *exit* and a *public way*.

❖ The exit discharge will typically begin when the building occupants reach the exterior at or very near grade level. It provides occupants with a path of travel away from the building. All components between the building and the public way are considered to be the exit discharge, regardless of the distance. In areas of sloping terrain, it is possible to have steps or stairs in the exit discharge leading to the public way. The exit discharge is part of the means of egress and, therefore, its components are subject to the requirements of the code (see Commentary Figures 202-E1 and 202-E3 and Section 1028).

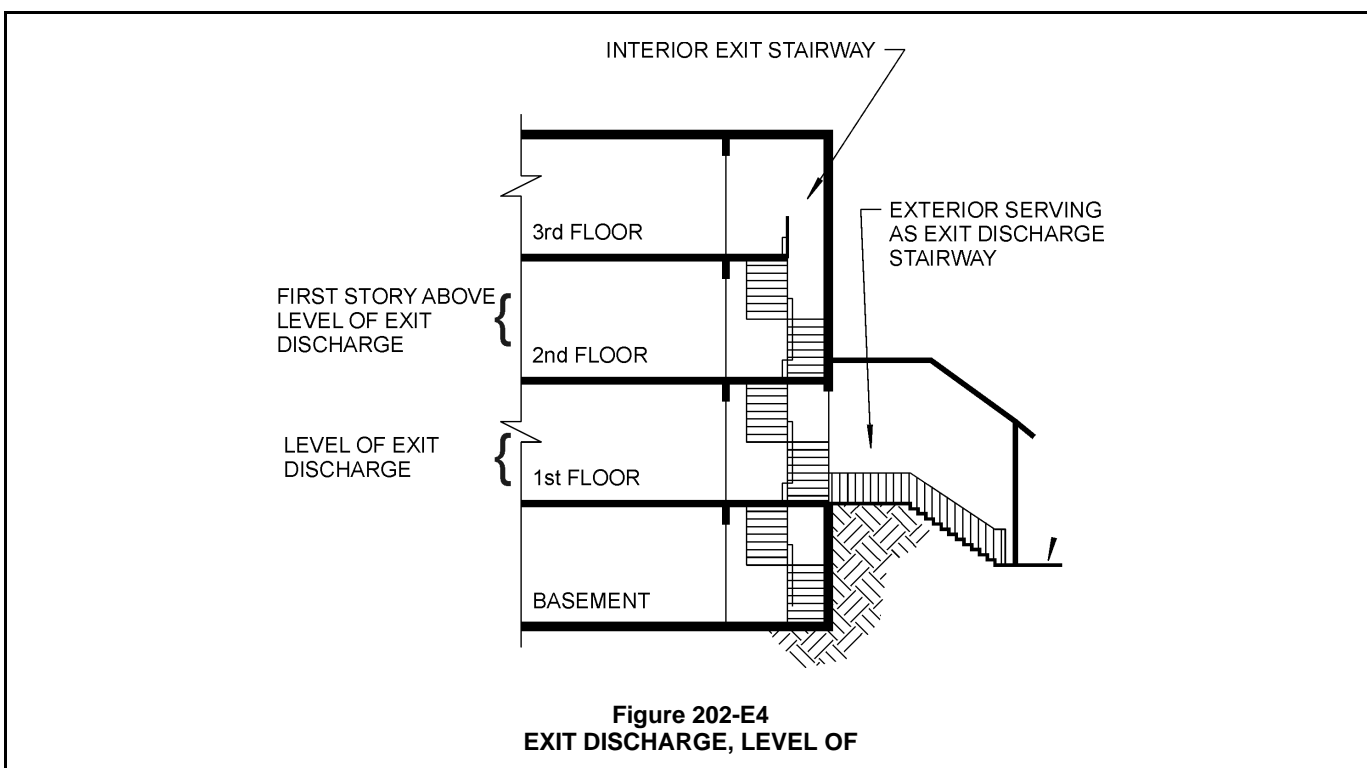
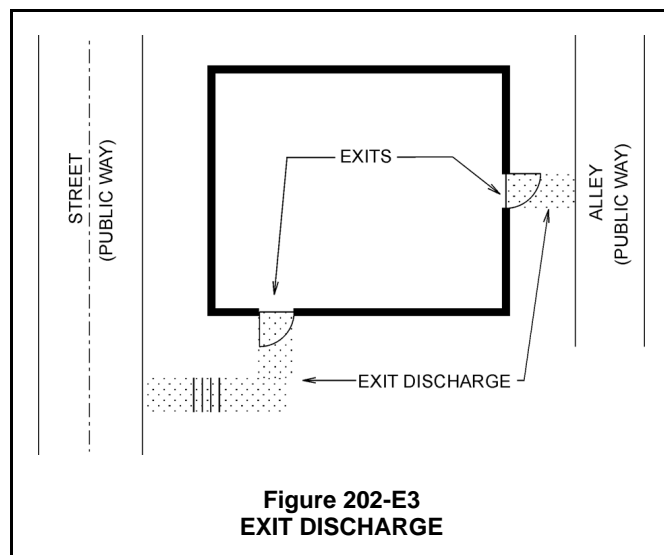
**[BE] EXIT DISCHARGE, LEVEL OF.** The *story* at the point at which an *exit* terminates and an *exit discharge* begins.

❖ The term is intended to describe the story where the transition from exit to exit discharge occurs. At this level, the occupant needs only to move in a substantially horizontal path to move along exit discharge (see Commentary Figure 202-E4). Since the level is a volume rather than a horizontal plane, exterior exit steps may be part of the exit discharge when they provide access to the level that is closest to grade.

**[BE] EXIT PASSAGEWAY.** An *exit* component that is separated from other interior spaces of a building or structure by

fire-resistance-rated construction and opening protectives, and provides for a protected path of egress travel in a horizontal direction to the *exit discharge*.

❖ This term refers to a horizontal portion of the means of egress that serves as an exit element. Since an exit passageway is considered an exit element, it must be protected and separated as required by the code for exits (see Section 1024). Exit passageways between a vertical exit enclosure and an exterior exit door are typically found on the level of exit discharge to provide a protected path from a centrally located exit stairway to the exit discharge. In taller buildings that reduce floor sizes as they move up (sometimes



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called a wedding cake building), exit passageways are sometimes utilized at “transfer floors” where stairway shaft locations shift outward as the floor size increases. Exit passageways that lead to an exterior exit door are commonly used in malls to satisfy the travel distance in buildings having a large floor area.

**EXPANDED PLASTIC.** A foam or cellular plastic material having a reduced density based on the presence of numerous small cavities or cells dispersed throughout the material.

❖ Expanded plastic is a synthetic or natural organic material that, under high temperatures or pressures, can be shaped, formed and molded into any shape and maintain that shape at ambient temperatures. Plastics are combustible materials, some of which will give off toxic gases when exposed to fire. The most commonly recognized expanded plastic product is a disposable coffee cup. When plastic is expanded, it becomes much more susceptible to combustion due to the larger surface area of the material per unit weight.

**EXPLOSION.** An effect produced by the sudden violent expansion of gases, which may be accompanied by a shock wave or disruption, or both, of enclosing materials or structures. An explosion could result from any of the following:

1. Chemical changes such as rapid oxidation, *deflagration* or *detonation*, decomposition of molecules and runaway polymerization (usually *detonations*).
2. Physical changes such as pressure tank ruptures.
3. Atomic changes (nuclear fission or fusion).

❖ Buildings containing materials that pose a threat of explosion are classified as Group H-1 when such materials are present in quantities exceeding the MAQ in Table 5003.1.1(1). Such buildings are required to be a detached storage building meeting the requirements of Section 415.6 of the IBC and Chapter 56 of the code.

**EXPLOSIVE.** A chemical compound, mixture or device, the primary or common purpose of which is to function by explosion. The term includes, but is not limited to, dynamite, black powder, pellet powder, initiating explosives, detonators, safety fuses, squibs, detonating cord, igniter cord, igniters and display fireworks, 1.3G.

The term “Explosive” includes any material determined to be within the scope of USC Title 18: Chapter 40 and also includes any material classified as an explosive other than consumer fireworks, 1.4G by the hazardous materials regulations of DOTn 49 CFR Parts 100-185.

❖ Explosives either detonate or deflagrate, rather than burn, when initiated by either heat, shock or electric current. Although these materials are normally designed and intended to be initiated by detonators under controlled conditions, heat, shock and electric current from uncontrolled sources may initiate these materials to produce an explosion.

**High explosive.** *Explosive material*, such as dynamite, which can be caused to detonate by means of a No. 8 test blasting cap where unconfined.

❖ High explosives can also deflagrate, but they are capable of even more. Before any appreciable amount of gas can escape and reduce the pressure, the body of the explosive is completely vaporized. The strength of a particular explosive depends on the amount of gas and heat it produces. At the very instant of their formation, the gases in a high-explosive state occupy only the original volume of the explosive material. Gas pressures can soar above 1 million pounds per square inch (psi); temperatures of 6,000°F (3316°C) and higher are common. Rapid expansion must occur and pressure waves move out at enormous velocities, often supersonic, doing tremendous damage.

**Low explosive.** *Explosive material* that will burn or deflagrate when ignited. It is characterized by a rate of reaction that is less than the speed of sound. Examples of low *explosives* include, but are not limited to, black powder, safety fuse, igniters, igniter cord, fuse lighters, fireworks, 1.3G and propellants, 1.3C.

❖ In low-explosive materials the burning rate is rapid but the created gases still have time to escape as the explosive is consumed. Gunpowder, for example, burns extremely rapidly and the gases are put to work, projecting an object out of a gun barrel. Pressures remain relatively low when the explosive is unconfined. Low explosive, like black powder, will deflagrate (burn intensely), producing a visible flame, such as a muzzle flash, but they do not ordinarily detonate.

**Mass-detonating explosives.** Division 1.1, 1.2 and 1.5 *explosives* alone or in combination, or loaded into various types of ammunition or containers, most of which can be expected to explode virtually instantaneously when a small portion is subjected to fire, severe concussion, impact, the impulse of an initiating agent or the effect of a considerable discharge of energy from without. Materials that react in this manner represent a mass explosion hazard. Such an *explosive* will normally cause severe structural damage to adjacent objects. Explosive propagation could occur immediately to other items of ammunition and *explosives* stored sufficiently close to and not adequately protected from the initially exploding pile with a time interval short enough so that two or more quantities must be considered as one for quantity-distance purposes.

❖ Mass-detonating explosives (typically stored in occupancies classified as Group H-1 by the IBC) present a detonation hazard, as do high explosives, and present a greater threat to adjacent objects and structures. The code, therefore, contains provisions in Table 5605.3 to deal with the separation distances for mass-explosion hazards.

**UN/DOtn Class 1 explosives.** The former classification system used by DOTn included the terms “high” and “low” *explosives* as defined herein. The following terms further define *explosives* under the current system applied by DOTn for all *explosive materials* defined as hazard Class 1 materials. Compatibility group letters are used in concert with the division to specify further limitations on each division noted (for example, the letter G identifies the material as a pyrotechnic substance or article containing a pyrotechnic substance and similar materials).

❖ The Department of Transportation (DOT) issued new regulations in 1991 based on the United Nations Recommendations on the Transportation of Dangerous Goods for the transportation of hazardous materials. DOT’s hazardous materials requirements with respect to hazard communications, classifications and packaging of explosives were revised by the new regulations.

**Division 1.1.** *Explosives* that have a mass explosion hazard. A mass explosion is one which affects almost the entire load instantaneously.

**Division 1.2.** *Explosives* that have a projection hazard but not a mass explosion hazard.

**Division 1.3.** *Explosives* that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.

**Division 1.4.** *Explosives* that pose a minor explosion hazard. The explosive effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire must not cause virtually instantaneous explosion of almost the entire contents of the package.

**Division 1.5.** Very insensitive *explosives*. This division is comprised of substances that have a mass explosion hazard but which are so insensitive that there is very little probability of initiation or of transition from burning to *detonation* under normal conditions of transport.

**Division 1.6.** Extremely insensitive articles which do not have a mass explosion hazard. This division is comprised of articles that contain only extremely insensitive detonating substances and which demonstrate a

negligible probability of accidental initiation or propagation.

❖ The DOT puts explosives in six classes according to the degree of hazard posed by the material (see Commentary Figure 202-E5). The most dangerous of these materials is capable of almost simultaneous detonation of all of the material in a single load or store. The least sensitive explosives produce blasts limited to the packages in which they are transported. This definition of “Explosive” includes materials such as: detonators, blasting agents and water gels. Examples of these materials are listed in DOTy 27, CFR 55.23.

**EXPLOSIVE MATERIAL.** The term “explosive” material means *explosives*, blasting agents and detonators.

❖ A list of explosive materials is maintained by the ATF pursuant to 18 USC, Chapter 40. This list (ATF Publication 5400.8) is available at no cost from the ATF Distribution Center, 7943 Angus Court, Springfield, VA 22153.

**[BE] EXTERIOR EXIT RAMP.** An *exit* component that serves to meet one or more *means of egress* design requirements, such as required number of *exits* or *exit access* travel distance, and is open to yards, courts or *public ways*.

❖ Requirements for an exterior exit ramp are different from those for an interior exit ramp. Exterior exit ramps are typically outside of the building, provide exits from levels above or below the level of exit discharge, and are exposed to at least some elements of weather. The protection requirements therefore are for the exterior walls between the building and the ramp, rather than interior walls. For the ramp requirements, see Section 1012. For specifics for exterior exit ramps, see Section 1027

**[BE] EXTERIOR EXIT STAIRWAY.** An *exit* component that serves to meet one or more *means of egress* design requirements, such as required number of *exits* or *exit access* travel distance, and is open to yards, courts or *public ways*.

❖ Requirements for an exterior exit stairway are different from those for an interior exit stairway. Exterior exit stairways are typically outside of the building,

BATF	OLD DOTn <sup>a</sup>	NEW DOTn <sup>b, c</sup>	Description
High Explosives	Class A Explosives	Division 1.1	Mass Explosion Potential
		Division 1.2	Projectile Hazard
Low Explosives	Class B Explosives	Division 1.3	Predominantly a Fire Hazard
	Class C Explosives	Division 1.4	No Significant Blast Hazard
Blasting Agents	Blasting Agents	Division 1.5	Very Sensitive Explosives
	Dangerous	Division 1.6	Extremely Insensitive Detonating Substances

a. Prior to September 30, 1991.

b. Effective October 1, 1991.

c. *International Fire Code* and new DOT classifications correlate.

**Figure 202-E5  
COMPARISON OF CLASSIFICATION SYSTEMS FOR EXPLOSIVE MATERIALS**

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provide exits from above or below the level of exit discharge, and are exposed to at least some elements of weather. The protection requirements therefore are for the exterior walls between the building and the stairway, rather than interior walls. For the stairway requirements, see Section 1011. For specifics for exterior exit stairways, see Section 1027.

**[BF] EXTERIOR WALL.** A wall, bearing or nonbearing, that is used as an enclosing wall for a building, other than a *fire wall*, and that has a slope of 60 degrees (1.05 rad) or greater with the horizontal plane.

❖ A wall is defined as an exterior element that encloses a structure and that has a slope equal to or greater than 60 degrees (1.05 rad) from the horizontal plane. Exterior enclosing elements with slopes less than this are generally subjected to more severe weather exposure than vertical surfaces and thus may experience a greater amount of water intrusion. These sloped surfaces, which may include elements, such as inset windowsills, sloped parapets and other architectural elements, should be designed to resist water penetration in a manner similar to a roof.

**EXTRA-HIGH-RACK COMBUSTIBLE STORAGE.** Storage on racks of Class I, II, III or IV commodities that exceed 40 feet (12 192 mm) in height and storage on racks of high-hazard commodities that exceed 30 feet (9144 mm) in height.

❖ This term was generated to address those storage areas that were of unusual height, and where that height would have an influence on the building or structure, the contents and the safeguards from the hazards of a fire or explosion. Extra-high-rack combustible storage is common to building occupancies that require a substantial amount of storage of commodities (supply) necessary to ensure that the process remains operational. An example of this type of storage is an automotive assembly plant where the rack storage contains a sufficient amount of material to service the assembly plant operation for several days or weeks.

**FABRICATION AREA.** An area within a semiconductor fabrication facility and related research and development areas in which there are processes using hazardous production materials. Such areas are allowed to include ancillary rooms or areas such as dressing rooms and offices that are directly related to the fabrication area processes.

❖ This definition describes the basic component of an HPM facility. The code uses this definition to set certain material limitations based on both quantity and density, and to require enclosure of the fabrication areas with fire-barrier assemblies in accordance with Section 707 of the IBC, or horizontal assemblies in accordance with Section 711 of the IBC. The fabrication area of an HPM facility is the area where the hazardous materials are actively handled and processed. The fabrication area includes accessory rooms and spaces, such as workstations and employee dressing rooms.

**[A] FACILITY.** A building or use in a fixed location including exterior storage areas for flammable and combustible substances and hazardous materials, piers, wharves, tank farms and similar uses. This term includes recreational vehicles, mobile home and manufactured housing parks, sales and storage lots.

❖ The scope of a fire code is broader than the scope of a building code, in that it addresses outdoor storage, tank farms, fire department access and similar activities. The term “facility” helps to more clearly define this scope to clarify the application of this code. As noted in the definition, a building would be included in the definition for “Facility.” This definition differs from that used in Chapter 11 of the IBC, which addresses the topic of accessibility for those with disabilities.

**FAIL-SAFE.** A design condition incorporating a feature for automatically counteracting the effect of an anticipated possible source of failure; also, a design condition eliminating or mitigating a hazardous condition by compensating automatically for a failure or malfunction.

❖ This definition provides consistency of terminology among the 11 sections of the code that use the term. A fail-safe design can include an automatic emergency shutoff valve that is designed to close upon loss of power or a process upset condition. It may include an excess flow control valve or feature which is designed to stop the flow of a gas or liquid when a preset flow rate is exceeded. In most cases, the fail-safe condition would stop the movement or processing of hazardous materials. The definition is based on a combination of a definition from *Webster’s Third New International Dictionary of the English Language, Unabridged* and NFPA 70E definitions of the term.

**FALLOUT AREA.** The area over which aerial shells are fired. The shells burst over the area, and unsafe debris and malfunctioning aerial shells fall into this area. The fallout area is the location where a typical aerial shell dud falls to the ground depending on the wind and the angle of mortar placement.

❖ The area described by this definition is a large, unoccupied open space that functions as a “safety zone” between the fireworks display launch area and the spectator areas and is included in the display site definition in this section. The layout of the fallout area is usually centered around the location of, and takes into account the launch angle of, the mortars used to launch the aerial displays. Local weather wind direction and speed forecasts may also affect the layout of the area. The fallout area provides a relatively safe area in which display debris and dud or malfunctioned shells may fall and is the starting point for the post-display inspection required by Section 5608.9. Within the fallout area, no spectators or vehicles should be allowed, and the area should be free of combustible materials that could be ignited by falling debris. In reviewing the fallout area site plan, the presence and location of trees, brush and other vege-

tation that could “hide” undetonated shells or be a fire ignition hazard should be considered. In some cases, it may be necessary to wet down the fallout area to further reduce the ignition hazard to vegetation by falling hot debris.

**FALSE ALARM.** The willful and knowing initiation or transmission of a signal, message or other notification of an event of fire when no such danger exists.

- ❖ The term “false alarm” can have several meanings beyond what this particular definition provides. This definition states that for the purposes of the code a false alarm is an unnecessary, intentional activation of a fire alarm system, signal or message. It would not include alarm activation as a result of a malfunctioning detector.

**FINES.** Small pieces or splinters of wood byproducts that will pass through a 0.25-inch (6.4 mm) screen.

- ❖ Fines range in size from sawdust to chips and are usually accumulated in piles.

**FIRE ALARM.** The giving, signaling or transmission to any public fire station, or company or to any officer or employee thereof, whether by telephone, spoken word or otherwise, of information to the effect that there is a fire at or near the place indicated by the person giving, signaling or transmitting such information.

- ❖ This is a general definition intended to clarify that a fire alarm is not simply a fire alarm system. This definition would allow a person’s actions to be considered part of the fire alarm. The key is that a fire alarm notifies the correct persons or group of persons, such as the fire department or a central station, of a fire.

**FIRE ALARM BOX, MANUAL.** See “Manual fire alarm box.”

**FIRE ALARM CONTROL UNIT.** A system component that receives inputs from automatic and manual fire alarm devices and may be capable of supplying power to detection devices and transponder(s) or off-premises transmitter(s). The control unit may be capable of providing a transfer of power to the notification appliances and transfer of condition to relays or devices.

- ❖ The fire alarm control unit (panel) acts as a point where all signals initiated within the protected building are received before the signal is transmitted to a constantly attended location. As the name implies, it also contains controls to test and manually activate or silence systems.

**FIRE ALARM SIGNAL.** A signal initiated by a fire alarm-initiating device such as a manual fire alarm box, automatic fire detector, waterflow switch or other device whose activation is indicative of the presence of a fire or fire signature.

- ❖ This signal is transmitted to a fire alarm control unit as a warning that requires immediate action. The personnel at the constantly attended location are trained to immediately respond to a fire alarm signal, which indicates the presence of a fire. A fire alarm signal assumes an actual fire has been detected (see the

definition of “Alarm signal”). The fire alarm signal is not the signal used to notify the occupants of an emergency condition. Such an action would involve the audible alarm, visual alarm or emergency voice/alarm notification appliances.

**FIRE ALARM SYSTEM.** A system or portion of a combination system consisting of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices and to initiate the appropriate response to those signals.

- ❖ Fire alarm systems are installed in buildings to limit fire casualties and property losses by notifying the occupants of the building, the local fire department or both of an emergency condition. The alarm notification appliances associated with fire alarm systems are intended to be evacuation alarms. All fire alarm systems must be designed and installed to comply with NFPA 72. The term is among the most generic terms used in the code. It does not necessarily imply an automatic or manual system, nor does it identify what type of notification, if any, should be provided. The definition only indicates that an appropriate response must be provided but does not indicate what that response must be. The appropriate responses are identified within the respective sections of Section 907.

**FIRE APPARATUS ACCESS ROAD.** A road that provides fire apparatus access from a fire station to a facility, building or portion thereof. This is a general term inclusive of all other terms such as *fire lane*, public street, private street, parking lot lane and access roadway.

- ❖ Fire apparatus access roads are required to be all-weather surfaced roadways that are designed for the weight and type of emergency vehicle that may use the road. No specific surface material is required for a fire apparatus access roadway. It is up to the fire code official to decide whether the surface will support the load of the anticipated emergency vehicles in accordance with Section 503.2.3.

It should be noted that this is a general term intended to include any private roadway providing the required access to a building. As such, private driveways could be included and subject to the provisions of Section 503.

**[BF] FIRE AREA.** The aggregate floor area enclosed and bounded by *fire walls*, *fire barriers*, *exterior walls* or *horizontal assemblies* of a building. Areas of the building not provided with surrounding walls shall be included in the fire area if such areas are included within the horizontal projection of the roof or floor next above.

- ❖ This term is used to describe a specific and controlled area within a building that may consist of a portion of the floor area within a single story, one entire story or the combined floor area of several stories, depending on how these areas are enclosed and separated from other floor areas. Where a fire barrier with a fire-resistance rating in accordance with Section 707.3.10 of the IBC divides the floor area of a one-story building,

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the floor area on each side of the wall would constitute a separate fire area. If a horizontal assembly separating the two stories in a two-story building is fire-resistance rated in accordance with Section 711.2.4 of the IBC, each story would be a separate fire area. In cases where mezzanines are present, the floor area of the mezzanine is included in the fire area calculations, even though the area of the mezzanine does not contribute to the building area calculations. See the commentary to Sections 707.3.10 and 711.2.4 of the IBC for further information. Note that, while fire walls are one way of creating fire areas, they are typically used to create separate buildings.

**[BF] FIRE BARRIER.** A fire-resistance-rated wall assembly of materials designed to restrict the spread of fire in which continuity is maintained.

- ❖ The term represents wall assemblies with a fire-resistance rating that are constructed in accordance with Section 707 of the IBC. Even though the definition applies to walls, horizontal assemblies can be fire barriers, also. See the definition of “Horizontal assembly” and the requirements in Section 711 of the IBC that apply to floor and roof assemblies designed to restrict the spread of fire.

**FIRE CHIEF.** The chief officer of the fire department serving the jurisdiction, or a duly authorized representative.

- ❖ This definition is necessary to note that when the term “fire chief” is used within the text of the code it is specifically referring to the chief officer of a fire department. This position can be delegated as necessary but must be appropriately authorized.

**FIRE CODE OFFICIAL.** The fire chief or other designated authority charged with the administration and enforcement of the code, or a duly authorized representative.

- ❖ Whoever holds the statutory power to enforce the fire code is termed the “fire code official.” Normally, responsibility for this enforcement is assigned to a fire prevention bureau or related code enforcement department of the state, county or municipality. In the case of a fire department, the role of fire code official is most often given to the fire chief, the fire marshal or the fire inspector. Often with regard to the fire code, the fire code official will be the fire marshal or fire chief. In some cases, direct reference will be made to the fire chief within the code because some situations are specific to the actions of the fire department, such as authority at fire scenes.

**FIRE COMMAND CENTER.** The principal attended or unattended location where the status of detection, alarm communications and control systems is displayed, and from which the system(s) can be manually controlled.

- ❖ Fire command centers are communication centers, typically in high-rise buildings, where dedicated manual and automatic facilities are located for the origination, control and transmission of information and instructions pertaining to a fire emergency to the

occupants (including fire department personnel) of the building. Fire command centers must provide facilities for the control and display of the status of all fire protection (detection, signaling, etc.) systems as well as critical building systems. These fire command centers must be located in secure areas as approved by the fire code official. Often, this is a location near the primary building entrance. Fire command centers may also be combined with other building operations and security facilities, when allowed by the fire code official; however, operating controls for use by the fire department must be clearly marked and not subject to tampering by unauthorized persons (see the commentary to Section 508.1 for further discussion).

**[BF] FIRE DAMPER.** A *listed* device installed in ducts and air transfer openings designed to close automatically upon detection of heat and resist the passage of flame. Fire dampers are classified for use in either static systems that will automatically shut down in the event of a fire, or in dynamic systems that continue to operate during a fire. A dynamic fire damper is tested and rated for closure under elevated temperature airflow.

- ❖ Fire dampers are used primarily in heating, ventilating and air-conditioning (HVAC) duct systems that pass through fire-resistance-rated walls or floors. Dampers may also be installed in rated walls independent of HVAC duct systems. Dampers are provided to maintain the fire-resistance rating of the penetrated assembly. Fire dampers are regulated by UL 555. See also the commentary to the definitions of “Damper” and “Smoke damper.”

**FIRE DEPARTMENT MASTER KEY.** A limited issue key of special or controlled design to be carried by fire department officials in command which will open key boxes on specified properties.

- ❖ Several companies market emergency rapid entry systems and other accessories that use fire department master keys. These keys are used to open key boxes and entry gates, and turn on/off special switches that control electric gates and certain building functions, such as smoke control systems, fans and special processes. These keys are highly secure in their design and very difficult, if not impossible, to duplicate other than by the manufacturer.

**FIRE DETECTOR, AUTOMATIC.** A device designed to detect the presence of a fire signature and to initiate action.

- ❖ Automatic fire detectors include all approved devices designed to detect the presence of a fire and automatically initiate emergency action. These include smoke-sensing fire detectors, heat-sensing fire detectors, flame-sensing fire detectors, gas-sensing fire detectors and other fire detectors that operate on other principles as approved by the fire code official. Automatic fire detectors must be selected based on the type and size of fire to be detected and the response required. The automatic fire detector sends a signal to a processing unit to initiate some predetermined action. The processing unit may be internal to

the device as is the case with single-station smoke detectors or it may be an external unit as in the case of a fire alarm control unit. Automatic fire detectors must be approved, installed and tested to comply with the code and NFPA 72.

**[BF] FIRE DOOR.** The door component of a fire door assembly.

❖ A fire door is the primary component of a fire door assembly. The fire protection rating assigned to a tested fire door is only valid if the door is installed in a labeled frame with appropriate hardware. Installation requirements within the code reference NFPA 80, *Standard for Fire Doors and Other Opening Protectives*. Door ratings are expressed in minutes or hours. Field modification of doors are primarily limited to the mounting of listed hardware.

**[BF] FIRE DOOR ASSEMBLY.** Any combination of a fire door, frame, hardware and other accessories that together provide a specific degree of fire protection to the opening.

❖ Fire door assemblies, (door, frame and hardware) are required to be tested using the appropriate standard and then installed in accordance with NFPA 80. Side-hinged doors, hardware and frames are often manufactured separately with manufacturers' and listing agencies defining acceptable combinations of assembly components that have been tested together.

**[BF] FIRE EXIT HARDWARE.** Panic hardware that is listed for use on fire door assemblies.

❖ Where a door that is required to be of fire-resistance-rated construction also has panic hardware, the hardware is required to be listed for use on the fire door. Thus, fire door hardware has been tested to function properly when exposed to the effects of a fire (see the definition for "Panic hardware" and Section 1010.1.10).

**FIRE LANE.** A road or other passageway developed to allow the passage of fire apparatus. A fire lane is not necessarily intended for vehicular traffic other than fire apparatus.

❖ The term "fire lane" is synonymous with "fire apparatus access road"; however, the driving surface may not be the same as for a public road.

**[BF] FIRE PARTITION.** A vertical assembly of materials designed to restrict the spread of fire in which openings are protected.

❖ Fire partitions are used as wall assemblies to separate adjacent tenant spaces in covered mall buildings, dwelling units, and sleeping rooms, and to enclose corridors and elevator lobbies. Section 708 of the IBC establishes the construction requirements for fire partitions. The fire-resistance ratings, continuity requirements and opening protective requirements for fire partitions are usually less restrictive than those for fire barriers.

**FIRE POINT.** The lowest temperature at which a liquid will ignite and achieve sustained burning when exposed to a test flame in accordance with ASTM D92.

❖ The fire point is the lowest temperature at which a liquid will ignite and sustain burning for a minimum of 5 seconds (fire point) when exposed to the test flame under a specific barometric pressure according to ASTM D92.

**[BF] FIRE PROTECTION RATING.** The period of time that an opening protective assembly will maintain the ability to confine a fire as determined by tests prescribed in Section 716 of the *International Building Code*. Ratings are stated in hours or minutes.

❖ The term "fire protection rating" applies to the fire performance of an opening protective, such as a fire door, which is determined through tests performed in accordance with NFPA 252 or UL 10C.

**FIRE PROTECTION SYSTEM.** Approved devices, equipment and systems or combinations of systems used to detect a fire, activate an alarm, extinguish or control a fire, control or manage smoke and products of a fire or any combination thereof.

❖ A fire protection system is any approved device or equipment used singly or in combination, either manually or automatically, and that is intended to detect a fire, notify the building occupants of a fire or suppress the fire. Fire protection systems include fire suppression systems, standpipe systems, fire alarm systems, fire detection systems, smoke control systems and smoke vents. All fire protection systems must be approved by the fire code official and tested in accordance with the referenced standards and Section 901.6.

**[BF] FIRE RESISTANCE.** That property of materials or their assemblies that prevents or retards the passage of excessive heat, hot gases or flames under conditions of use.

❖ All materials offer some degree of fire resistance. A sheet of plywood has a low level of fire resistance as compared to a concrete block, which has a higher level of fire resistance. The fire resistance of a material or an assembly is evaluated by testing performed in accordance with ASTM E119. Tested materials will be assigned a fire-resistance rating consistent with the demonstrated performance.

**[BF] FIRE-RESISTANCE RATING.** The period of time a building element, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both, as determined by the tests, or the methods based on tests, prescribed in Section 703 of the *International Building Code*.

❖ This refers to the period of time a building element, component or assembly maintains the ability to confine a fire, continues to perform a given structural

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function, or both, as determined by tests or the methods based on tests, prescribed in Section 703 of the IBC.

The fire-resistance rating is developed using standardized test methods (i.e., ASTM E119, etc.). Assemblies rated under these tests are deemed to be able to perform their function for a specified period of time under specific fire conditions (standard time-temperature curve).

The fire-resistance rating is not intended to be a prediction of the actual length of time that an assembly will perform its intended function under actual fire conditions. Although the time-temperature curves of standardized fire test methods are usually selected to approximate at least some real-life fire conditions, the very wide range of actual fire conditions makes the listed fire-resistance rating more of a nominal, comparative index than a predictor of fire-resistance time in any given fire incident.

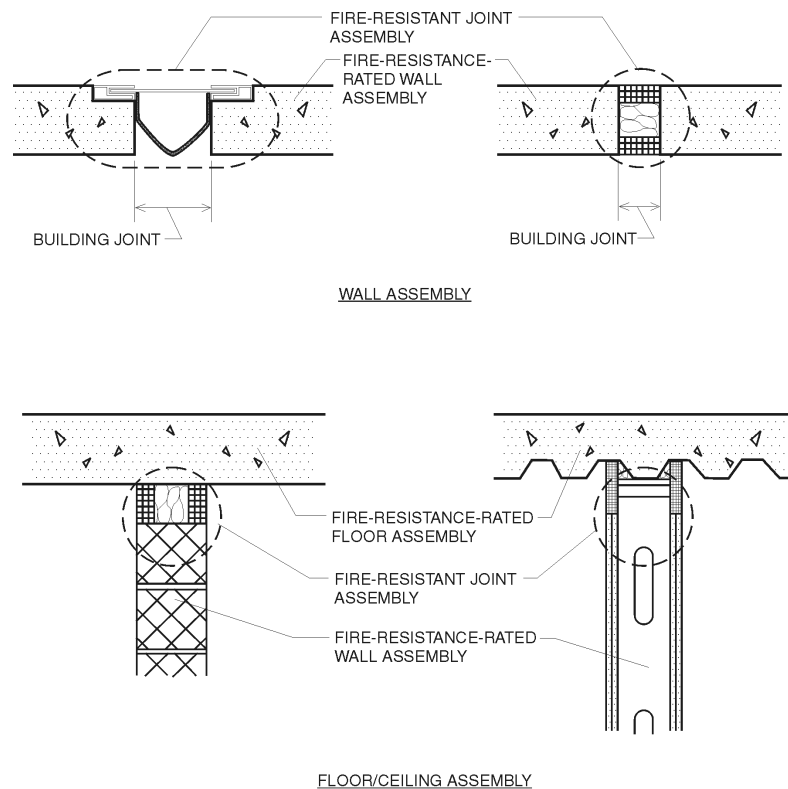
**[BF] FIRE-RESISTANT JOINT SYSTEM.** An assemblage of specific materials or products that are designed, tested and fire-resistance rated in accordance with either ASTM E 1966 or UL 2079 to resist for a prescribed period of time the passage of fire through joints made in or between fire-resistance-rated assemblies.

❖ In order to maintain the fire-resistant integrity of fire-resistance-rated assemblies, joints that occur within an assembly or between adjacent assemblies must

be protected through an installation that has been tested in accordance with ASTM E1966 or UL 2079. Some common examples of applications where a fire-resistant joint system would be required are expansion joints in fire-resistance-rated floors or walls and the junction between fire-resistance-rated floors and walls (see Commentary Figure 202-F1 for examples). The regular joints that occur within a uniform assembly are most often tested as part of fire testing (e.g., in accordance with ASTM E119) for that entire assembly. The required details for these joints are specified in the listings for the underlying assembly. These joints do not need additional testing in accordance with ASTM E1966 or UL 2079. An example of such joints is the joints between individual sheets of gypsum board in a gypsum-sheathed stud wall. Consequently, other than the joints covering or filling the gaps within an assembly, the need for ASTM E1966 or UL 2079 tested joint systems is usually for the joints between dissimilar or adjacent assemblies.

**FIRE SAFETY FUNCTIONS.** Building and fire control functions that are intended to increase the level of life safety for occupants or to control the spread of the harmful effects of fire.

❖ In many cases, automatic fire detectors are installed even in buildings not required to have a fire alarm system. These fire detectors perform specific func-



**Figure 202-F1**  
**EXAMPLES OF FIRE-RESISTANT JOINT SYSTEMS**

tions, such as releasing door hold-open devices, activating elevator recall, smoke damper activation or air distribution system shutdown (see Section 907.3).

**[BF] FIRE SEPARATION DISTANCE.** The distance measured from the building face to one of the following:

1. The closest interior *lot line*.
2. To the centerline of a street, an alley or *public way*.
3. To an imaginary line between two buildings on the lot.

The distance shall be measured at right angles from the face of the wall.

❖ Fire separation distance is the distance from the exterior wall of the building to one of the three following locations, measured perpendicular to the exterior wall face: an interior lot line; the centerline of a street or public way; or an imaginary line between two buildings on the same property. The imaginary line can be located anywhere between the two buildings; it is the designer's choice, but once established, the location of the line applies to both buildings and cannot be revised.

The distance can vary with irregular-shaped lots and buildings. When applying the exterior wall requirements of Table 602 of the IBC, the required exterior wall fire-resistance rating might vary along a building side; for example, where the lot line is not parallel to the exterior wall. For further information, see Chapter 7 of the *IBC Commentary*.

**[BF] FIRE WALL.** A fire-resistance-rated wall having protected openings, which restricts the spread of fire and extends continuously from the foundation to or through the roof, with sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall.

❖ Fire walls must meet the construction requirements in Section 706 of the IBC. The requirements for fire walls are much more restrictive than for fire barriers or fire partitions. The material constituting the fire wall must be noncombustible in all construction types except Type V. The vertical and horizontal continuity requirements are much more restrictive as are the opening protectives. A fire wall also has stringent requirements for continuity and for protection of any openings through it. A fire wall, unlike the fire barrier and fire partition, must be built so it will remain in place if the construction on either side of it collapses. However, the fire wall is not required to remain in place if construction on both sides of it collapses (i.e., the fire wall is not required to be a free-standing or cantilevered wall). Fire walls are used to divide a structure into separate buildings (see the definition of "Area, building"). To be considered separate buildings, the division must be vertical. The term "fire wall" applies to vertically constructed assemblies only and not to horizontal assemblies.

**FIRE WATCH.** A temporary measure intended to ensure continuous and systematic surveillance of a building or portion thereof by one or more qualified individuals for the pur-

poses of identifying and controlling fire hazards, detecting early signs of unwanted fire, raising an alarm of fire and notifying the fire department.

❖ This term is used in several places throughout the code. A fire watch, sometimes referred to as standby personnel, provides temporary fire safety where there are potential hazards, such as during hot work operations or when fire protection systems are out of service. A fire watch is not simply to watch for a fire but also to prevent fire by identifying and controlling fire hazards, such as the separation of combustibles from areas where welding is to occur. A fire watch also provides a method of notifying the fire department if a fire should occur.

**[BF] FIREBLOCKING.** Building materials, or materials *approved* for use as fireblocking, installed to resist the free passage of flame to other areas of the building through concealed spaces.

❖ Fireblocking is required to hinder the concealed spread of flame, heat and other products of combustion within hollow spaces inside of walls or floor/ceiling assemblies. This is done by periodically subdividing that space, as indicated in Section 718.2 of the IBC, using construction materials that have some resistance to fire and by sealing the openings around penetrations through those materials.

Some fireblocking materials are permitted to be combustible based on the rationale that a substantial combustible material will provide a barrier adequate to perform the intended function (also see Section 718 of the IBC).

**FIREWORKS.** Any composition or device for the purpose of producing a visible or an audible effect for entertainment purposes by combustion, *deflagration* or *detonation* that meets the definition of 1.4G fireworks or 1.3G fireworks.

❖ This term refers to any device, other than a novelty or theatrical pyrotechnic article, intended to produce visible or audible effects by combustion, deflagration or detonation and any chemical compound or mechanically mixed preparation of an explosive or inflammable nature that is used for the purpose of making any manufactured fireworks and is not included in any other class of explosives.

**Fireworks, 1.4G.** Small fireworks devices containing restricted amounts of pyrotechnic composition designed primarily to produce visible or audible effects by combustion. Such 1.4G fireworks which comply with the construction, chemical composition and labeling regulations of the DOTn for Fireworks, UN 0336, and the U.S. Consumer Product Safety Commission as set forth in CPSC 16 CFR Parts 1500 and 1507, are not *explosive materials* for the purpose of this code.

❖ The requirements for storage, display and labeling depend on the correct application of this definition. This definition reflects the construction, chemical composition and labeling requirements of the U.S. Consumer Product Safety Commission (CPSC), found in Title 16, Code of Federal Regulations, Parts

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1500 and 1507. Consumer 1.4G fireworks are not considered to be explosives subject to the provisions of Chapter 56. They are, however, subject to the fireworks regulations of the chapter.

**Fireworks, 1.3G.** Large fireworks devices, which are *explosive materials*, intended for use in fireworks displays and designed to produce audible or visible effects by combustion, *deflagration* or *detonation*. Such 1.3G fireworks include, but are not limited to, firecrackers containing more than 130 milligrams (2 grains) of explosive composition, aerial shells containing more than 40 grams of pyrotechnic composition and other display pieces which exceed the limits for classification as 1.4G fireworks. Such 1.3G fireworks are also described as Fireworks, UN 0335 by the DOTn.

- ❖ This category of fireworks represents a considerable life safety hazard in comparison to the consumer 1.4G fireworks. This definition reflects the construction, chemical composition and labeling requirements of the CPSC, found in Title 16, Code of Federal Regulations, Parts 1500 and 1507.

**FIREWORKS DISPLAY.** A presentation of fireworks for a public or private gathering.

- ❖ The areas selected for the discharge site, spectator viewing area, parking areas and the fallout area must be inspected and approved by the authority having jurisdiction.

**[BG] FIXED BASE OPERATOR (FBO).** A commercial business granted the right by the airport sponsor to operate on an airport and provide aeronautical services such as fueling, hangaring, tie-down and parking, aircraft rental, aircraft maintenance and flight instruction.

- ❖ Fixed base operator is a term of the aviation industry used to describe a firm that is permanently based at an airport and providing a variety of aircraft services. It is used in conjunction with Section 914.8.3 in the context of determining the appropriate level of fire suppression required in various aircraft hangars that will be found at an airport (see the commentary, Section 914.8.3).

**[BE] FIXED SEATING.** Furniture or fixtures designed and installed for the use of sitting and secured in place including bench-type seats and seats with or without back or arm rests.

- ❖ Fixed seating is secured to the floor or is a part of a seating system. Some of the varieties are bench seating, such as in bleachers, which can come with or without back rests; theater seating with arms for each viewer and seats that flip up; lecture halls with individual seats with tablet arms that are fixed or retractable; pew-type seating in courtrooms or churches; or booths in a restaurant. To allow appropriate egress from these spaces the occupant load tables allow for the individual seats to be counted to determine occupant load for the space. Space between the seats (i.e., aisle accessways) and aisles leading to the exits for these types of seating are addressed in Section 1029. Given their unique

issues, bleachers, folding and telescopic seating and grandstands are referenced to ICC 300 in Section 1029.1.1.

**[BF] FLAME SPREAD.** The propagation of flame over a surface.

- ❖ The rate at which flames travel along the surface of a combustible finish material directly impacts the speed with which a fire spreads within a room or space, and is, therefore, regulated by Chapter 8.

**[BF] FLAME SPREAD INDEX.** A comparative measure, expressed as a dimensionless number, derived from visual measurements of the spread of flame versus time for a material tested in accordance with ASTM E84 or UL 723.

- ❖ The ASTM E84 (or UL 723) test method renders measurements of surface flame spread (and smoke density) in comparison with test results obtained by using select red oak as a control material. Red oak is used as a control material for furnace calibration because it is a fairly uniform grade of lumber that is readily available nationally, is uniform in thickness and moisture content, and generally gives consistent and reproducible results. The results of this test simply provide a relative understanding of flame spread potential. The flame spread index is sometimes abbreviated as FSI.

**FLAMMABLE CRYOGENIC FLUID.** A *cryogenic fluid* that is flammable in its vapor state.

- ❖ These fluids are flammable in a vapor stage or are to be considered as flammable. It may be possible for a fluid to be nonflammable in the liquid phase but flammable in the vapor stage. The vapor phase would be the more hazardous form of the material. Again, similar to the definition of “Cryogenic fluid,” this describes the applicability of the code requirements. Flammability is dealt with in Chapter 58.

**FLAMMABLE FINISHES.** Coatings to articles or materials in which the material being applied is a flammable liquid, combustible liquid, combustible powder, fiberglass resin or flammable or combustible gel coating.

- ❖ This general definition is used to describe all the operations regulated in this chapter including spray applications, dip tank operations and powder-coating operations.

Refer to the definitions of “Combustible dust,” “Combustible liquid” and “Flammable liquid.” Note that although “combustible powder” is not defined in the code, the terms “combustible dust” and “combustible powder” have been used interchangeably. Also, the terms “gel” and “combustible gel” are not defined by the code. Gels or pastes and liquids are classified as liquids when classifying hazardous materials. For example, the flash point of a gel, paste or liquid determines the flammable or combustible classification of the product.

**FLAMMABLE GAS.** A material which is a gas at 68°F (20°C) or less at 14.7 pounds per square inch atmosphere

(psia) (101 kPa) of pressure [a material that has a *boiling point* of 68°F (20°C) or less at 14.7 psia (101 kPa)] which:

1. Is ignitable at 14.7 psia (101 kPa) when in a mixture of 13 percent or less by volume with air; or
2. Has a flammable range at 14.7 psia (101 kPa) with air of not less than 12 percent, regardless of the lower limit.

The limits specified shall be determined at 14.7 psi (101 kPa) of pressure and a temperature of 68°F (20°C) in accordance with ASTM E 681.

❖ The ASTM E681 test method covers the determination of the lower and upper concentration limits of chemicals having sufficient vapor pressure to form flammable mixtures in air at atmospheric pressure at the test temperature. The flammability limits depend on the test temperature and pressure. This test method is limited to an initial pressure of the local ambient or less, with a practical lower pressure limit of approximately 13 kPa (100 mm Hg). The maximum practical operating temperature of this equipment is approximately 302°F (150°C).

**FLAMMABLE LIQUEFIED GAS.** A liquefied *compressed gas* which, under a charged pressure, is partially liquid at a temperature of 68°F (20°C) and which is flammable.

❖ Flammable liquefied gases are widely useful because of their properties, including high heat output in combustion for most gases, high reactivity in chemical processing with other gases, extremely low temperatures available from some gases and the economy of handling them all in a compact form at high pressure or low temperature.

**FLAMMABLE LIQUID.** A liquid having a closed cup flash point below 100°F (38°C). Flammable liquids are further categorized into a group known as Class I liquids. The Class I category is subdivided as follows:

**Class IA.** Liquids having a flash point below 73°F (23°C) and having a *boiling point* below 100°F (38°C).

**Class IB.** Liquids having a *flash point* below 73°F (23°C) and having a *boiling point* at or above 100°F (38°C).

**Class IC.** Liquids having a *flash point* at or above 73°F (23°C) and below 100°F (38°C).

The category of flammable liquids does not include *compressed gases* or *cryogenic fluids*.

❖ Flammable liquids have a closed-cup flash point less than 100°F (38°C); the classification of Class I liquid into three classes is dependent on their flash point. The 100°F (38°C) flash point limitation for flammable liquids assumes possible indoor ambient temperature conditions of 100°F (38°C). The vapor pressure limitation of 40 pounds per square inch absolute (psia) (276 kPa) at 100°F (38°C) is the threshold for the definition of what constitutes a liquid for the purposes of classifying the material as a flammable or combustible liquid. Flammable liquids are classified into three classes based on a combination of their flash point and boiling point. Class IA has a flash point below

73°F (23°C) and a boiling point below 100°F (38°C). Class IB has a flash point below 73°F (23°C) and a boiling point at or above 100°F (38°C). Class IC has a flash point above 73°F (23°C) and below 100°F (38°C). Flammable liquids do not include compressed gases or cryogenic fluids. Compressed gases are regulated in Chapter 53 and cryogenic fluids are regulated in Chapter 55.

**FLAMMABLE MATERIAL.** A material capable of being readily ignited from common sources of heat or at a temperature of 600°F (316°C) or less.

❖ The primary focus of this term is to classify solid materials that are more hazardous than normal combustibles because of their susceptibility to ignition as flammable materials. Additionally, any material that will readily ignite at or below 600°F (316°C) would be considered flammable. The term “flammable materials” should not be confused with combustible materials.

**FLAMMABLE SOLID.** A solid, other than a blasting agent or *explosive*, that is capable of causing fire through friction, absorption of moisture, spontaneous chemical change or retained heat from manufacturing or processing, or which has an ignition temperature below 212°F (100°C) or which burns so vigorously and persistently when ignited as to create a serious hazard. A chemical shall be considered a flammable solid as determined in accordance with the test method of CPSC 16 CFR Part 1500.44, if it ignites and burns with a self-sustained flame at a rate greater than 0.0866 inch (2.2 mm) per second along its major axis.

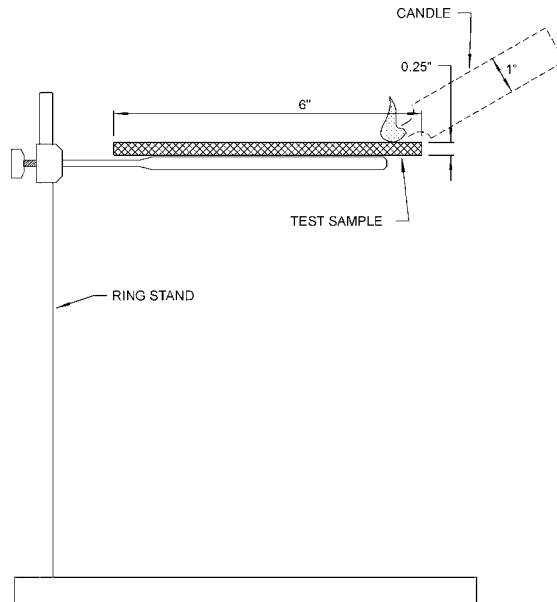
❖ Flammable solids include various materials that either ignite readily, burn vigorously or are difficult to extinguish. Materials that may not ignite easily or burn vigorously in bulk form may do so in finely divided form. This is especially true of most flammable metals. Ignition sources for flammable solids include frictional heat from machining or cutting operations; absorption of moisture from air (as opposed to water-reactive materials forming flammable vapors when mixed with water); spontaneous chemical changes such as sublimation (the chemical process through which solids emit vapors without first changing phase to liquids); and heat absorbed during manufacturing processes like oil quenching or heat treating. Solid materials with ignition temperatures below 212°F (100°C) that ignite before melting are also considered flammable solids, as are materials burning robustly and persistently when ignited, including magnesium and coal. CPSC has developed a standard test method (CPSC 16 CFR 1500.44) that is referenced for determining when a material complies with the definition. Commentary Figure 202-F2 depicts the equipment and test method. A material burning at a rate greater than 0.1 inch (2.5 mm) per second is considered a flammable solid for the purpose of applying the requirements of this chapter.

Commentary Figure 202-F3 lists both the melting points and ignition temperatures for several pure metals in bulk form. These materials may ignite at much

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lower temperatures when finely divided. Moreover, many metals, such as calcium, hafnium, plutonium, sodium, thorium and zirconium, will ignite in air under certain conditions. Thorium and plutonium will

release radiation when they burn. Likewise, many metals react with each other in finely divided form. For example, iron or steel filings and fine magnesium particles, combined with frictional heat or cutting oil,



For SI: 1 inch = 25.4 mm.

**Figure 202-F2  
FLAMMABLE SOLID TEST METHOD**

Material	Melting point (°F)	Ignition temperature (°F)
Aluminum <sup>a</sup>	1,220	1,832
Barium	1,337	347
Calcium	1,548	1,300
Hafnium	4,032	—
Iron <sup>b</sup>	2,795	1,706
Lithium	367	356
Magnesium	1,202	1,153
Plutonium	1,184	1,112
Potassium <sup>c</sup>	144	156
Sodium	208	239
Strontium	1,425	1,328
Thorium	3,353	932
Titanium	3,140	2,900
Uranium <sup>d</sup>	2,070	6,900
Zinc	786	1,652
Zirconium	3,326	2,552

For SI: °C = [(°F)-32]/1.8.

- a. Above indicated temperature.
- b. Ignition in oxygen.
- c. Spontaneous ignition in moist air.
- d. Below indicated temperature.

**Figure 202-F3  
MELTING AND IGNITION TEMPERATURES OF SELECTED PURE METALS IN SOLID FORM**

can ignite in a thermite reaction. Aluminum, iron and steel are not usually recognized as combustible metals; however, aluminum, iron and steel can be ignited in powdered form. Rather than producing an open flame, both iron and steel produce a vigorous sparking reaction when ignited. On the other hand, aluminum may burn with explosive force.

Although the definition of “Flammable solid” could be literally interpreted as being applicable to a much wider variety of common materials (e.g., plastics, household items, toys, etc.) because ordinary combustible materials could fail the CPSC test, the definition text clearly limits its application to “chemicals.” It is not the intent of this chapter to regulate such common-place materials or items because, practically speaking, such a sweeping application could result in

many buildings, including Group R buildings, being classified or reclassified in Group H-3, which is certainly not the intent of the code. Commentary Figure 202-F4 describes fire hazards of selected common flammable solids that are regulated by this chapter.

**FLAMMABLE VAPOR AREA.** An area in which the concentration of flammable constituents (vapor, gas, fume, mist or dust) in air exceeds 25 percent of their lower flammable limit (LFL) because of the flammable finish processes operation. It shall include:

1. The interior of spray booths.
2. The interior of ducts exhausting from spraying processes.
3. Any area in the direct path of spray or any area containing dangerous quantities of air-suspended powder,

Material	Description
Carbon Carbon black	Carbon black is formed by combustion of certain gaseous hydrocarbons and hydrocarbon cracking. It is most hazardous after manufacture when particles may still be hot. Carbon black absorbs oxygen while cooling and smoldering may develop. After cooling, the material is not subject to spontaneous heating. A mixture of carbon black and oxidizable oils may produce heating.
Lamp black	Lamp black, a type of carbon black, is formed by incomplete burning of carbonaceous oils. It absorbs gases to some degree and has a strong affinity for liquids. It heats when in contact with drying oils and may ignite spontaneously soon after bagging begins.
Lead sulfocyanate	Burns slowly and decomposes to form flammable and toxic hydrogen disulfide and toxic carbon disulfide when heated.
Nitroaniline	Melts at 295°F with a flash point of 390°F. When in contact with organic materials, it may produce spontaneous ignition.
Nitrochlorobenzene	A solid material giving off flammable vapors when heated (sublimation).
Sulfides Antimony pentasulfide	Antimony pentasulfide is readily ignited when in contact with oxidizing materials and yields flammable and toxic hydrogen sulfide when in contact with strong acids.
Phosphorus pentasulfide	Phosphorus pentasulfide ignites readily and is subject to spontaneous heating in the presence of moisture. The ignition temperature is 287°F. Phosphorus pentasulfide produces toxic sulfur dioxide and phosphorus pentoxide when it burns, as well as flammable and toxic hydrogen sulfide when in contact with water.
Phosphorus sesquisulfide	Phosphorus sesquisulfide is highly flammable and ignites at 212°F to produce toxic sulfur dioxide.
Potassium and sodium sulfides	Both potassium and sodium sulfide are moderately flammable and they produce sulfur dioxide when burning and hydrogen sulfide comes in contact with acids.
Sulfur	The melting point is 234°F and the boiling point is 832°F with a flash point of 405°F. Sulfur vapors are highly flammable in air. Sulfur dust is a severe explosion hazard with ignition temperatures in the range of 274°F.
Naphthalene	Combustible in both solid and liquid form. Vapors and dusts form explosive mixtures in air.

For SI: °C = [(°F) - 32]/1.8.

**Figure 202-F4  
COMMON FLAMMABLE SOLIDS AND THEIR PROPERTIES**

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combustible residue, dust, deposits, vapor or mists as a result of spraying operations.

4. The area in the vicinity of dip tanks, drain boards or associated drying, conveying or other equipment during operation or shutdown periods.

The *fire code official* is authorized to determine the extent of the flammable vapor area, taking into consideration the material characteristics of the flammable materials, the degree of sustained ventilation and the nature of the operations.

- ❖ The extent of the flammable vapor area should be determined by the fire code official based on an evaluation of the coating process, the liquid being used, the ventilation rate in the area and other variables that might increase the hazard.

**FLAMMABLE VAPORS OR FUMES.** The concentration of flammable constituents in air that exceeds 25 percent of their lower flammable limit (LFL).

- ❖ Vapors or fumes are only considered flammable when there is a high enough concentration for an ignition to occur if exposed to an ignition source. The code specifically defines “Flammable” as being greater than 25 percent of the LFL.

**FLASH POINT.** The minimum temperature in degrees Fahrenheit at which a liquid will give off sufficient vapors to form an ignitable mixture with air near the surface or in the container, but will not sustain combustion. The flash point of a liquid shall be determined by appropriate test procedure and apparatus as specified in ASTM D 56, ASTM D 93 or ASTM D 3278.

- ❖ The flash point is the characteristic used in the classification of flammable and combustible liquids. The flash point is the minimum temperature of a liquid at which it gives off sufficient vapor to form an ignitable mixture with air above its surface. The Tag Closed Tester (ASTM D56), the Pensky-Martens Closed Tester (ASTM D93) and the Small Scale Closed-Cup Apparatus (ASTM D3278) are the referenced test procedures for determining the flash points of liquids. The applicability of the three test methods depends on the viscosity of the test liquid and the expected flash point.

**FLEET VEHICLE MOTOR FUEL-DISPENSING FACILITY.** That portion of a commercial, industrial, governmental or manufacturing property where liquids used as fuels are stored and dispensed into the fuel tanks of motor vehicles that are used in connection with such businesses, by persons within the employ of such businesses.

- ❖ This is sometimes referred to as “you own the tanks, you own the vehicles” motor fuel-dispensing facility. The intent is to allow greater fuel storage tank capacities and reduced separation distances between the dispenser and above-ground tanks when the operator has control of the entire operation, including the vehicles being fueled. In other words, the person dispens-

ing the fuel is an employee of the facility operator. Motor fuel-dispensing facilities are classified in occupancy Group M by the IBC.

**[BE] FLIGHT.** A continuous run of rectangular treads, *winders* or combination thereof from one landing to another.

- ❖ Two points of clarification for stairways are addressed by the definition of “Flight.” First, a flight is made up of the treads and risers that occur between landings. Therefore, a stairway connecting two stories that includes an intermediate landing consists of two flights. Secondly, the inclusion of *winders* within a stairway does not create multiple flights. *Winders* are simply treads within a flight and are often combined with rectangular treads within the same flight.

**FLOAT.** A floating structure normally used as a point of transfer for passengers and goods, or both, for mooring purposes.

- ❖ A float is a deck section that lays on top of or is attached to (or both) a buoyant material in the water. The sections are attached to each other and held in place by methods that are designed to keep the floats in place.

**[BE] FLOOR AREA, GROSS.** The floor area within the inside perimeter of the *exterior walls* of the building under consideration, exclusive of vent shafts and courts, without deduction for *corridors*, *stairways*, *ramps*, closets, the thickness of interior walls, columns or other features. The floor area of a building, or portion thereof, not provided with surrounding *exterior walls* shall be the usable area under the horizontal projection of the roof or floor above. The *gross floor area* shall not include shafts with no openings or interior courts.

- ❖ Gross floor area is that area measured within the perimeter formed by the inside surface of the exterior walls. The area of all occupiable and nonoccupiable spaces, including mechanical and elevator shafts, toilet rooms, closets, and mechanical equipment rooms, are included in the gross floor area. This area could also include any covered porches, carports or other exterior space intended to be used as part of the building’s occupiable space. This gross and net floor areas are primarily used for the determination of occupant load in accordance with Table 1004.1.2.

**[BE] FLOOR AREA, NET.** The actual occupied area not including unoccupied accessory areas such as *corridors*, *stairways*, *ramps*, toilet rooms, mechanical rooms and closets.

- ❖ This net area is intended to be only the room areas that are used for specific occupancy purposes and does not include circulation areas, such as *corridors*, *ramps* or *stairways*, and service and utility spaces, such as toilet rooms and mechanical and electrical equipment rooms. Net floor area is typically measured between inside faces of walls within a room. Floor area, net and gross is utilized in Table 1004.1.2 to determine occupant load for a space.

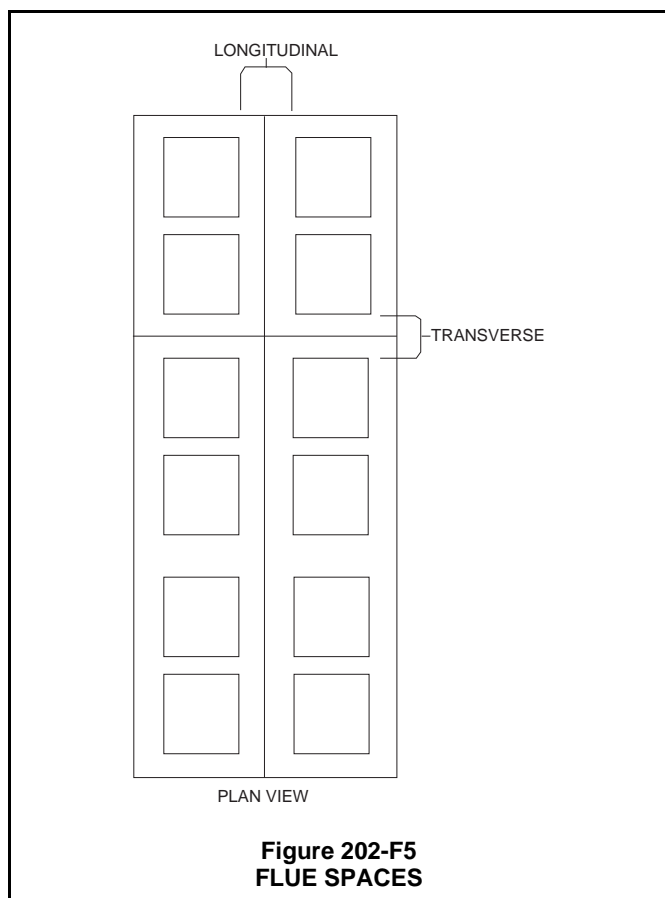
**FLUE SPACES.**

**Longitudinal flue space.** The flue space between rows of storage perpendicular to the direction of loading.

- ❖ The longitudinal flue space is a continuous open area between a double row- or multiple-row-type rack storage system. The flue space is to be clear for a set dimension, as required in Table 3208.3, from the floor to the top of the highest commodity for the entire length of the rack system. The flue spaces are an important feature for automatic sprinkler systems to effectively suppress and potentially control the fire. Reducing or eliminating such spaces will potentially reduce, if not eliminate, sprinkler effectiveness (see Commentary Figure 202-F5).

**Transverse flue space.** The space between rows of storage parallel to the direction of loading.

- ❖ The transverse flue space is a continuous open area between commodities in single-row-, double-row- and multiple-row-type rack storage systems. The flue space is to be clear for a set dimension, as required in Table 3208.3, from the floor to the top of the highest commodity for the entire width of the rack system. The flue spaces are an important feature for automatic sprinkler systems to effectively suppress and potentially control the fire. Reducing or eliminating such spaces will potentially reduce, if not eliminate, sprinkler effectiveness (see Commentary Figure 202-F5).



**FLUIDIZED BED.** A container holding powder coating material that is aerated from below so as to form an air-supported expanded cloud of such material through which the preheated object to be coated is immersed and transported.

- ❖ A fluidized bed differs from an electrostatic fluidized bed in that the fluidized bed uses an air stream instead of electrostatic charge. The air stream behaves like a fluid as the object is passed through it. Additionally, the object is preheated. In an electrostatic fluidized bed, the object is heated/cured in an oven after the coating process.

**FOAM-EXTINGUISHING SYSTEM.** A special system discharging a foam made from concentrates, either mechanically or chemically, over the area to be protected.

- ❖ Foam-extinguishing systems must be of an approved type and installed and tested to comply with NFPA 11, 11A and 16. All foams are intended to exclude oxygen from the fire, cool the area of the fire and insulate adjoining surfaces from heat caused by the fire. Foam systems are commonly used to extinguish flammable or combustible liquid fires (see commentary, Section 904.7). While water applied by an automatic sprinkler system can only act horizontally upon the surface that it reaches, foam-extinguishing agents have the ability to act vertically in addition to horizontally; and, unlike gaseous extinguishing agents, foam does not dissipate rapidly where there is no confined space. Thus, foam systems are also used where there is a need to fill a nonconfined space with extinguishing material as in the case of certain industrial applications.

**[BE] FOLDING AND TELESCOPIC SEATING.** Tiered seating having an overall shape and size that is capable of being reduced for purposes of moving or storing and is not a building element.

- ❖ Bleachers, folding and telescopic seating and grandstands are essentially unique forms of tiered seating that are supported on a dedicated structural system. All types are addressed in ICC 300, the safety standard for these types of seating arrangements. Folding and telescopic seating are commonly used in gymnasiums and sports arenas where the seating can be configured in a variety of ways for various types of events. "Building element" is a defined term in the IBC which is primarily used in conjunction with the structural elements regulated in Table 601 of the IBC. While telescopic seating may be attached to a wall, the system when pulled out or folded includes its main support system. Such seating is not considered a building element of the building or structure in which it is located (see Section 1029.1.1).

**[BG] FOSTER CARE FACILITIES.** Facilities that provide care to more than five children, 2<sup>1</sup>/<sub>2</sub> years of age or less.

- ❖ Foster care facilities are group homes where children live, not day care facilities. By being under 2<sup>1</sup>/<sub>2</sub> years of age, children are assumed not capable of self-preservation, thus there is a need for higher levels of active and passive protection in the building (see the

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commentary to Occupancy Group I-2). Group homes with children over 2½ years of age would be Group R-4 or I-1, depending on the number of children housed in the facility. The “more than five children” is intended to clarify that a foster care family would not be considered a Group I-2 facility. See also the definitions for “24-hour basis,” “Custodial care,” “Group home,” “Incapable of self-preservation” and “Personal care service.”

**FUEL LIMIT SWITCH.** A mechanism, located on a tank vehicle, that limits the quantity of product dispensed at one time.

❖ This definition pertains to mobile fueling operations regulated by Section 5706.5.4.5 and describes a limit control that prevents more than a specified amount of liquid fuel from being dispensed at one time from a tank vehicle used in the mobile fueling operation (see commentary, Section 5706.5.4.5).

**FUMIGANT.** A substance which by itself or in combination with any other substance emits or liberates a gas, fume or vapor utilized for the destruction or control of insects, fungi, vermin, germs, rats or other pests, and shall be distinguished from insecticides and disinfectants which are essentially effective in the solid or liquid phases. Examples are methyl bromide, ethylene dibromide, hydrogen cyanide, carbon disulfide and sulfuryl fluoride.

❖ Pesticides that are applied in gaseous form within a closed space and kill by inhalation are termed “fumigants.” The basic fumigant material may be a volatile solid, liquid or gas. An example of a volatile solid fumigant is paradichlorobenzene. This substance, by the process of sublimation, fills a closed space with gas. It is marketed either as moth balls or moth cakes. Sublimation refers to the changing state from a solid to a gas without entering a liquid state. Many fumigants are flammable or combustible and all are toxic, posing health hazards that range from simply hazardous to deadly with minimal exposure.

**FUMIGATION.** The utilization within an enclosed space of a fumigant in concentrations that are hazardous or acutely toxic to humans.

❖ Fumigation sites are usually contained within a building but may also be at an outdoor location, aboard a vessel or in a vehicle. Soil fumigation can also be successful. The key to any fumigation is applying the appropriate fumigant for the correct duration, usually at least 8 hours for proper soaking to occur. The fumigant gas must penetrate every nook and cranny of the fumigation space or area; therefore, proper enclosure and sealing of the space or area is critical. Rooms can be sealed easily by caulking or taping doors, windows and ventilation openings. Entire structures can be sealed by encapsulation in plastic sheeting. Even trees can be isolated with an air-tight tent and soils can be fumigated by covering the area with plastic covers. Other sections of this commentary discuss operational safeguards for fumigation operations.

**FURNACE CLASS A.** An oven or furnace that has heat utilization equipment operating at approximately atmospheric pressure wherein there is a potential explosion or fire hazard that could be occasioned by the presence of flammable volatiles or combustible materials processed or heated in the furnace.

**Note:** Such flammable volatiles or combustible materials can, for instance, originate from the following:

1. Paints, powders, inks, and adhesives from finishing processes, such as dipped, coated, sprayed and impregnated materials.
2. The substrate material.
3. Wood, paper and plastic pallets, spacers or packaging materials.
4. Polymerization or other molecular rearrangements.

Potentially flammable materials, such as quench oil, water-borne finishes, cooling oil or cooking oils, that present a hazard are ventilated according to Class A standards.

❖ Ovens may also use a low-oxygen atmosphere to evaporate solvent. This kind of equipment has potential hazards involving the process material and heat generation.

**FURNACE CLASS B.** An oven or furnace that has heat utilization equipment operating at approximately atmospheric pressure wherein there are no flammable volatiles or combustible materials being heated.

❖ Even though no flammable, volatile or combustible materials are heated in this kind of oven, the process can still be a serious fire and explosion hazard.

**FURNACE CLASS C.** An oven or furnace that has a potential hazard due to a flammable or other special atmosphere being used for treatment of material in process. This type of furnace can use any type of heating system and includes a special atmosphere supply system. Also included in the Class C classification are integral quench furnaces and molten salt bath furnaces.

❖ These are units in which there is an explosion hazard because a special flammable atmosphere is being used for treatment of material in process. Within this class, an integral quench tank is used, which is a container that holds a quench medium into which a metalwork is immersed for various heat treatment processes. A molten bath furnace is a heated container that holds a melt or fusion into which metalwork is immersed for various heat treatment processes.

**FURNACE CLASS D.** An oven or furnace that operates at temperatures from above ambient to over 5,000°F (2760°C) and at pressures normally below atmospheric using any type of heating system. These furnaces can include the use of special processing atmospheres.

❖ These are generally referred to as vacuum furnaces because they operate below normal atmospheric pressure. Vacuum furnaces are described as either cold-wall furnaces, hot-wall furnaces, or furnaces

used for casting or melting of metal at temperatures up to 5,000°F (2760°C) or higher.

**GAS CABINET.** A fully enclosed, ventilated, noncombustible enclosure used to provide an isolated environment for *compressed gas* cylinders in storage or use. Doors and access ports for exchanging cylinders and accessing pressure-regulating controls are allowed to be included.

❖ This term refers to an assembly constructed and designed to protect compressed gas cylinders and associated equipment.

**GAS DETECTION SYSTEM, CONTINUOUS.** See “Continuous gas detection system.”

**GAS ROOM.** A separately ventilated, fully enclosed room in which only *compressed gases* and associated equipment and supplies are stored or used.

❖ A gas room is an on-site built room that meets the construction requirements of the IBC. This room will require separation based on the amount of gases stored in the room.

**GAS ROOM, HYDROGEN FUEL.** See “Hydrogen fuel gas room.”

❖ See the commentary to “Hydrogen fuel gas room.”

**GASEOUS HYDROGEN SYSTEM.** An assembly of piping, devices and apparatus designed to generate, store, contain, distribute or transport a nontoxic, gaseous hydrogen-containing mixture having not less than 95-percent hydrogen gas by volume and not more than 1-percent oxygen by volume. Gaseous hydrogen systems consist of items such as *compressed gas* containers, reactors and appurtenances, including pressure regulators, pressure relief devices, manifolds, pumps, compressors and interconnecting piping and tubing and controls.

❖ This term includes the source of hydrogen and all piping and devices between the source and the equipment being used. The gas in a hydrogen system is above the upper flammable limit (UFL) and is therefore “too rich” to burn. Any leakage, however, can quickly create conditions that will be explosive under ambient conditions.

**[BG] GRADE FLOOR OPENING.** A window or other opening located such that the sill height of the opening is not more than 44 inches (1118 mm) above or below the finished ground level adjacent to the opening.

❖ Openings used for emergency escape or rescue are clearly easier to use the closer they are to grade. This definition specifies that the maximum sill height above the exterior adjacent grade must be no more than 44 inches (1118 mm) for an opening to qualify as a grade floor opening (see Section 1030.3).

**[BG] GRADE PLANE.** A reference plane representing the average of finished ground level adjoining the building at exterior walls. Where the finished ground level slopes away from the exterior walls, the reference plane shall be established by the lowest points within the area between the building and the *lot line* or, where the *lot line* is more than 6 feet

(1829 mm) from the building, between the building and a point 6 feet (1829 mm) from the building.

❖ This term is used in the definitions of “Basement” and “Story above grade plane.” It is critical in determining the height of a building and the number of stories above grade, which are regulated by Chapter 5 of the IBC, and in determining fire protection system requirements in Chapter 9. Since the finished ground surface adjacent to the building may vary (depending on site conditions), the mean average taken at various points around the building constitutes the grade plane.

Situations may arise where the ground adjacent to the building slopes away from the building because of site or landscaping considerations. In this case, the lowest finished ground level at any point between the building’s exterior wall and a point 6 feet (1829 mm) from the building [or the lot line, if closer than 6 feet (1829 mm)] comes under consideration.

In the context of the code, the term “grade” means the finished ground level at the exterior walls. While the grade plane is a hypothetical horizontal plane derived as indicated above, the grade is that which actually exists or is intended to exist at the completion of site work. The only situation where the grade plane and the grade are identical is when the site is perfectly level for a distance of 6 feet (1829 mm) from all exterior walls. See the commentary to this definition in Chapters 2 and 5 of the IBC for a more detailed discussion and illustrations of sloping grade scenarios.

**[BE] GRANDSTAND.** Tiered seating supported on a dedicated structural system and two or more rows high and is not a building element (see “*Bleachers*”).

❖ Bleachers, folding and telescopic seating and grandstands are essentially unique forms of tiered seating that are supported on a dedicated structural system. All types are addressed in the safety standard for these types of seating arrangements, ICC 300. Grandstands can be found at a county fair ground, along a parade route or within indoor facilities. Examples are sports arenas and public auditoriums, as well as places of religious worship and gallery-type lecture halls. “Building element” is a defined term in the IBC which is primarily used in conjunction with the structural elements regulated in Table 601 of the IBC. Grandstands have a separate structural system. Individual bench seats directly attached to a floor system are not a grandstand. The terms “bleacher” and “grandstand” are basically interchangeable. There is no cut-off in size or number of seats that separates bleachers and grandstands (see Section 1029.1.1).

**[BG] GROUP HOME.** A facility for social rehabilitation, substance abuse or mental health problems that contains a group housing arrangement that provides custodial care but does not provide medical care.

❖ The term “group home” is listed under Group I-1 and R-4 occupancies. See the commentary under “Custo-

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dial care.” The number of occupants would differentiate which occupancy classification is applicable to the facility. Residents live in a supervised living arrangement. Facilities can be for persons with developmental, emotional, mental or physical difficulties or for persons recovering from drugs or alcohol abuse. The intent of these facilities is to promote recovery, community integration and improved quality of life. While there may be security restrictions, occupants are not restrained (see the definition of Occupancy Group I-3 for restrained conditions). The focus is the increase in an individual’s capacity to be successful in living, working, learning and social environments to the best of their ability. See also the commentary to “24-hour basis,” “Custodial care,” “Foster care facilities,” “Incapable of self-preservation.” “Personal care services” and “Nursing homes.”

**[BE] GUARD.** A building component or a system of building components located at or near the open sides of elevated walking surfaces that minimizes the possibility of a fall from the walking surface to a lower level.

❖ Guards are sometimes mistakenly referred to as “guardrails.” In actuality, the guard consists of the entire vertical portion of the barrier, not just the top rail (see commentary to “Handrail” and Section 1015). The purpose of guards is to minimize the potential for falls at dropoffs adjacent to walking surfaces. Loading requirements for guards are located in Section 1607.8 of the IBC.

**[BG] GUEST ROOM.** A room used or intended to be used by one or more guests for living or sleeping purposes.

❖ Lodging houses with five or fewer guest rooms are allowed by the IBC as Group R-3 occupancy. They are also permitted under the IRC. See the definitions of “Lodging house” and “Residential Group R-3” occupancies.

**[BS] GYPSUM BOARD.** Gypsum wallboard, gypsum sheathing, gypsum base for gypsum veneer plaster, exterior gypsum soffit board, predecorated gypsum board or water-resistant gypsum backing board complying with the standards listed in Tables 2506.2 and 2507.2 and Chapter 35 of the *International Building Code*.

❖ Gypsum board is the most commonly used material for interior wall covering. Gypsum board is also used for exterior sheathing, plaster lath and ceiling covering. Because it is installed in sheet form, it is less labor intensive and generally considered more cost effective than other wall and ceiling materials, such as plaster. Gypsum board requires a minimal amount of finishing and will readily accept paint, wallpaper, vinyl fabric, special textured paint and similar surface finish materials.

Gypsum board will be subject to severe failure when placed in direct contact with water or continuous moisture. For this reason, the code does not allow gypsum board to be used in wet areas unless it is provided with a finish material impervious to moisture.

**[BG] HABITABLE SPACE.** A space in a building for living, sleeping, eating or cooking. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not considered habitable spaces.

❖ These spaces are normally considered inhabited in the course of residential living and provide the four basic characteristics associated with it: living, sleeping, eating and cooking. All habitable spaces are considered occupiable spaces, though other occupiable spaces, such as halls or utility rooms, are not considered habitable (see the definition of “Occupiable space” in the IBC).

**HALOGENATED EXTINGUISHING SYSTEM.** A fire-extinguishing system using one or more atoms of an element from the halogen chemical series: fluorine, chlorine, bromine and iodine.

❖ Halon is a colorless, odorless gas that inhibits the chemical reaction of fire. Halon extinguishing systems are useful in occupancies, such as computer rooms where an electrically nonconductive medium is essential or desirable and where cleanup of other extinguishing agents presents a problem. The halon extinguishing system must be of an approved type and installed and tested to comply with NFPA 12A.

Halon extinguishing agents have been identified as a source of emissions resulting in the depletion of the stratospheric ozone layer. For this reason, production of new supplies of halon has been phased out. Alternative gaseous extinguishing agents, such as clean agents, have been developed as alternatives to halon.

**HANDLING.** The deliberate transport by any means to a point of storage or use.

❖ Handling is concerned with transporting hazardous materials within a building’s means of egress. A hazardous material that is not in either storage or use is essentially being handled.

**[BE] HANDRAIL.** A horizontal or sloping rail intended for grasping by the hand for guidance or support.

❖ Handrails are provided along walking surfaces that lead from one elevation to another, such as ramps, and stairways. Handrails may be any shape in cross section provided that they can be gripped by hand for support and guidance and for checking possible falls on the adjacent walking surface. In addition to being necessary in normal day-to-day use, handrails are especially needed in times of emergency when the pace of egress travel is hurried and the probability for occupant instability while traveling along the sloped or stepped walking surface is greater. Handrails, by themselves, are not intended to be used in place of guards to limit falls at drop-offs. Where guards and handrails are used together, the handrail is a separate element typically attached to the inside surface of the guard. The top guard cannot be used as a required handrail, except within dwelling units where the height is restricted to that of a handrail (see Sec-

tion 1014). See the commentary to the definition of “Guard.” For loading on handrails, see Section 1607.8 of the IBC.

**HAZARDOUS MATERIALS.** Those chemicals or substances which are *physical hazards* or *health hazards* as defined and classified in this chapter, whether the materials are in usable or waste condition.

❖ The term “hazardous materials” refers to materials posing either a physical or health hazard.

**HAZARDOUS PRODUCTION MATERIAL (HPM).** A solid, liquid or gas associated with semiconductor manufacturing that has a degree-of-hazard rating in health, flammability or instability of Class 3 or 4 as ranked by NFPA 704 and which is used directly in research, laboratory or production processes which have, as their end product, materials that are not hazardous.

❖ This definition identifies those specific materials that can be contained within an HPM facility. The restriction in the definition for only hazardous materials with a Class 3 or 4 rating is not intended to exclude materials that are less hazardous, but to clarify that materials of the indicated higher ranking are still permitted in an HPM facility without classifying the building as Groups H-1 through H-4. NFPA 704 is referenced to establish the degree of hazard ratings for all materials as related to health, flammability and instability risks. See Commentary Figure 202-H1 for a list of commonly used HPM and their hazard classifications.

**HEALTH HAZARD.** A classification of a chemical for which there is statistically significant evidence that acute or chronic health effects are capable of occurring in exposed persons. The term “health hazard” includes chemicals that are toxic, highly toxic and *corrosive*.

❖ Materials that pose risks to people from handling or exposure are considered health hazards. Even though the materials may also be flammable, those classified as health hazards either will not burn or will not pose a fire hazard similar to that of ordinary combustible materials. Materials that pose a health hazard may also pose a physical hazard and must comply with the requirements of the code applicable to both hazards. Toxins that attack specific organs are indicative of the other health-hazard materials regulated by this chapter. Hepatotoxins, such as carbon tetrachloride, are capable of causing liver damage and nephrotoxins, such as halogenated hydrocarbons, can cause kidney damage. Neurotoxins include mercury and calcium disulfide, which may produce toxic effects on the nervous system. Although the definition of “Health hazard” includes a reference to carcinogens, it is not the intent of this chapter to regulate carcinogens that are not otherwise classified as an irritant, sensitizer or other known health hazard, such as a target organ toxin. Federal regulations address the permitted workplace exposure conditions to known carcinogens.

**HEAT DETECTOR.** See “Detector, heat.”

**[BG] HEIGHT, BUILDING.** The vertical distance from grade plane to the average height of the highest roof surface.

❖ This definition establishes the two points of measurement that determine the height of a building. This measurement is used to determine compliance with the building height limitations of Sections 503.1 and 504 and Tables 504.3 and 504.4, which limit building height both in terms of the number of stories and the number of feet between the two points of measurement.

The lower point of measurement is the grade plane (see the definition of “Grade plane”). The upper point of measurement is the roof surface of the building, with consideration given to sloped roofs (such as a hip or gable roof). In the case of sloped roofs, the average height would be used as the upper point of measurement, rather than the eave line or the ridge line. The average height of the roof is the mid-height between the roof eave and the roof ridge, regardless of the shape of the roof.

This definition also indicates that building height is measured to the highest roof surface. In the case of a building with multiple roof levels, the highest of the various roof levels must be used to determine the building height. If the highest of the various roof levels is a sloped roof, then the average height of that sloped roof must be used. The average height of multiple roof levels is not to be used to determine the building height. Where structures are divided into multiple buildings by fire walls, building height is determinable for each building separately.

The distance that a building extends above ground also determines the relative hazards of that building. Simply stated, a taller building presents relatively greater safety hazards than a shorter building for several reasons, including fire service access and time for occupant egress. The code specifically defines how building height is measured to enable various code requirements, such as type of construction and fire suppression, to be consistent with those relative hazards.

The term “height” is also used frequently in the code for other limitations related to, and sometimes not related to, “building height.” For example, Section 1510 of the IBC limits the height of a penthouse above the top of the roof. Since a “Penthouse” is defined as a structure that is built above the roof of a building, it is above the point to which “Building height” is measured. Therefore a penthouse would not affect the measurement of building height and can be located above the maximum allowed roof height provided it complies with the limitations of Section 1510 of the IBC. Other provisions such as Section 1015 of the code and Section 1406 of the IBC specify requirements based on height, but such height is usually measured from a location other than grade plane and is not intended to be building height.

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**HELIPORT.** An area of land or water or a structural surface that is used, or intended for use, for the landing and taking off of helicopters, and any appurtenant areas which are used, or intended for use, for heliport buildings and other heliport facilities.

- ❖ Heliports present special problems because they are frequently located in congested areas of cities, on

roofs of buildings, near hospitals and on piers adjacent to water.

**HELISTOP.** The same as “Heliport,” except that fueling, defueling, maintenance, repairs or storage of helicopters is not permitted.

- ❖ A helistop is a place for landing and taking off for helicopters with no procedures or operations occurring

Material	Description or Use	NFPA 704 Hazard Classification			
		Health	Flammability	Reactivity	Other
Acetic acid	Corrosive liquid used for wet etching (metal)	2	2	1	
Acetone	Flammable liquid used for wafer cleaning	1	3	0	
Ammonium fluoride	Corrosive for wet etching (oxide)	3	0	0	
Arsenic trichloride	Diffusion	3	0	1	W
Arsenic trioxide	Diffusion	4	0	0	
Arsine	Poison flammable gas used for epitaxial growth, diffusion and ion implantation	4	4	3	
Boron tribromide	Corrosive liquid used for diffusion	4	0	3	W
Boron trichloride	Nonflammable corrosive gas used for diffusion	4	0	1	W
Chlorine	Poison gas used for dry etching	3	0	0	0XY
Diborane	Highly reactive flammable gas used for diffusion	3	4	3	W
Dichlorosilane	Flammable liquefied gas used for epitaxial growth	4	4	4	
Gallium	Reactive metal used as a semiconductor crystal material	1	0	3	
Gallium arsenide	Reactive metal salt used as a semiconductor crystal material	3	0	0	
Gallium arsenide phosphide	Reactive metal salt used as a semiconductor crystal material	3	0	0	
Germanium	Reactive metal used as a semiconductor crystal material	0	0	3	
Hydrofluoric acid	Highly corrosive liquid or gas used for wet etching (oxide)	4	0	0	
Hydrogen peroxide <sup>a</sup>	Organic peroxide used for wafer cleaning	2	0	1	0XY
Isopropanol	Flammable liquid used for wafer cleaning	1	3	0	
Methanol	Flammable liquid used for wafer cleaning	1	3	0	
Nitric acid	Corrosive liquid used for wet etching (metal)	3	0	0	0XY
Oxygen (liquid)	Oxidizing gas used for oxidation	3	0	0	0XY
Phosphine	Flammable liquefied poison gas used for diffusion and ion implantation	4	4	4	
Phosphoric acid	Corrosive liquid used for wet etching (metal)	2	0	0	
Phosphorus oxychloride	Corrosive liquid used for diffusion	4	0	3	W
Phosphorus pentoxide	Corrosive solid sublimed for use in diffusion	4	0	3	W
Phosphorus tribromide	Corrosive liquid used for diffusion	4	0	3	W
Silane	Pyrophoric gas used for oxidation	2	4	4	
Silicon	Flammable solid (metal) used as a semiconductor crystal material	2	4	2	W
1, 1, 1-Trichloroethane	Mildly flammable solvent (difficult to ignite) used for wafer cleaning	2	1	0	
Tetrachlorosilane	Flammable liquid used for epitaxial growth	3	4	2	W

a. NFPA 704 values for 35 to 52 percent by weight (the most concentration) are listed. The reactivity hazard increases to 3 at concentrations above 52 percent.

**Figure 202-H1  
HAZARDOUS PRODUCTION MATERIALS (HPM) USED IN THE MANUFACTURE OF SEMICONDUCTORS**

other than loading or off-loading of passengers or freight.

**HI-BOY.** A cart used to transport hot roofing materials on a roof.

- ❖ A hi-boy, also known as a hot carrier, is a wheeled tank used on the roof deck to move hot asphalt around the work area. Hi-boys are available in either insulated or noninsulated models, and typically hold either 30 or 55 gallons (114 or 208 L).

**HIGH-PILED COMBUSTIBLE STORAGE.** Storage of combustible materials in closely packed piles or combustible materials on pallets, in racks or on shelves where the top of storage is greater than 12 feet (3658 mm) in height. Where required by the *fire code official*, *high-piled combustible storage* also includes certain high-hazard commodities, such as rubber tires, Group A plastics, flammable liquids, idle pallets and similar commodities, where the top of storage is greater than 6 feet (1829 mm) in height.

- ❖ High-piled combustible storage has two distinct features not common to other storage areas: the large quantity of commodities (or products) and storage in a compact arrangement (density). The height values used to distinguish high-piled storage from general or incidental storage were largely based on fire tests [12 feet (3638 mm) for Class I–IV and 6 feet (1829 mm) for high hazard]. These tests were conducted to determine the effects of various configurations, quantities and classes of commodities as well as various fire protection features.

**HIGH-PILED STORAGE AREA.** An area within a building which is designated, intended, proposed or actually used for *high-piled combustible storage*.

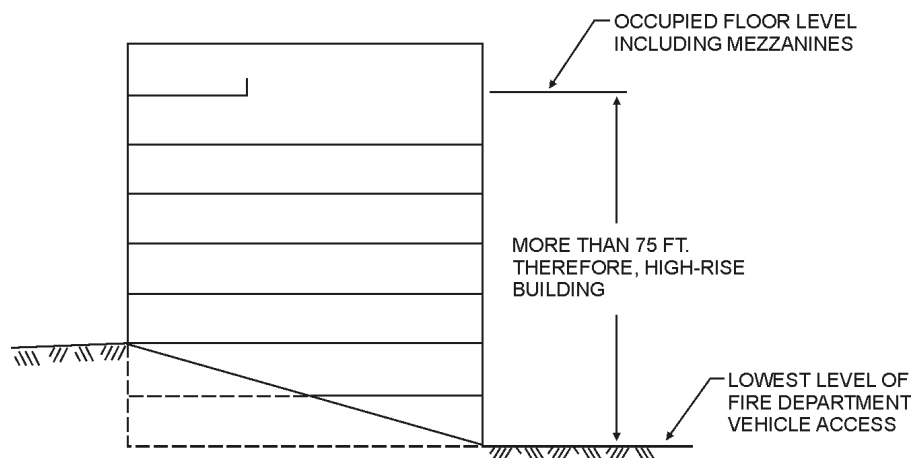
- ❖ This term defines the area or space where the combustible commodity is actually located. The intent of defining this area is to differentiate such a space from any of the other more traditionally defined occupan-

cies (for example, business, factory, etc.) and the amount of fire protection that is required in these unique spaces. Spaces not actually containing high-piled storage are not considered part of the high-piled storage area; thus, those areas would not need to be added into the aggregate area when applying Table 3206.2.

The definition is not clear as to how aisles are to be addressed. Section 3206.9 has several requirements related to aisles that are focused primarily upon access to exits and fire department access. NFPA 13, however, has specific aisle dimensions for rack storage, which are provided based upon testing of actual storage commodities and the performance of sprinkler systems. These aisles serve more as “fire breaks” to slow the spread of fire from storage array to storage array. Therefore, any aisles required by NFPA 13 would be required to be included when determining the actual high-piled storage area involving rack storage. See the commentary to Sections 3206.9 and 3206.3.2.1 for further discussion.

**[BG] HIGH-RISE BUILDING.** A building with an occupied floor located more than 75 feet (22 860 mm) above the lowest level of fire department vehicle access.

- ❖ Determining what qualifies as a high-rise building is a fairly unique measurement of height and is not based on the definition of “Building height.” The critical measurement is from the lowest ground location where a fire department will be able to set its fire-fighting equipment to a floor level of occupied floors as shown in Commentary Figure 202-H2. It is not a measurement from grade plane to top of the building. The basis of the measurement is analyzing the capability of fighting a fire and rescuing occupants from the outside of the building. Once past a height of 75 feet (22 860 mm) above ground level, ground-based fire fighting will not be sufficient. High-rise buildings must comply with the requirements of Section 403.



For SI: 1 foot = 304.8 mm.

**Figure 202-H2  
HIGH-RISE BUILDING**

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**HIGH-VOLTAGE TRANSMISSION LINE.** An electrical power transmission line operating at or above 66 kilovolts.

❖ High-voltage transmission lines are used to carry large amounts of electrical power (66,000 volts or more) over long distances, usually from a main power generation station to main substations, because the line losses are much smaller than with lower-voltage lines. They may also be used for electric power transmission from one central station to another for load sharing. The term “high voltage transmission line” as used in the context of the code is referring only to overhead conductors that are made of either copper or aluminum. In other contexts, the term could include underground lines as well.

**HIGHLY TOXIC.** A material which produces a lethal dose or lethal concentration which falls within any of the following categories:

1. A chemical that has a median lethal dose (LD<sub>50</sub>) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
2. A chemical that has a median lethal dose (LD<sub>50</sub>) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
3. A chemical that has a median lethal concentration (LC<sub>50</sub>) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume or dust, when administered by continuous inhalation for one hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

Mixtures of these materials with ordinary materials, such as water, might not warrant classification as highly toxic. While this system is basically simple in application, any hazard evaluation that is required for the precise categorization of this type of material shall be performed by experienced, technically competent persons.

❖ This definition, as does the definition of “Toxic,” gives very specific criteria in the form of lethal doses and lethal concentrations as administered to albino rats and albino rabbits. The lethal dosages are related to the ingestion and skin contact with materials, generally liquids and solids. The lethal concentrations are related to vapors, dusts, gases or mists as inhaled by albino rats. Inhalation can occur from either a gas, vapor or mist that is generated from highly toxic or toxic liquids. In some cases, a liquid may be considered highly toxic or toxic if ingested or if skin contact occurs, but vapors are not an inhalation hazard according to the criteria. These definitions give criteria to help determine what materials are regulated by this chapter and Chapter 50. Often, materials are listed as toxic or highly toxic, on MSDS, but may not necessarily meet these criteria. Instead, the terminology may be used to describe irritant characteristics of

the material. For a list of common highly toxic materials, see Commentary Figure 202-H3.

**HIGHLY VOLATILE LIQUID.** A liquefied *compressed gas* with a *boiling point* of less than 68°F (20°C).

❖ This definition provides criteria for the classification of a material as being highly volatile, and provides correlation with the defined terms “Liquid” and “Cryogenic fluid.” Basically, if the boiling point of a material is at room temperature or lower it would be considered volatile. The concern usually associated with highly volatile liquids is the volume of vapors released to the atmosphere. These vapors could be harmless, but many liquids, for example, may be corrosive, toxic or flammable. Additionally, vapors are more susceptible to ignition than liquids.

**HIGHWAY.** A public street, public alley or public road.

❖ Roads, alleys and similar thoroughfares or vehicular accessways on private property are not included in this definition. However, when private roadways adjacent to an explosives magazine or blasting site are commonly used for vehicular traffic by the public, the separation required should be the same as that required for public rights-of-way or public access should be suspended.

**[A] HISTORIC BUILDINGS.** Buildings that are listed in or eligible for listing in the National Register of Historic Places, or designated as historic under an appropriate state or local law.

❖ To be considered “historic,” a building needs to be designated as such through a federal, state or local law. In addition, there are buildings that have been reviewed for eligibility to be listed as a national historic building. Those listed as eligible for national listing also are considered historic for the purposes of the code. Buildings that are within a historic district are not necessarily, themselves, historic buildings. The determination of their designation as historic would depend on the specifics of the listing of the historic area. The IEBC provides specific provisions applying to historic buildings.

**HOGGED MATERIALS.** Wood waste materials produced from the lumber production process.

❖ This term refers to mill waste that may include a mixture of bark, chips or dust along with other byproducts of trees. Material designated as hogged fuel is included in this category.

**[M] HOOD.** An air-intake device used to capture by entrainment, impingement, adhesion or similar means, grease and similar contaminants before they enter a duct system.

**Type I.** A kitchen hood for collecting and removing grease vapors and smoke.

❖ A kitchen exhaust system, which includes the hood serving a commercial cooking appliance, is a specialized exhaust system. A commercial cooking appliance can generate large quantities of air contaminants, such as grease vapors, smoke and

combustion byproducts. The descriptor “Type I” used in conjunction with the term “hood” refers to an exhaust system that is required for all cooking appliances that are used for commercial purposes and that produce grease-laden vapors or smoke.

**Type II.** A general kitchen hood for collecting and removing steam vapor, heat, odors and products of combustion.

- ❖ A Type II exhaust hood is considered a light-duty hood that would typically be installed over steam kettles, conventional ovens, food warmers, some types of enclosed pizza ovens, steam tables and dishwashing machines. A Type II hood is not intended for grease or smoke removal. The primary purpose of a Type II hood is to capture and remove water vapor, waste heat and any products of combustion that might be associated with the heating of the appliance, such as from fuel gas combustion.

**[BF] HORIZONTAL ASSEMBLY.** A fire-resistance-rated floor or roof assembly of materials designed to restrict the spread of fire in which continuity is maintained.

- ❖ A horizontal assembly is a component for completing compartmentation. Horizontal assemblies have all

openings and penetrations protected equal to the rating for the fire-resistance-rated floor or roof assembly. Horizontal assemblies are regulated by Section 711 of the IBC.

**[BE] HORIZONTAL EXIT.** An *exit* component consisting of fire-resistance-rated construction and opening protectives intended to compartmentalize portions of a building thereby creating refuge areas that afford safety from fire and smoke from the area of fire origin.

- ❖ This term refers to a fire-resistance-rated wall that subdivides a structure into multiple compartments and provides an effective barrier to protect occupants from a fire condition within one of the compartments. After occupants pass through a horizontal exit, they must be provided not only with sufficient space to gather but also with access to another exit, such as an exterior door or exit stairway, through which they can exit the building. Commentary Figure 202-H4 depicts the exits serving a single building that is subdivided with a fire-resistance-rated wall (see Section 1026).

Material	Health	Flammability	Reactivity	Other	TLV/TWA Value <sup>a</sup>
Acrolein (CH <sub>2</sub> :CHCHO)	3	3	2		0.1 ppm TLV/TWA
Adiponitrile (NC[CH <sub>2</sub> ] <sub>4</sub> CN)	4	2	0		
Allyl Alcohol (CH <sub>2</sub> :CHCH <sub>2</sub> OH)	3	3	2		2 ppm TLV/TWA
Benzotrifluoride (C <sub>6</sub> H <sub>5</sub> CF <sub>3</sub> )	4	3	0		
Beryllium (Be)	4	1	0		2 mcg/m <sup>3</sup> TLV/TWA
Bromine (Br)	4	0	0	OXY	0.3 ppm TLV/TWA
Bromine Pentafluoride (BF <sub>5</sub> )	4	0	3	OXY/W	0.1 ppm TLV/TWA
Chloropicrin (CCl <sub>3</sub> NO <sub>2</sub> )	4	0	3		0.1 ppm TLV/TWA
Cyanogen (NCCN)	4	4	2		10 ppm TLV/TWA
Dimethyl Sulfate (CH <sub>3</sub> OSO <sub>2</sub> OCH <sub>3</sub> )	4	2	0		0.1 ppm TLV/TWA (skin—suspected carcinogen)
Ethylamine (C <sub>2</sub> H <sub>5</sub> NH <sub>2</sub> )	3	4	0		10 ppm TLV/TWA
Epichlorhydrin (chloromethyl oxirane) ([OCH <sub>2</sub> CH]CH <sub>2</sub> Cl)	3	3	2		0.1 ppm TLV/TWA (skin)
Hydrazine, anhydrous (H <sub>2</sub> NNH <sub>2</sub> )	3	3	2		0.1 ppm TLV/TWA (skin—suspected carcinogen)
Hydrogen Cyanide, anhydrous (HCN)	4	4	2		10 ppm TLV-C
Hydrogen Fluoride (HF)	4	0	0		3 ppm TLV-C
Parathion ([C <sub>2</sub> H <sub>5</sub> O] <sub>2</sub> PSOC <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> )	4	1	2		0.1 mg/m <sup>3</sup> TLV/TWA
Phenol (C <sub>6</sub> H <sub>5</sub> OH)	3	2	0		5 ppm TLV/TWA (skin)
Sodium Hydride (NaH)	3	3	2	W	
Sodium Peroxide (Na <sub>2</sub> O <sub>2</sub> )	3	0	2	W	
1,1,2-Trichloroethane (CHCl <sub>2</sub> CH <sub>2</sub> Cl)—Not to be confused with 1,1,1-Trichloroethane	3	1	0		10ppm TLV/TWA (skin)

a. TLV/TWA means Threshold Limit Value/Time-weighted Average. See definition in Chapter 2 of the *International Mechanical Code*.

**Figure 202-H3  
COMMON HIGHLY TOXIC MATERIALS AND THEIR HAZARDS**

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### [BG] HOSPITALS AND PSYCHIATRIC HOSPITALS.

Facilities that provide care or treatment for the medical, psychiatric, obstetrical, or surgical treatment of inpatient care recipients that are incapable of self-preservation.

- ❖ Persons in hospital facilities may be physically incapable of self-preservation or at least extremely limited in their ability to evacuate. In psychiatric hospitals they may be confined within an area of a building for care or security purposes. In consideration of occupants' health, as well as safety, hospitals and nursing homes at least partially rely on defend-in-place strategies. See the commentary to Occupancy Group I-2 and Section 407 of the IBC.

Care facilities encompass a full spectrum of acuity and support services and span a wide range of occupancy types including Groups B, E, I and R. The level of care provided describes the condition and capabilities of an occupant which then indicates appropriate standards for protection systems, both passive and active. See also the definitions for "24-hour basis," "Care suite," "Custodial care," "Detoxification facilities," "Incapable of self-preservation," "Medical care" and "Nursing homes."

**HOT WORK.** Operations including cutting, welding, Thermit welding, brazing, soldering, grinding, thermal spraying, thawing pipe, installation of torch-applied roof systems or any other similar activity.

- ❖ This term describes the scope of what would be considered hot work as it is regulated in this chapter. The scope is broad and would include any activity that produces sparks, slag or other waste products. This would include both gas and electric methods. Torch-applied roof systems are also included.

**HOT WORK AREA.** The area exposed to sparks, hot slag, radiant heat, or convective heat as a result of the hot work.

- ❖ This definition helps to locate which areas would be considered part of the hot work area to better understand the level of susceptibility to ignition.

**HOT WORK EQUIPMENT.** Electric or gas welding or cutting equipment used for hot work.

- ❖ In the past, chapters dealing with hot work focused primarily on gas welding. Electric welding, though it

does not deal with oxygen and fuel gases, still presents ignition hazards (see Commentary Figure 202-H5).

**HOT WORK PERMITS.** Permits issued by the responsible person at the facility under the hot work permit program permitting welding or other hot work to be done in locations referred to in Section 3503.3 and prepermitted by the *fire code official*.

- ❖ As applied in Chapter 35, this permit differs from a typical permit in that it is not directly issued by the fire code official. Instead, a hot work operations facility is given permission to designate a person, perhaps the



Figure 202-H5  
TYPICAL WELDING CART

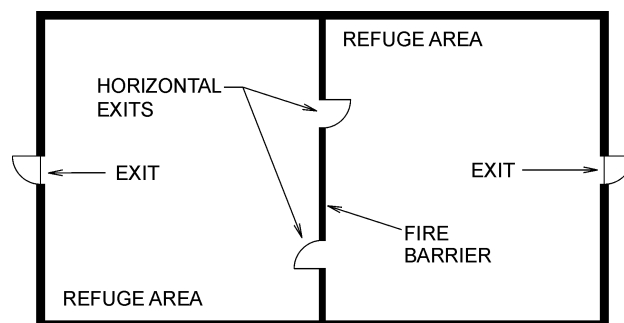


Figure 202-H4  
HORIZONTAL EXIT

safety officer, to issue permits as needed. This results in flexibility for facilities where hot work is a common occurrence. These permits are issued under what is called a hot work program, which is also defined in this section.

**HOT WORK PROGRAM.** A permitted program, carried out by *approved* facilities-designated personnel, allowing them to oversee and issue permits for hot work conducted by their personnel or at their facility. The intent is to have trained, on-site, responsible personnel ensure that required hot work safety measures are taken to prevent fires and fire spread.

- ❖ This kind of program is described in the definition for “Hot work permits.” This program allows someone on site to control the issuing of permits for hot work. The person who is charged with this responsibility must be trained in hot work operations and have the necessary authority. Having such a program at a facility encourages a better understanding of fire safety and perhaps more incentive to play an active role in the prevention of fires. This program reduces the administrative burden on the fire department and ensures that hot work operations can proceed as needed.

**HPM FACILITY.** See “Semiconductor fabrication facility.”

**HPM ROOM.** A room used in conjunction with or serving a Group H-5 occupancy, where HPM is stored or used and which is classified as a Group H-2, H-3 or H-4 occupancy.

- ❖ An HPM room in a Group H-5 facility is used for the storage and use of HPM in excess of the MAQs permitted in Table 5003.1.1(1) or (2). The rooms are, therefore, considered a Group H-2, H-3 or H-4 occupancy, depending on the type of hazardous material (see Commentary Figure 202-S3).

**HYDROGEN FUEL GAS ROOM.** A room or space that is intended exclusively to house a *gaseous hydrogen system*.

- ❖ This term refers to an enclosed space used exclusively for a gaseous hydrogen system that requires construction and protection that are unique to the hazards associated with this use. The room itself may be considered as an incidental accessory occupancy or a Group H occupancy, depending on the amount of hydrogen in such rooms. The definition itself should not be interpreted to prevent hydrogen piping systems from serving distributed hydrogen-using equipment and appliances located elsewhere on site or in the building; however, the amount of hydrogen within such piping needs to be evaluated with respect to the MAQs in Table 5003.1.1(1).

**IMMEDIATELY DANGEROUS TO LIFE AND HEALTH (IDLH).** The concentration of air-borne contaminants that poses a threat of death, immediate or delayed permanent adverse health effects, or effects that could prevent escape from such an environment. This contaminant concentration level is established by the National Institute of Occupational Safety and Health (NIOSH) based on both toxicity and flammability. It generally is expressed in parts per million by volume (ppm v/v) or milligrams per cubic meter (mg/

m<sup>3</sup>). Where adequate data do not exist for precise establishment of IDLH concentrations, an independent certified industrial hygienist, industrial toxicologist, appropriate regulatory agency or other source *approved* by the *fire code official* shall make such determination.

- ❖ There are three general atmospheres that make up an IDLH toxic condition. These are toxic, flammable and oxygen deficient. In the absence of an IDLH value, the fire code official may consider using an estimated IDLH of 10 times the lower explosive limit (LEL) while an IDLH oxygen-deficient atmosphere is 19.5-percent oxygen or lower. The EPA has determined that 10 percent of the IDLH value is an acceptable level of concern for evaluating hazmat release concentrations and public protective options.

**IMPAIRMENT COORDINATOR.** The person responsible for the maintenance of a particular *fire protection system*.

- ❖ To minimize the time a fire protection system is out of service, the building owner or other designee is required to monitor impairment procedures (see commentary Section 901.7.1). This person has the responsibility for performing the actions necessary during the impairment and is the single point of contact for issues relating to the impairment; thus, it should be a person who has both authority and knowledge of the facility under consideration.

**[BG] INCAPABLE OF SELF-PRESERVATION.** Persons who, because of age, physical limitations, mental limitations, chemical dependency or medical treatment, cannot respond as an individual to an emergency situation.

- ❖ Patients/residents of nursing homes and hospitals may be in situations where they are unable to self-evacuate due to physical limitations arising from, for example, medication, operation, injury or connection to medical equipment.

Care facilities encompass a full spectrum of acuity and support services and span a wide range of occupancy types including Groups E, I and R. There are three types of care defined in the codes: personal, custodial and medical. The level of care provided describes the condition and capabilities of an occupant which then indicates appropriate standards for protection systems, both active and passive. See also the definitions for “24-hour basis,” “Custodial care,” “Detoxification facilities,” “Foster care facilities,” “Group home,” “Hospitals and psychiatric hospitals,” “Medical care,” “Nursing home” and “Personal care services.”

**INCOMPATIBLE MATERIALS.** Materials that, when mixed, have the potential to react in a manner which generates heat, fumes, gases or byproducts which are hazardous to life or property.

- ❖ Incompatible materials constitute a dangerous chemical combination whether in storage or in use. Determining which chemicals in combination pose a hazard is not always easy. MSDS may not provide all of the necessary information. When in doubt, the fire

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code official should seek additional information from the manufacturer of the chemicals involved, the building owner or experts who are knowledgeable in industrial hygiene or chemistry. NFPA's *Fire Protection Guide to Hazardous Materials* also contains useful information on hazardous chemical reactions.

**INERT GAS.** A gas that is capable of reacting with other materials only under abnormal conditions such as high temperatures, pressures and similar extrinsic physical forces. Within the context of the code, inert gases do not exhibit either physical or *health hazard* properties as defined (other than acting as a simple asphyxiant) or hazard properties other than those of a *compressed gas*. Some of the more common inert gases include argon, helium, krypton, neon, nitrogen and xenon.

❖ The term "inert gas" is used in a number of sections throughout the code. For example, it is used in the exception to Section 2501.1, Sections 2906.4 and 2309.6.2, as well as in Chapters 50, 53, 57 and 64. The term "inert gas" is also used in the IMC and the IFGC without definition. This definition is not in conflict with the provisions found in either of these companion codes.

While inert gases do not present a physical hazard or health hazard as regulated by Chapter 50, inert gases are hazardous materials in the sense that they are simple asphyxiants that can cause injury or death by displacing oxygen. Any atmosphere containing 19.5 percent or less by volume of oxygen is considered oxygen deficient and inert gases can create such an environment. Inert gases are colorless, odorless, tasteless and are not irritating. As a result, the only means of detecting an oxygen-deficient atmosphere is through the use of gas detection equipment. Inert gases include argon, nitrogen, helium and carbon dioxide. Inert compressed gases and cryogenic fluids have other hazards, such as the potential energy within their containers. Because of these hazards, the provisions in Chapter 53 for compressed gases and Chapter 55 for cryogenic fluids are applicable regardless if the stored gas or cryogenic fluid is inert.

The definition includes an explanatory sentence intended to inform the user that inert gases do not react readily with other materials under normal temperatures and pressures, but it is possible for a reaction to occur. For example, even nitrogen combines with some of the more active metals such as lithium and magnesium to form nitrides, and at high temperatures it will also combine with hydrogen, oxygen and other elements. The inert gases neon, krypton and xenon are considered rare due to their scarcity. Although these gases are commonly referred to as inert gases, the formation of compounds is possible. For example, xenon combines with fluorine to form various fluorides, and with oxygen to form oxides. The compounds thus formed are crystalline solids.

By defining the term the likelihood of using gases that are not inert, including carbon dioxide, will be reduced.

**INHABITED BUILDING.** A building regularly occupied in whole or in part as a habitation for people, or any place of religious worship, schoolhouse, railroad station, store or other structure where people are accustomed to assemble, except any building or structure occupied in connection with the manufacture, transportation, storage or use of *explosive materials*.

❖ Building use need not conform to regular intervals or schedules to be considered inhabited if people routinely occupy the building. Those buildings at a storage or blasting site used for the manufacture, transportation or storage of explosive materials must be considered as magazines rather than inhabited buildings for the purpose of applying the provisions of Section 5604.

**INITIATING DEVICE.** A system component that originates transmission of a change-of-state condition, such as in a smoke detector, manual fire alarm box, or supervisory switch.

❖ All fire protection systems consist of devices, which upon use or actuation, will initiate the intended operation. A manual fire alarm box, for example, upon actuation will transmit a fire alarm signal. In the case of a single-station device, the initiating device and the notification appliance are one in the same.

**INSECTICIDAL FOGGING.** The utilization of insecticidal liquids passed through fog-generating units where, by means of pressure and turbulence, with or without the application of heat, such liquids are transformed and discharged in the form of fog or mist blown into an area to be treated.

❖ Insecticidal fogging as a means of pest control was developed during World War II as part of a program to use smoke-screen techniques for control of malaria-bearing mosquitos. The product of the fog-generating process is an aerosol, which is a suspension of liquid particles in air. Many insecticides used in the fogging process are flammable and pose a fire hazard requiring safeguards, such as the securing of all ignition sources during fogging and for up to 24 hours afterward.

Aerosol insecticides also pose a toxicity hazard; therefore, proper entry precautions for the fogged area should be observed.

**[BE] INTERIOR EXIT RAMP.** An exit component that serves to meet one or more means of egress design requirements, such as required number of exits or exit access travel distance, and provides for a protected path of egress travel to the exit discharge or public way.

❖ To qualify as an interior exit ramp the ramp must be enclosed with a fire-resistance-rated enclosure in order to provide a protected path between the exit access and exit discharge. This enclosure must extend directly to the exterior at grade; extend through an exit passageway to grade; or comply with one of the allowances for exit discharge through a lobby, vestibule or horizontal exit. Travel distance is measured to the entrance to the enclosure for the interior exit ramp. Ramps that are utilized by occupants for evacuation, but do not meet the provisions for exits, are considered exit access elements (see

“Exit access ramp”). For exterior exit ramp requirements, see Section 1027.

**[BE] INTERIOR EXIT STAIRWAY.** An exit component that serves to meet one or more means of egress design requirements, such as required number of exits or exit access travel distance, and provides for a protected path of egress travel to the exit discharge or public way.

❖ To qualify as an interior exit stairway, the ramp must be enclosed with a fire-resistance-rated enclosure in order to provide a protected path between the exit access and exit discharge. This enclosure must extend directly to the exterior at grade; extend through an exit passageway to grade; or comply with one of the allowances for exit discharge through a lobby, vestibule or horizontal exit. Travel distance is measured to the entrance to the enclosure for the interior exit stairway. Stairways that are utilized by occupants for evacuation, but do not meet the provisions for exits, are considered exit access elements (see “Exit access stairway”). For exterior exit stairway requirements, see Section 1027.

**[BG] INTERIOR FINISH.** Interior finish includes interior wall and ceiling finish and interior floor finish.

❖ This is a more general term that addresses all exposed surfaces, which includes walls, ceilings and floors. Interior finish material is exposed to the interior space enclosed by these building elements.

**[BG] INTERIOR FLOOR-WALL BASE.** Interior floor finish trim used to provide a functional or decorative border at the intersection of walls and floors.

❖ This definition, which addresses interior floor-wall base trim materials, provides an understanding and clarification of these types of products versus other interior trim materials. In many cases, floor covering material is just seamlessly turned-up or used at the intersection of the floor and the wall thus becoming the floor-wall base trim. Because of their location at the floor-line, floor-wall base materials are not likely to be involved in a fire until the floor covering is also involved, usually at room flashover. See also the commentary to Section 804.4.

**[BG] INTERIOR WALL AND CEILING FINISH.** The exposed interior surfaces of buildings, including but not limited to: fixed or movable walls and partitions; toilet room privacy partitions; columns; ceilings; and interior wainscoting, paneling or other finish applied structurally or for decoration, acoustical correction, surface insulation, structural *fire resistance* or similar purposes, but not including trim.

❖ A material that is applied to ceilings as well as walls, columns, partitions (including the privacy partitions in bathrooms that could pose a significant threat in larger bathrooms if unrated) and other vertical interior surfaces whether fixed or movable. The application of this material may be for structural, decorative, acoustical, structural fire resistance and other similar reasons. Trim, such as baseboard, door or window

casing, is not considered interior wall and ceiling finish. Interior wall and ceiling finish is regulated by Section 803.

**IRRITANT.** A chemical which is not *corrosive*, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. A chemical is a skin irritant if, when tested on the intact skin of albino rabbits by the methods of CPSC 16 CFR Part 1500.41 for an exposure of four or more hours or by other appropriate techniques, it results in an empirical score of 5 or more. A chemical is classified as an eye irritant if so determined under the procedure listed in CPSC 16 CFR Part 1500.42 or other *approved* techniques.

❖ Materials classified as irritants include a wide range of materials that pose a health hazard with acute effects caused by short-term exposure. Exposure to irritants may result in a minor, troublesome injury at the point of contact; however, the injury usually heals without leaving a scar. In comparison, corrosives can cause permanent destruction of tissue at the point of contact—with a scar the likely result. Many household insecticides and pesticides are common irritants. The definition is derived from DOL 29 CFR 1910.1200.

**[A] JURISDICTION.** The governmental unit that has adopted this code under due legislative authority.

❖ The governmental unit such as a town, township, county or state that has the legal authority under state statutes to adopt a building code.

**KEY BOX.** A secure device with a lock operable only by a fire department master key, and containing building entry keys and other keys that may be required for access in an emergency.

❖ The key box is part of an emergency entry system. The building owner/manager places a key box or key vault in an approved location on the exterior of the building or at the entrance to a facility, placing keys, access cards or security codes inside the box. The emergency responders can use their special fire department master key to enter the box, retrieve the contents and gain access to the building or facility. There are several different brands of highly secure key boxes available that are tested and listed as anti-theft devices. See the commentary to the definition of “Fire department master key” and Section 506.1 for further discussion.

**[A] LABELED.** Equipment, materials or products to which have been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, *approved* agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the labeled items and whose labeling indicates either that the equipment, material or product meets identified standards or has been tested and found suitable for a specified purpose.

❖ The term “labeled” is not to be confused with the term “listed.” A label is a marking or other identifying mark

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that indicates approval from a nationally recognized testing laboratory, approved agency or other organization that evaluates products. A label is used to identify materials and assemblies that must bear the identification of the manufacturer, as well as a third-party quality control agency. The quality control agency allows the use of its label based on the results of periodic audits and inspections of the manufacturer's plant. This is one form of quality control. The code often requires labeled equipment and systems (see the definition for "Listed").

**LEVEL OF EXIT DISCHARGE.** See "Exit discharge, level of."

**LIMITED SPRAYING SPACE.** An area in which operations for touch-up or spot painting of a surface area of 9 square feet (0.84 m<sup>2</sup>) or less are conducted.

❖ This definition is applicable only to small touch-up-type operations. The requirements in this chapter for limited spraying operations are for an occasional user of flammable/combustible liquids, as opposed to an area used continuously for spraying. An example of such an operation is a furniture distributor that uses a limited spraying space to touch up scratches on products before sale. The limited application method could utilize dedicated spray-finishing equipment or simply an aerosol can (see commentary, Section 2404.9).

**LIQUEFIED NATURAL GAS (LNG).** A fluid in the liquid state composed predominantly of methane and which may contain minor quantities of ethane, propane, nitrogen or other components normally found in natural gas.

❖ Liquefied natural gas (LNG) for motor vehicle fuel comes from the same source as compressed natural gas (CNG). Unlike liquefied petroleum gas (LP-gas), which changes from vapor to a liquid at room temperature by application of pressure, LNG has to be cooled for it to liquefy. LNG is usually in a liquid state at the dispensing station (see Section 2308).

**LIQUEFIED PETROLEUM GAS (LP-gas).** A material which is composed predominantly of the following hydrocarbons or mixtures of them: propane, propylene, butane (normal butane or isobutane) and butylenes.

❖ The definition of LP-gas is consistent with that found in NFPA 58, with one exception: NFPA 58 requires that the vapor pressure of an LP-gas mixture be less than or equal to that of commercial propane.

**LIQUID.** A material having a melting point that is equal to or less than 68°F (20°C) and a *boiling point* which is greater than 68°F (20°C) at 14.7 pounds per square inch absolute (psia) (101 kPa). Where not otherwise identified, the term "liquid" includes both flammable and *combustible liquids*.

❖ In dealing with liquids, two areas are important to check on the MSDS:

1. What is the specific gravity of the liquid? The specific gravity is the chemical's weight compared to the weight of an equal volume of

water. If the specific gravity is lower than 1.0 (which is the specific gravity of water), the chemical will float. If it is higher than 1.0, it will sink. A flammable liquid that has a specific gravity lower than 1.0 will float on top of any fire-fighting water that is applied. It can then become a running fire as it floats on top of the water that is running off from the scene.

2. Will the chemical mix with water? If a chemical will mix with water, it limits the fire-fighting ability of water and another method of extinguishment should be considered.

**LIQUID OXYGEN AMBULATORY CONTAINER.** A container used for liquid oxygen not exceeding 0.396 gallons (1.5 liters) specifically designed for use as a medical device as defined by 21 USC Chapter 9 that is intended for portable therapeutic use and to be filled from its companion base unit, a liquid oxygen home care container.

❖ These containers are a smaller, portable version of the liquid oxygen (LOX) home care container defined elsewhere in this section. They are used by patients in need of continuous oxygen therapy to enhance their mobility and, thus, improve their lifestyle. See the commentary to the definition of "Liquid oxygen home care container" for a technical description of LOX containers. A key aspect in this definition is that these containers are considered medical devices by the U.S. Food and Drug Administration under the Code of Federal Regulations, Title 21— Federal Food, Drug and Cosmetic Act. LOX containers used as medical devices are unique in that they are intended for therapeutic use only and not for use in industrial applications. These containers include in their design all appurtenances, such as regulators, gauges, piping and controls, and require no external piping other than the application of disposable breathing apparatus (see Commentary Figure 202-L1).

**LIQUID OXYGEN HOME CARE CONTAINER.** A container used for liquid oxygen not exceeding 15.8 gallons (60 liters) specifically designed for use as a medical device as defined by 21 USC Chapter 9 that is intended to deliver gaseous oxygen for therapeutic use in a home environment.

❖ A LOX home care container is a cryogenic container equipped with a vaporizer, a pressure control system and a means of pressure relief. The container is constructed similar to a thermos bottle with the inner container generally constructed of stainless steel and installed within an outer container constructed of carbon steel or aluminum. The space between the inner and outer vessel is filled with an insulating material or may be placed in a negative pressure (vacuum). The insulation and space limits the heat transfer to the inner container. A vaporizer converts the LOX to oxygen gas, which flows through a pressure control system so the flow rate of oxygen is regulated. These containers can be used for stationary home oxygen therapy or, as indicated in the definition of "Liquid

oxygen ambulatory container,” to refill the LOX ambulatory container. A key aspect in this definition is that these containers are also considered medical devices by the U.S. Food and Drug Administration under the Code of Federal Regulations, Title 21—Federal Food, Drug and Cosmetic Act. LOX containers used as medical devices are unique in that they are intended for therapeutic use only and not for use in industrial applications (see Commentary Figure 202-L2).

**LIQUID STORAGE ROOM.** A room classified as a Group H-3 occupancy used for the storage of flammable or *combustible liquids* in a closed condition.

- ❖ The Group H-3 occupancy classification for storage of flammable or combustible liquids in closed containers recognizes the hazardous nature of these materials.

**LIQUID STORAGE WAREHOUSE.** A building classified as a Group H-2 or H-3 occupancy used for the storage of flammable or *combustible liquids* in a closed condition.

- ❖ This definition clarifies both the occupancy group (Group H-2 or H-3, depending on the pressure of vessels stored) and that a liquid storage warehouse is a building as described in Section 5704.3.8. The term “liquid storage warehouse” is used in the code in Tables 903.2.11.6, 5704.3.6.3(2) and 5704.3.6.3(3) and Sections 2306.2.2, 5104.6, 5704.3.4.3 and 5704.3.1.1 through 5704.3.8.5. Note that the term “liquid storage warehouse” is not used in the IBC. See the commentary to Section 5704.3 for further information on these unique buildings.

**[A] LISTED.** Equipment, materials, products or services included in a list published by an organization acceptable to the *fire code official* and concerned with evaluation of products or services that maintains periodic inspection of produc-

tion of listed equipment or materials or periodic evaluation of services and whose listing states either that the equipment, material, product or service meets identified standards or has been tested and found suitable for a specified purpose.

- ❖ The term “listed,” which is not to be confused with “labeled,” is a form of quality control. Essentially, a particular product, piece of equipment or system is evaluated or tested and the results are published in a list by agencies, such as approved testing laboratories and inspection agencies. Listed products and equipment are periodically inspected to maintain the listing. The code often requires listed equipment or systems (see also the definition for “Labeled”).

The question is often asked whether the listing of a product can be voided or violated. The use of a listing mark applied to a product is authorized by the listing agency and is a “statement” by the product manufacturer that the product, as manufactured, met all appropriate requirements (such as the criteria contained in a test standard) at the time of manufacture and shipment to a point-of-use or point-of-sale. After that point in time, any alteration or modification may make it difficult for the fire code official or the listing agency to determine if the product meets the criteria by which its listing was originally attained. Listed products are subject to the review and approval of the fire code official. Where the fire code official determines that a field modification or alteration to the product is significant enough to call its impact on the listing into question, an evaluation in the field by the listing agency may be required in order to verify the compliance of the product with the original listing cri-



**Figure 202-L1**  
**LIQUID OXYGEN AMBULATORY CONTAINER**  
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**Figure 202-L2**  
**LIQUID OXYGEN HOME CARE CONTAINER**  
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teria. Such field evaluations or tests would be the responsibility of the owner with no expense to the jurisdiction (see the commentary to Section 104.9.2).

**LOCKDOWN.** An emergency situation, in other than a Group I-3 occupancy, requiring that the occupants be sheltered and secured in place within a building when normal evacuation would put occupants at risk.

❖ Buildings are developing “lockdown” plans in response to such security threats as terrorist attacks or shootings such as the events that have occurred at Columbine High School or Virginia Tech and other venues. In such incidents, security authorities recommend that building occupants be kept inside of the building behind locked doors until authorized to move by safety authorities. Sometimes, lockdown procedures can work in direct opposition to traditional life safety safeguards, particularly as pertains to maintaining a viable means of egress. Requirements have been added to the code on lockdown plans, lockdown drills and lockdown operations, not only in schools, but in all buildings where a lockdown plan is desired in order to reduce the conflicts between security and life safety (see Section 406.4).

**[BG] LODGING HOUSE.** A one-family dwelling where one or more occupants are primarily permanent in nature and rent is paid for guest rooms.

❖ The code establishes a lodging house as a Group R-3 occupancy where there are five or fewer guest rooms. This definition provides a distinction from Group R-1 occupancies where the occupants are expected to be transient. A lodging house has one or more occupants who are permanent; this is their home.

**LONGITUDINAL FLUE SPACE.** See “Flue space—longitudinal.”

**[A] LOT.** A portion or parcel of land considered as a unit.

❖ A lot is a legally recorded parcel of land, the boundaries of which are described on a deed. When code requirements are based on some element of a lot (such as yard area or lot line location), it is the physical attributes of the parcel of land that the code is addressing, not issues of ownership. Adjacent lots owned by the same party are treated as if they were owned by different parties because ownership can change at any time. However, a group of platted lots or subdivision lots could be joined together and “considered as a unit” for the purposes of the code. For example, a collection of platted lots could be used as a single building lot for the construction of a covered mall and its associated anchor buildings. Local jurisdictions may require for taxing or other purposes that the lots be legally joined, or merged, as well.

A condominium form of building ownership, whether a residential or a commercial condominium, does not create separate lots (i.e., parcels of land) and such unit owners are treated as separate tenants, not separate lot owners. The lines separating one part of a condominium from another are not lot

lines but lines indicating the limits of ownership. As such, walls constructed on lines separating condominium ownership would not need to be fire (or party) walls.

Legal property lines do not always constitute site boundaries (i.e., malls, condominiums, townhouses). A site could contain multiple legal “lot” divisions.

**[A] LOT LINE.** A line dividing one lot from another, or from a street or any public place.

❖ Lot lines are legally recorded divisions between two adjacent land parcels or lots. They are the reference point for the location of buildings for exterior separation and other code purposes (see the definition of “Lot”).

**[BE] LOW ENERGY POWER-OPERATED DOOR.** Swinging door which opens automatically upon an action by a pedestrian such as pressing a push plate or waving a hand in front of a sensor. The door closes automatically, and operates with decreased forces and decreased speeds. See also “Power-assisted door” and “Power-operated door.”

❖ There are basically three different doors that provide some type of power assistance for entry – low energy power-operated doors, power-assisted doors and power-operated doors. The low energy power-operated door is typically a side-swinging door that also operates as a manual door. However, the door has the additional feature of automatic operation when a person pushes on a plate or sensor located on a wall or post near the door [See IBC Commentary Figures 202(31), 202(32) and 202(33)]. The low energy power-assisted door and power-assisted door are operated by the user touching something; therefore, they both must comply with BMHA156.19.

**LOW-PRESSURE TANK.** A storage tank designed to withstand an internal pressure greater than 0.5 pound per square inch gauge (psig) (3.4 kPa) but not greater than 15 psig (103.4 kPa).

❖ This definition makes a differentiation between what is considered a low-pressure tank and what is considered a high-pressure tank. Low-pressure tanks are generally less hazardous than high-pressure tanks because the rate of release of cryogenic fluids is much lower.

**LOWER EXPLOSIVE LIMIT (LEL).** See “Lower flammable limit.”

❖ See the commentary for the definition of “Lower flammable limit (LFL).”

**LOWER FLAMMABLE LIMIT (LFL).** The minimum concentration of vapor in air at which propagation of flame will occur in the presence of an ignition source. The LFL is sometimes referred to as LEL or lower explosive limit.

❖ LFL or LEL is the bottom limit on a flammability range, which is the range in which a flammable vapor is mixed with air in just the right percentages to allow combustion. This is an important concept because the requirement for ventilation is based on keeping the vapor concentrations outside of the flammability

range. The upper portion of the range is called the UEL, or upper explosive limit; another term that carries the same meaning is UFL, or upper flammable limit. As long as flammable vapors are not within the range between UFL and LFL, combustion is unlikely.

**LP-GAS CONTAINER.** Any vessel, including cylinders, tanks, portable tanks and cargo tanks, used for transporting or storing LP-gases.

- ❖ The definition of LP-gas container provides consistency with NFPA 58 and makes it clear that the containers being regulated in Chapter 61 of the code are specifically those used for the storage or transport of LP-gas, not the generic, 60 gallon (227.1 L) or less containers defined in Section 202 of the code.

An LP-gas container can be constructed as a cylinder, portable tank, stationary tank or as a cargo tank vehicle. Cylinders are generally constructed to the requirements of the DOT while stationary tanks, portable tanks and cargo tanks are generally constructed to the requirements of the ASME *Boiler and Pressure Vessel Code* for unfired pressure vessels. In addition to these requirements, LP-gas containers must also be constructed in accordance with the requirements in NFPA 58.

All LP-gas containers must meet the requirements contained in Chapter 5 of NFPA 58, which addresses all components used in the construction of container assemblies or complete LP-gas systems. These requirements include general provisions that are applicable to all containers, visual inspection requirements for DOT cylinders in stationary service, container service pressures, required openings for DOT cylinders and ASME containers, container markings and container appurtenances. A container appurtenance is a device installed in container openings for safety, control, or operating purposes. Appurtenances include a pressure relief device, one or more pressure regulators, an overfill prevention device, a manual shutoff valve, and a means of gauging the liquid level and the pressure inside the container. The types of appurtenances required for LP-gas containers are based on whether the container is constructed as a cylinder or tank. For stationary tanks, its volumetric capacity will dictate the required container appurtenances.

**MAGAZINE.** A building, structure or container, other than an operating building, *approved* for storage of *explosive materials*.

- ❖ Structures for the storage of explosive materials are not considered inhabited buildings for the purpose of applying Section 5604. Explosives, a necessary part of our industrialized society, must be transported from places of manufacture to a location of use. Somewhere along the line, they will probably have to be stored. This type of storage place is called a magazine.

**Indoor.** A portable structure, such as a box, bin or other container, constructed as required for Type 2, 4 or 5 maga-

zines in accordance with NFPA 495, NFPA 1124 or DOTy 27 CFR Part 55 so as to be fire resistant and theft resistant.

- ❖ These magazines are sometimes found inside warehouses, wholesale houses and retail establishments on wheels or casters to allow easy movement when needed.

**Type 1.** A permanent structure, such as a building or igloo, that is bullet resistant, fire resistant, theft resistant, weather resistant and ventilated in accordance with the requirements of NFPA 495, NFPA 1124 or DOTy 27 CFR Part 55.

- ❖ The walls of a Type 1 magazine should be constructed of either masonry, metal or wood. The foundation should consist of brick, concrete, cement, block, stone or wood post. The floors should be constructed of nonsparking material and be strong enough to bear the weight of the maximum quantity to be stored. The listed standards give the sizes of material for each type of construction material.

**Type 2.** A portable or mobile structure, such as a box, skid-magazine, trailer or semitrailer, constructed in accordance with the requirements of NFPA 495, NFPA 1124 or DOTy 27 CFR Part 55 that is fire resistant, theft resistant, weather resistant and ventilated. If used outdoors, a Type 2 magazine is also bullet resistant.

- ❖ Construction of a Type 2 magazine may be either:

1. Wood [having sides, bottoms, and covers or doors constructed of 2-inch (51 mm) hardwood, well braced at corners and covered with sheet metal (not less than 26 gauge) with exposed nails countersunk].
2. Metal [having sides, bottoms and covers or doors constructed of 12-gauge (0.1046 inch) metal and lined inside with a nonsparking material. Edges of metal shall overlap sides at least 1 inch (25 mm)].

**Type 3.** A fire resistant, theft resistant and weather resistant “day box” or portable structure constructed in accordance with NFPA 495, NFPA 1124 or DOTy 27 CFR Part 55 used for the temporary storage of *explosive materials*.

- ❖ Construction of a Type 3 magazine may be of not less than 12-gauge (0.1046 inch) steel, lined with 1/2-inch (12.7 mm) plywood or 1/2-inch (12.7 mm) hardboard. The door or lid must overlap the door opening by at least 1 inch (25 mm).

**Type 4.** A permanent, portable or mobile structure such as a building, igloo, box, semitrailer or other mobile container that is fire resistant, theft resistant and weather resistant and constructed in accordance with NFPA 495, NFPA 1124 or DOTy 27 CFR Part 55.

- ❖ Construction of a Type 4 magazine may be of masonry, metal-covered wood, fabricated metal or a combination of these materials.

**Type 5.** A permanent, portable or mobile structure such as a building, igloo, box, bin, tank, semitrailer, bulk trailer,

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tank trailer, bulk truck, tank truck or other mobile container that is theft resistant, which is constructed in accordance with NFPA 495, NFPA 1124 or DOTy 27 CFR Part 55.

- ❖ Restrictions on Type 5 outdoor storage facilities:
  - Ground around the storage facility must slope away for drainage. Wheels must be removed from vehicles used as unattended storage facilities or they must be immobilized by kingpin locking devices.
- ❖ Restrictions on Type 5 indoor storage facilities:
  - Blasting agents are not to be stored in any kind of indoor storage facility in a residence or dwelling.

**MAGNESIUM.** The pure metal and alloys, of which the major part is magnesium.

- ❖ Magnesium is a silvery-white combustible metal weighing only two-thirds as much as aluminum and having good structural properties when suitably alloyed. For this reason, magnesium alloys are used to a great extent in the construction of aircraft; automobiles and trucks; household appliances; furniture; office equipment, machine parts and numerous other applications. Powdered magnesium is used in signal flares and other fireworks to produce an intense white light.

The melting point of pure magnesium is 1,202°F (650°C). The ignition temperature is generally considered to be very close to the melting point, but ignition of magnesium in certain forms may occur at lower air temperatures. Magnesium ribbon and fine magnesium shavings can be ignited under some conditions at temperatures of 950°F (510°C), and very finely divided magnesium powder has been ignited at an air temperature below 900°F (482°C).

The ease of ignition of magnesium depends to a large extent upon the size and shape of the material as well as the intensity of the ignition source. The flame of a match may be sufficient to ignite magnesium ribbon, shavings or chips with thin feather edges, and a spark will ignite fine dust such as is produced in grinding operations. Heavier pieces, such as ingots or thick-walled castings, are difficult to ignite because heat is rapidly conducted away from a localized ignition source. If the entire piece of metal can be raised to the ignition temperature, however, self-sustained burning will occur.

Because the melting point of magnesium is low, the metal melts as it burns and, after some minutes of burning, produces puddles of molten magnesium. The production of molten metal will depend to a considerable extent on the physical condition of the material. Finely divided magnesium, such as shavings, dust and small scraps, will burn more rapidly and produce less molten metal than will an equal quantity of magnesium in the more solid form of ingots or castings.

Metal products marketed under a variety of trade names and designations and commonly referred to as “magnesium” may, in fact, be one of a large number of alloys containing widely differing percentages of magnesium, aluminum, zinc and manganese. Some of these alloys have melting points and ignition temperatures considerably lower than that of pure magnesium.

**MALL.** See “Covered mall building.”

**MANUAL FIRE ALARM BOX.** A manually operated device used to initiate an alarm signal.

- ❖ Manual fire alarm boxes are commonly known as pull stations. Manual fire alarm boxes include all manual devices used to activate a manual fire alarm system and have many configurations, depending on the manufacturer. All manual fire alarm devices, however, must be approved and installed in accordance with NFPA 72 for the particular application. Manual fire alarm boxes may be combined in guard tour boxes.

**MANUAL STOCKING METHODS.** Stocking methods utilizing ladders or other nonmechanical equipment to move stock.

- ❖ Manual stocking methods do not require the use of mechanical means to stock and retrieve commodities. Commodities may be stocked or retrieved on foot where the commodity is accessible from a floor or landing, or through the use of a portable ladder or portable stair.

**MARINA.** Any portion of the ocean or inland water, either naturally or artificially protected, for the mooring, servicing or safety of vessels and shall include artificially protected works, the public or private lands ashore, and structures or facilities provided within the enclosed body of water and ashore for the mooring or servicing of vessels or the servicing of their crews or passengers.

- ❖ A marina is a protected area where the mooring of marine vessels occurs along with the associated operations to service the vessels, such as fueling, maintenance and repair facilities, ship chandlers, stores and restaurants, the launching of vessels and the loading of vessels with cargo or persons. Marine vessels moored in a marina are usually in close proximity to each other with floats of minimal widths, usually enough for people to walk on, and small carts to carry supplies that are to be loaded onto the vessels. The marina may offer out-of-water-storage, which is useful out of season and important in climates susceptible to freezing waters. Dry storage or “dry stacking” boat storage stores boats vertically in double, triple or even quadruple rack systems. Boats are placed into and retrieved from the storage racks with a forklift.

**MARINE MOTOR FUEL-DISPENSING FACILITY.** That portion of property where flammable or *combustible liquids* or gases used as fuel for watercraft are stored and dis-

pensed from fixed equipment on shore, piers, wharves, floats or barges into the fuel tanks of watercraft and shall include all other facilities used in connection therewith.

- ❖ A marine motor fuel-dispensing facility is not to be confused with a bulk marine terminal, which transfers fuel by way of flange-to-flange connections. A marine motor fuel-dispensing facility uses automotive-type dispensing equipment. Motor fuel-dispensing facilities are classified in Occupancy Group M by the IBC.

**MATERIAL SAFETY DATA SHEET (MSDS).** Information concerning a hazardous material which is prepared in accordance with the provisions of DOL 29 CFR Part 1910.1200 or in accordance with the provisions of a federally approved state OSHA plan.

- ❖ To comply with right-to-know legislation, building owners are required to provide or prepare a MSDS for all hazardous materials that may be on the premises. The MSDS is the single best source of information in dealing with the requirements of the IBC and the code.

**MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA.** The maximum amount of a hazardous material allowed to be stored or used within a *control area* inside a building or an outdoor *control area*. The maximum allowable quantity per control area is based on the material state (solid, liquid or gas) and the material storage or use conditions.

- ❖ Exceeding this amount, also referred to as the MAQ, will place the use area or building into a hazardous occupancy classification. See Tables 5003.1.1(1), 5003.1.1(2), 5003.1.1(3), 5003.1.1(4) and 5003.8.3.2.

**[BE] MEANS OF EGRESS.** A continuous and unobstructed path of vertical and horizontal egress travel from any occupied portion of a building or structure to a *public way*. A means of egress consists of three separate and distinct parts: the *exit access*, the *exit* and the *exit discharge*.

- ❖ The means of egress is the path traveled by building occupants to leave the building and the site on which it is located. It includes all interior and exterior elements that the occupants must utilize as they make their way from every room and usable space within the building to a public way such as a street or alley. The elements that make up the means of egress create the lifeline that occupants utilize to travel out of the structure and to a safe distance from the structure. The means of egress provisions of the code strive to provide a reasonable level of life safety in every structure. The means of egress provisions are subdivided into three distinct portions (see the definitions of "Exit access," "Exit" and "Exit discharge").

**MECHANICAL STOCKING METHODS.** Stocking methods utilizing motorized vehicles or hydraulic jacks to move stock.

- ❖ Mechanical stocking methods are generally associated with rack storage. The mass of the commodity, the height of the rack storage or the shear quantity of commodity on any one pallet will normally put stocking or retrieval beyond human reach or strength.

Methods commonly employed for this type of operation are manned forklifts or unmanned mechanized storage and retrieval systems.

**[BG] MEDICAL CARE.** Care involving medical or surgical procedures, nursing or for psychiatric purposes.

- ❖ Persons who need medical care are likely to be incapable of self-preservation or at least extremely limited in their ability to evacuate. In consideration of occupants' health as well as safety, hospitals and nursing homes at least partially rely on defend-in-place strategies rather than evacuation. See also the commentary to Occupancy Group I-2.

Care facilities encompass a full spectrum of occupant acuity and support services, and span a wide range of occupancy types, including Groups E, I and R. There are three types of care defined in the codes: personal, custodial and medical. On the lower end of the care spectrum, i.e., personal care, is when occupants are supervised but do not need custodial or medical care. But, where occupants may be elderly or impaired, i.e., custodial care, they may need occasional daily living assistance, such as cooking and cleaning. Persons who receive custodial care may or may not require assistance with evacuation depending on the occupancy and conditions of the occupancy. On the opposite end of the care spectrum, persons receiving care may be completely bedridden and dependant on medical gases and emergency power to maintain life (i.e., medical care). The level of care provided describes the condition and capabilities of an occupant which then indicates appropriate standards for protection systems, both active and passive. See also the definitions for "24-hour basis," "Custodial care," "Detoxification facilities," "Foster care facilities," "Group home," "Hospitals and psychiatric hospitals," "Incapable of self-preservation," "Nursing homes" and "Personal care services."

**MEMBRANE STRUCTURE.** An air-inflated, air-supported, cable or frame-covered structure as defined by the *International Building Code* and not otherwise defined as a tent. See Chapter 31 of the *International Building Code*.

- ❖ This definition is broadly inclusive of all types of membrane structures, regardless of the supporting mechanism or structure, as defined in Chapter 2 of the IBC as "Air-inflated structure," "Air-supported structure," "Cable-restrained, air supported structure," "Membrane-covered cable structure" and "Membrane-covered frame structure." Note that tents are not included. See the definitions of "Air-inflated structure," "Air supported structure" and "Tent."

**[BE] MERCHANDISE PAD.** A merchandise pad is an area for display of merchandise surrounded by *aisles*, permanent fixtures or walls. Merchandise pads contain elements such as nonfixed and moveable fixtures, cases, racks, counters and partitions as indicated in Section 105.2 of the *International Building Code* from which customers browse or shop.

- ❖ Merchandise pads would most likely be found in large stores with changing displays of clothes or furniture.

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This is not a raised display-only area. These areas allow customers to move between displays or racks. In regards to means of egress, merchandise pads could be considered analogous to areas of fixed seating or groups of tables. The aisle accessways are within the merchandise pad and lead to the aisles on the outside edges of the merchandise pads. Not all stores will contain merchandise pads (e.g., a typical grocery store with fixed shelves and aisles).

**METAL HYDRIDE.** A generic name for compounds composed of metallic element(s) and hydrogen.

❖ Hydride is the name given to the negative ion of hydrogen. With the exception of inert gases, every element in the Periodic Table of Elements can form a hydride. The hazards of hydrides will vary based on the elemental molecule to which the -H ion attaches itself.

A metal hydride is a metallic alloy that will adsorb and release hydrogen molecules. (The term “adsorb” means a taking up by physical or chemical forces of the molecules of hydrogen gas by the surfaces of solids with which they are in contact.) With metal hydrides, adsorption occurs when the hydrogen molecules accumulate on the surface of metal. Many of the metals used in metal hydride storage systems (MHSS) are designed to be reversible, meaning they can adsorb and release hydrogen from the system. The adsorption and release occurs when heat is transferred within the MHSS, which upsets the equilibrium condition between the hydrogen, the hydrogen-adsorbing alloy and the metal hydride system.

**METAL HYDRIDE STORAGE SYSTEM.** A *closed system* consisting of a group of components assembled as a package to contain metal-hydrogen compounds for which there exists an equilibrium condition where the hydrogen-adsorbing metal alloy(s), hydrogen gas and the metal-hydrogen compound(s) coexist and where only hydrogen gas is released from the system in normal use.

❖ Metal hydride storage systems (MHSS) are another technological advancement in fuel-cell technology

that is becoming a commonly used method for storing hydrogen and is an alternative to traditional compressed or cryogenic fluid storage methods for supplying hydrogen to fuel cells. A MHSS will release or adsorb hydrogen gas when the equilibrium condition is changed. Changes in the equilibrium condition cause the system to either release heat (exothermic) or absorb heat (endothermic). MHSSs designed in compliance with Section 5807 are designed so only hydrogen is released from or introduced into the system during its discharge or filling. The requirements in Section 5807 provide guidance to fire code officials and design professionals in the design, construction, inspection and testing of systems and components used as a MHSS (see Commentary Figure 202-M1).

**[BG] MEZZANINE.** An intermediate level or levels between the floor and ceiling of any story and in accordance with Section 505 of the *International Building Code*.

❖ A common design feature in factories, warehouses and mercantile buildings is an intermediate loft, or platform, between the story levels of a building. This type of feature, or mezzanine, can be found in buildings of all occupancies. The IBC must deal with whether this intermediate level is another story of the building or whether it can simply be treated as part of the story in which it is contained. The basic rule is that the intermediate level must be less than one-third of the area of the story below (of the room in which it is located) in order to be considered a mezzanine. Requirements for mezzanines are found in Section 505 of the IBC.

**MOBILE FUELING.** The operation of dispensing liquid fuels from tank vehicles into the fuel tanks of motor vehicles. Mobile fueling may also be known by the terms “Mobile fleet fueling,” “Wet fueling” and “Wet hosing.”

❖ This definition pertains to the fueling process regulated by Section 5706.5.4.5, wherein fuel is dispensed from the tank vehicle directly to the fuel tank of a vehicle (see commentary, Section 5706.5.4.5).



**Figure 202-M1**  
**METAL HYDRIDE STORAGE CONTAINER AND ITS METAL HYDRIDE CONTENT**  
Photo courtesy of Ovanics Hydrogen Systems, LLC

**MORTAR.** A tube from which fireworks shells are fired into the air.

- ❖ Mortars must be inspected carefully for defects, such as dents, bent ends, damaged interiors and damaged plugs, prior to placement and use. Defective mortars must not be used. Careful inspection of mortars is of particular importance for paper mortars that can sustain undetected damage to their interiors that can result in serious malfunctions.

**MULTIPLE-STATION ALARM DEVICE.** Two or more single-station alarm devices that can be interconnected such that actuation of one causes all integral or separate audible alarms to operate. A multiple-station alarm device can consist of one single-station alarm device having connections to other detectors or to a manual fire alarm box.

- ❖ This definition refers to a combination of similar or different types of alarm devices that could be interconnected. The actuation of any two devices, whether a smoke detector or manual fire alarm box, will activate the required audible alarms at all interconnected devices.

**MULTIPLE-STATION SMOKE ALARM.** Two or more single-station alarm devices that are capable of interconnection such that actuation of one causes the appropriate alarm signal to operate in all interconnected alarms.

- ❖ In occupancies with sleeping areas, occupants must be notified in a fire so that they can promptly evacuate the premises. In accordance with the requirements of NFPA 72, multiple-station smoke alarms are self-contained, smoke-activated alarm devices built in accordance with UL 217 that can be interconnected with other devices so that all integral or separate alarms will operate when any one device is activated.

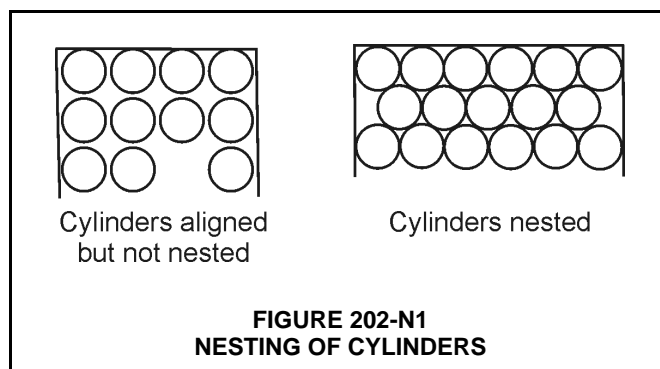
**NESTING.** A method of securing flat-bottomed *compressed gas* cylinders upright in a tight mass using a contiguous three-point contact system whereby all cylinders within a group have not less than three points of contact with other cylinders, walls or bracing.

- ❖ Nesting is the placement of cylinders in tightly packed groups in which three sides of the group are comprised of walls or barriers and each cylinder is in contact with a wall or another cylinder in at least three places. It is generally considered an alternative to chaining or otherwise physically securing compressed gas cylinders (as required by Section 5303.5.3) under conditions of occupancy where cylinders must be readily moveable, such as in a filling plant.

Placing cylinders in multipoint contact with one another can reduce cylinder instability while affording the ready mobility required by an operation being conducted by trained personnel. Such a configuration is relatively secure for all cylinders involved because even those cylinders on the open side would have to be displaced from behind, i.e., an area within the nest itself. This reduces the potential for damage to the cylinder valve since a knockdown of the cylinder

could result in leakage of hazardous gas or create a projectile situation.

One safety precaution that could reduce the likelihood of a cylinder on the face of the nest having a valve sheared is maintaining an open space in front of the nest, free of shelves, counters or other projections, which could act to break the valve on an overturning cylinder. Additionally, valve protection caps should be in place on the cylinders at all times when the cylinder is not connected, being filled or emptied (see Commentary Figure 202-N1).



**FIGURE 202-N1  
NESTING OF CYLINDERS**

**NET EXPLOSIVE WEIGHT (net weight).** The weight of *explosive material* expressed in pounds. The net explosive weight is the aggregate amount of *explosive material* contained within buildings, magazines, structures or portions thereof, used to establish quantity-distance relationships.

- ❖ This definition is included to correlate the use of the provisions of this chapter. The definition is based on Department of Defense (DOD) concepts; however, prescriptive requirements have been removed from the DOD definition and placed into the body of the code. The net explosive weight may vary depending on building construction; for example, in cases where appropriate barrier walls or appropriate distances have been employed to avoid propagation.

**NORMAL TEMPERATURE AND PRESSURE (NTP).** A temperature of 70°F (21°C) and a pressure of 1 atmosphere [14.7 psia (101 kPa)].

- ❖ Reaction by some chemicals is based on temperature and pressure. Understanding this relationship to normal room temperature and pressure (elevation) can provide information on the hazards for the chemical being considered.

**[BE] NOSING.** The leading edge of treads of *stairs* and of landings at the top of *stairway flights*.

- ❖ The front edge of the tread that is exposed to the users foot provides the visual clue for the placement of the foot in both ascent and descent. The nosings of a stair are a reference point for the measurement of as tread depth and riser height. The line connecting the nosings serves as the reference for the measurement of handrail and guard heights, as well as headroom. The code assures their uniformity by limiting

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the projection of the tread and landing nosings that results in a stairway that is easy to use. If too large, they are a tripping hazard when walking up a stair. If too small in relation to tread depth, the effective tread depth required for heel clearance in descent is minimized. The code provides limits for both minimum and maximum nosing projections and establishes a minimum tread depth when no projection is required. An exception to these limits exists in the requirements for both alternating tread devices and ship ladders where an exaggerated projected tread depth, required to provide for reasonable foot room, is unique to the steeper gradient and functional use of these devices.

**NOTIFICATION ZONE.** See “Zone, notification.”

**NUISANCE ALARM.** An alarm caused by mechanical failure, malfunction, improper installation or lack of proper maintenance, or an alarm activated by a cause that cannot be determined.

❖ A nuisance alarm is essentially any alarm that occurs as a result of a condition that does not arise during the normal operation of the equipment. A nuisance alarm is not the same as a false alarm. A person who intentionally initiates an alarm by using a manual pull station or a person who accidentally initiates a smoke detector is not initiating a nuisance alarm. A nuisance alarm is, by nature, a factor of the system itself. See commentary to the definition of “False alarm.”

**[BG] NURSING HOMES.** Facilities that provide care, including both intermediate care facilities and skilled nursing facilities, where any of the persons are incapable of self-preservation.

❖ Persons in nursing homes may be physically incapable of self-preservation or at least extremely limited in their ability to evacuate. In dementia wards, they may be confined within an area of a building for care or security purposes. In consideration of occupants’ health as well as safety, hospitals and nursing homes at least partially rely on defend-in-place strategies. See the commentary for Occupancy Group I-2 and Section 407 of the IBC.

Care facilities encompass a full spectrum of occupant acuity and support services, and span a wide range of occupancy types including Groups B, E, I and R. The level of care provided describes the condition and capabilities of an occupant which then indicates appropriate standards for protection systems, both passive and active. See also the definitions for “24-hour basis,” “Care suite,” “Custodial care,” “Detoxification facilities,” “Hospitals and psychiatric hospitals,” “Incapable of self-preservation” and “Medical care.”

**OCCUPANCY CLASSIFICATION.** For the purposes of this code, certain occupancies are defined as follows:

❖ The provisions of Sections 302 through 312 of the IBC control the classification of buildings and structures as to their use and occupancy. The purpose of those provisions is to provide rational criteria for the

classification of various occupancies into groups based on their relative fire hazard and life safety properties. This is necessary because the IBC, as well as many provisions of the code, utilize occupancy group classification as a fundamental principle for differentiating code requirements related to fire and life safety protection. By organizing occupancies with similar fire hazard and life safety properties into occupancy groups, the IBC and the code have adopted the means to differentiate occupancies such that various fire protection and life safety requirements can be rationally organized and applied. Each specific group has an individual classification and represents a different characteristic and level of fire hazard that requires special code provisions to lessen the associated risks. See Chapter 3 of the IBC commentary for further discussion of occupancy groups and examples of how they are applied.

**[BG] Assembly Group A.** Assembly Group A occupancy includes, among others, the use of a building or structure, or a portion thereof, for the gathering of persons for purposes such as civic, social or religious functions; recreation, food or drink consumption; or awaiting transportation.

❖ Because of the arrangement and density of the occupant load associated with occupancies classified in the Group A assembly category, the potential for multiple fatalities and injuries from fire is comparatively high. For example, no other use listed in Section 302.1 of the IBC contemplates occupant loads as dense as 5 square feet (0.46 m<sup>2</sup>) per person (see Table 1004.1.2). Darkened spaces in theaters, nightclubs and the like serve to increase hazards. In sudden emergencies, the congestion caused by large numbers of people rushing to exits can cause panic conditions. For these and many other reasons, there is a relatively high degree of hazard to life safety in assembly facilities. The relative hazards of assembly occupancies are reflected in the height and area limitations of Tables 504.3, 504.4 and 506.2 that are, in comparison, generally more restrictive than for buildings in other group classifications.

A room or space with an occupant load of 50 or more persons should not be automatically classified as a Group A; however, if a room or space is used for assembly purposes (i.e., gathering of persons for purposes such as civic, social or religious functions; recreation, food or drink consumption or awaiting transportation in accordance with Section 303.1) and the occupant load is 50 or more, Group A is likely to be the appropriate designation. Other uses can have an occupant load of more than 50 in a space or room; for example, a large office space, a grocery store or the main floor of a major retail business, but these are not assembly occupancies.

There are five specific assembly group classifications, Groups A-1 through A-5, described in this section. Where used in the code, the general term “Group A” is intended to include all five classifications.

The fundamental characteristics of all assembly occupancies are identified in this section. Structures that are designed or occupied for assembly purposes must be placed in one of the assembly group classifications. There are buildings and spaces which are used for assembly purposes, but are not classified as Assembly occupancies. These “exceptions” to this rule include small assembly buildings, tenant spaces and assembly spaces in mixed-use buildings. These exceptions to the Group A classification are addressed below.

**[BG] Small buildings and tenant spaces.** A building or tenant space used for assembly purposes with an *occupant load* of less than 50 persons shall be classified as a Group B occupancy.

- ❖ There are often small establishments that typically serve food and have a few seats that technically meet the definition of an assembly Group A occupancy but due to the low occupant load pose a lower risk than a typical assembly occupancy. These types of buildings and tenant spaces are to be considered as Group B occupancies when the occupant load is determined to be less than 50 persons. Examples of this include small “fast food” establishments and small “mom-and-pop” cafes or coffee shops.

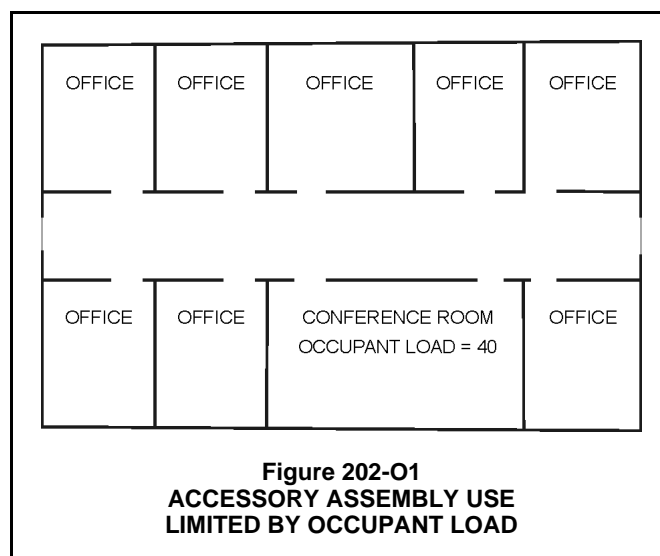
**[BG] Small assembly spaces.** The following rooms and spaces shall not be classified as assembly occupancies:

1. A room or space used for assembly purposes with an *occupant load* of less than 50 persons and accessory to another occupancy shall be classified as a Group B occupancy or as part of that occupancy.
2. A room or space used for assembly purposes that is less than 750 square feet (70 m<sup>2</sup>) in area and accessory to another occupancy shall be classified as a Group B occupancy or as part of that occupancy.

- ❖ Assembly rooms or spaces within larger buildings that house other uses are classified based upon their occupant loads. Where the occupant load of the assembly space is less than 50, or where the floor area of the space used for assembly purposes is less than 750 square feet (65 m<sup>2</sup>), a classification of other than Group A is permitted. In both cases, the purpose of the assembly space must be accessory to the principal occupancy of the structure (i.e., the activities in the assembly space are subordinate and secondary to the primary occupancy). If either the occupant load or floor area requirement is satisfied and the purpose of the assembly space is accessory to the principal occupancy, the space is permitted to either be classified as a Group B occupancy or as part of the principal occupancy. In either case, the assembly space is not required to be less than 10 percent of the area of the story on which it is located as is specified for accessory occupancies in Section 508.2 of the IBC (IBC Interpretation No. 20-04).

The allowances given to assembly spaces in buildings containing multiple uses are a practical code consideration that permits a mixed-use condition to exist without requiring compliance with the provisions for mixed occupancies (see Section 508 of the IBC). Although the term “accessory” is used in describing the relationship of the uses, the intent of the term here is that the use of the space is related to, or part of, the main use of the space. These exceptions are not limited by the accessory use requirements found in Section 508.2 of the IBC.

**Example 1:** An office building, classified as a Group B occupancy, has a conference room used for staff meetings with an occupant load of 40 (see Commentary Figure 202-O1). The occupancy classification of a conference room is generally considered a Group A-3. Since the occupant load of the conference room is less than 50 and its function is clearly accessory to the business area, the room is permitted to be classified the same as the main occupancy, Group B.



**Example 2:** A 749-square-foot (70 m<sup>2</sup>) assembly area is located adjacent to a mercantile floor area of 5,000 square feet (465 m<sup>2</sup>) (see Commentary Figure 202-O2). Although the assembly use area occupies 15 percent of the 5,000-square-foot (465 m<sup>2</sup>) floor area, it does not exceed 750 square feet (70 m<sup>2</sup>) and is not considered a Group A occupancy, but rather is classified as part of the Group M occupancy.

**[BG] Associated with Group E occupancies.** A room or space used for assembly purposes that is associated with a Group E occupancy is not considered a separate occupancy.

- ❖ A typical educational facility for students in the 12th grade and below invariably contains many types of assembly spaces other than classrooms, such as auditoriums, cafeterias, gymnasiums and libraries. Such assembly spaces in a Group E building are not

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intended to be regulated as separate Group A occupancies, regardless of their floor area, but rather an extension of the Group E classification. It is worth mentioning, for such assembly functions to be considered part of the primary Group E occupancy, the assembly functions must be ancillary and supportive to the educational operation of the building. Otherwise, they would be classified into the appropriate Group A occupancy based upon their specific function. These assembly spaces, where classified as a portion of the Group E occupancy, are still considered as assembly in nature and must comply with assembly space requirements specified for accessibility and means of egress. However, often such school facilities are used for other functions, such as a meeting of a community service organization or a community crafts fair. These types of uses fall outside of the intent of this section and, therefore, such assembly spaces would need to be classified as a Group A.

**[BG] Accessory with places of religious worship.**

Accessory religious educational rooms and religious auditoriums with *occupant loads* of less than 100 per room or space are not considered separate occupancies

- ❖ Places of religious worship are listed as a Group A-3 occupancy. In addition to the worship hall, it is common for such facilities to contain smaller rooms used for educational activities. This provision allows such spaces to be considered as part of the Group A-3 classification rather than create a mixed-occupancy condition. For example, classrooms are normally classified as Group E if occupied by persons of ages through the 12th grade, or as Group B if the educa-

tion is provided to adults. These types of classrooms could be considered as a part of the Group A-3 occupancy under the provisions of this section. Where such rooms are used at certain times for other than as a religious auditorium or for religious education, Section 302 of the IBC requires that the requirements of each occupancy be applied.

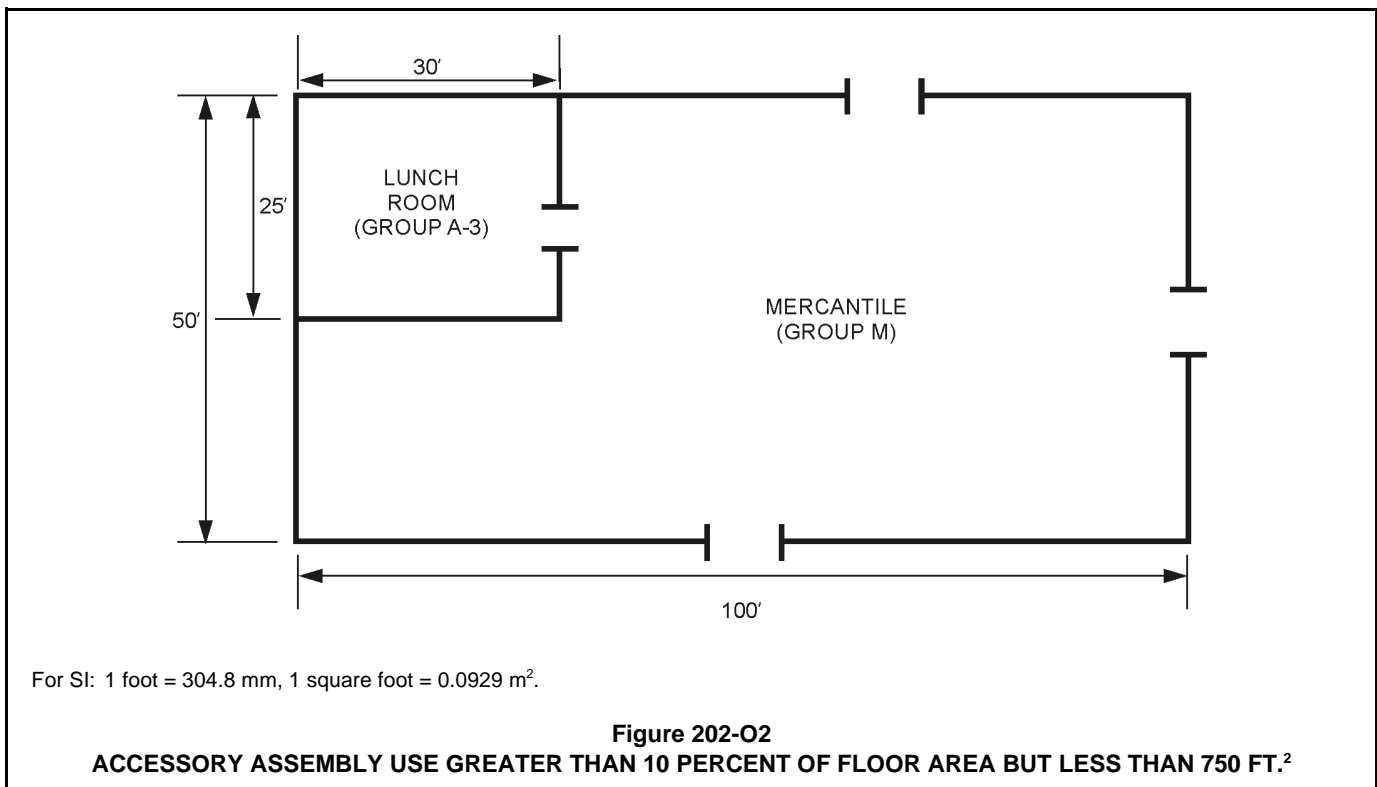
**[BG] Assembly Group A-1.** Group A occupancy includes assembly uses, usually with fixed seating, intended for the production and viewing of performing arts or motion pictures including, but not limited to:

- Motion picture theaters
- Symphony and concert halls
- Television and radio studios admitting an audience
- Theaters

- ❖ Some of the characteristics of Group A-1 occupancies are large, concentrated occupant loads; low lighting levels; above-normal sound levels; and a moderate fuel load.

Group A-1 is characterized by two basic types of activities. The first type is one in which the facility is occupied for the production and viewing of theatrical or operatic performances. Facilities of this type ordinarily have fixed seating; a permanent raised stage; a proscenium wall and curtain; fixed or portable scenery drops; lighting devices; dressing rooms; mechanical appliances or other theatrical accessories and equipment (see Commentary Figure 202-O3).

The second type is one in which the structure is primarily occupied for the viewing of motion pictures. Facilities of this type ordinarily have fixed seating, no stage, a viewing screen, motion picture projection



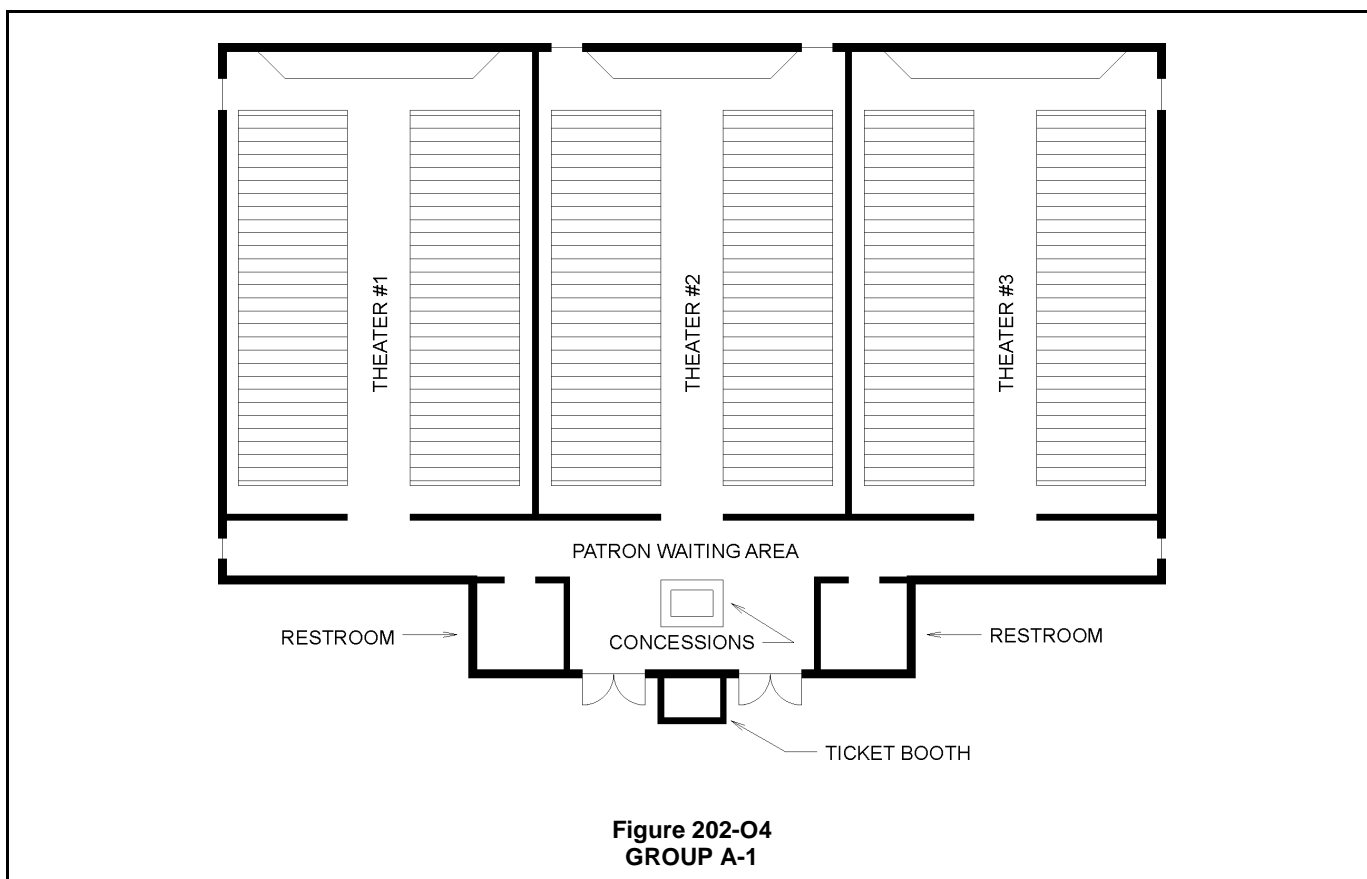
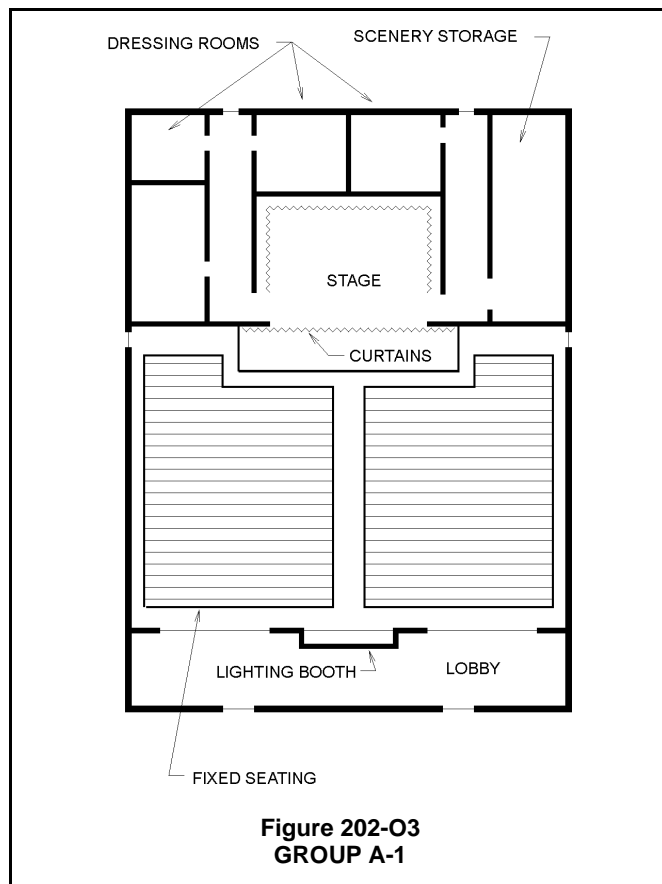
booths and equipment (see Commentary Figure 202-04).

Group A-1 presents a significant potential life safety hazard because of the large occupant loads and the concentration of people within confined spaces. The means of egress is an important factor in the design of such facilities. Theaters for the performing arts that require stages are considered particularly hazardous because of the amount of combustibles, such as curtains, drops, scenery, construction materials and other accessories normally associated with stage operation. As such, special protection requirements applicable to stages and platforms are provided in Section 410 of the IBC and Chapter 10 of the code.

**[BG] Assembly Group A-2.** Group A-2 occupancy includes assembly uses intended for food and/or drink consumption including, but not limited to:

- Banquet halls
- Casinos (gaming areas)
- Night clubs
- Restaurants, cafeterias and similar dining facilities (including associated commercial kitchens)
- Taverns and bars

❖ Group A-2 includes occupancies in which people congregate in high densities for social entertainment, such as drinking and dancing (e.g., nightclubs, dance halls, banquet halls, cabarets, etc.) and food and drink consumption (e.g., restaurants). The unique-



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ness of these occupancies is characterized by some or all of the following:

- Low lighting levels;
- Entertainment by a live band or recorded music generating above-normal sound levels;
- No theatrical stage accessories;
- Later-than-average operating hours;
- Tables and seating arranged or positioned so as to create ill-defined aisles;
- A specific area designated for dancing;
- Service facilities for alcoholic beverages and food; and
- High occupant load density.

The fire records are very clear in identifying that the characteristics listed above often cause a delayed awareness of a fire situation and confuse the appropriate response, resulting in an increased egress time and sometimes panic. Together, these factors may result in extensive life and property losses. These characteristics are only advisory in determining whether Group A-2 is the appropriate classification. Often, there are additional characteristics that are unique to a project, which also must be taken into consideration when a classification is made.

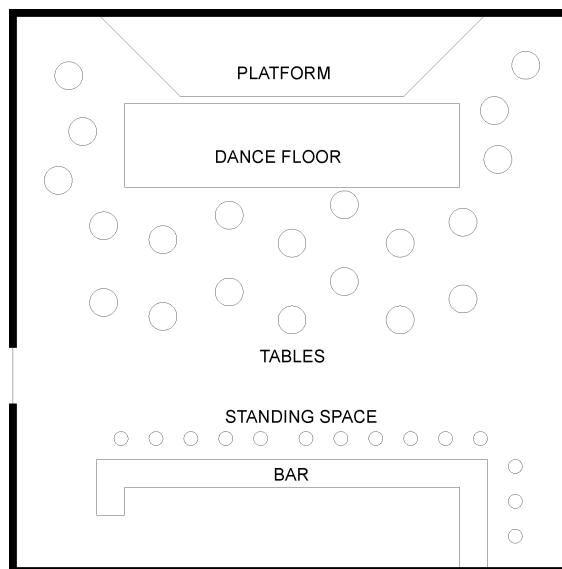
**Example:** The Downtown Club, a popular local nightclub/dance hall, features a different band every weekend (see Commentary Figure 202-O5). It is equipped with a bar and basic kitchen facilities so that beverages and appetizers can be served. There is a platform for a band to perform, a dance floor in front of the platform and numerous cocktail tables and chairs. The tables and chairs are not fixed, resulting in a

hazardous arrangement because there are no distinct aisles. When the band performs, the house lights are dimmed and spotlights are keyed in on the performers. The club is equipped with a sound system that is used at loud levels. The club is open until 3:00 a.m.—the latest time the local jurisdiction will allow.

From this description of the Downtown Club, one can readily see that the appropriate classification is Group A-2. Sometimes, however, it is not this easy to determine the appropriate classification. In such cases, the building official must seek additional information regarding the functions of the building and each area within the building.

Two of the specific uses listed as Group A-2 occupancies are typically not considered as facilities primarily used for food and/or drink consumption, however, their classification as such has been deemed appropriate for varying reasons. The placement of casino gaming areas in the Group A-2 classification is because they share many hazard characteristics with night clubs and, to some extent, the other uses in the category. The presence of distracting lights, sounds and decorations, along with the potential for alcohol consumption, create an assembly environment that is best addressed under the Group A-2 provisions. The classification is specific to the gaming areas of a casino, therefore, other related uses, such as administrative, storage and lodging areas are to be individually classified based upon their specific use.

Although commercial kitchens do not pose the same conditions and concerns as the other uses classified as Group A-2, their classification as such recognizes the relationship that exists between the



**Figure 202-O5**  
**GROUP A-2**

dining and cooking areas. Providing a physical fire-resistive separation between the kitchen and the dining area that it serves is often found to be impractical. Assigning a single occupancy classification for both the commercial kitchen and its associated dining area eliminates any potential for an unnecessary mixed-occupancy condition. This single classification approach can also be applied where the occupant load of the dining area is below 50, allowing for a Group B classification. Under such circumstances, the kitchen would be considered an extension of the Group B dining facility.

**[BG] Assembly Group A-3.** Group A-3 occupancy includes assembly uses intended for worship, recreation or amusement and other assembly uses not classified elsewhere in Group A, including, but not limited to:

- Amusement arcades
- Art galleries
- Bowling alleys
- Community halls
- Courtrooms
- Dance halls (not including food or drink consumption)
- Exhibition halls
- Funeral parlors
- Gymnasiums (without spectator seating)
- Indoor swimming pools (without spectator seating)
- Indoor tennis courts (without spectator seating)
- Lecture halls
- Libraries
- Museums
- Places of religious worship
- Pool and billiard parlors
- Waiting areas in transportation terminals

- ❖ Structures in which people assemble for the purpose of social activities (such as entertainment, recreation and amusement) that are neither classified in Group A-1 or A-2 nor appropriately classified in Group A-4 or A-5 are to be classified in Group A-3. Exhibition halls, libraries, dance halls (not including food and drink), places of religious worship, museums, gymnasiums, recreation centers, health clubs, fellowship halls, indoor shooting galleries, bowling centers and billiard halls are among the facilities often classified in Group A-3. Also, since they most nearly resemble this occupancy classification, public and private spaces used for assembly are often classified in Group A-3. These include large courtrooms, meeting rooms and conference centers. Similarly, lecture rooms located in colleges, universities or in schools for students above the 12th grade that have an occupant load of 50 or more are also classified in Group A-3, as well as structures in which people gather exclusively for worship and other religious purposes. Although such worship and religious purposes are without restriction to any particular sect or creed, the intent of the code is to limit Group A-3 classification to occupancies that are specifically related to worship services, devotions and religious rituals.

The fire hazard in terms of combustible contents (fuel load) in structures classified in Group A-3 is most often expected to be moderate to low. Since structures classified in Group A-3 vary widely as to the purpose for which they are used, the range of fuel load varies widely. For example, the fuel load in a library or an exhibition hall usually is considerably greater than that normally found in a gymnasium.

**[BG] Assembly Group A-4.** Group A-4 occupancy includes assembly uses intended for viewing of indoor sporting events and activities with spectator seating including, but not limited to:

- Arenas
- Skating rinks
- Swimming pools
- Tennis courts

- ❖ Structures provided with spectator seating in which people assemble to watch an indoor sporting event are to be classified as Group A-4. Arenas, skating rinks, swimming pools and tennis courts are among the facilities often classified as Group A-4. The distinguishing factor between Group A-4 and A-5 structures is whether the event is indoors or outdoors. Group A-4 facilities are limited to indoor structures only. The distinguishing factor between Group A-3 and A-4 facilities is the presence of a defined seating area. While Group A-3 facilities are indoors (i.e., tennis courts, swimming pools), they typically do not have a defined seating area in which to view the event. Only facilities that are both indoors and have a defined seating area are to be classified as Group A-4.

**[BG] Assembly Group A-5.** Group A-5 occupancy includes assembly uses intended for participation in or viewing outdoor activities including, but not limited to:

- Amusement park structures
- Bleachers*
- Grandstands
- Stadiums

- ❖ Structures classified in Group A-5 are outdoor facilities where people assemble to view or participate in social and recreational activities (e.g., stadiums, grandstands, bleachers, coliseums). In order to qualify as an outdoor facility, the structure must be one where the products of combustion are freely and rapidly vented to the atmosphere (i.e., a structure without enclosures that would prevent the free movement of smoke from the occupied area to the outside). Any recreation facility that has exterior walls that enclose the facility and a roof that fully covers the area would not be classified in Group A-5, but rather in Group A-3 or A-4 depending on whether a seating area has been provided. In the case of a structure with a retractable roof, the more stringent occupancy classification (i.e., Group A-4) would be required.

Since occupancies classified in Group A-5 are primarily viewing and sports participation areas, the fuel load associated with them is very low (i.e., the structure itself and seats). Since the fuel load present is

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relatively low and the expectation is that smoke will be quickly evacuated from the structure, the relative fire hazard of occupancies classified in Group A-5 is expected to be low. The life safety hazard from panic that might occur in an emergency, however, is a serious concern; hence, the capability of large crowds to exit the structure quickly and orderly during emergencies is an important design consideration (see Section 1029).

Both A-4 and A-5 occupancies will include a variety of uses that support the viewing of sports and similar activities. There will likely be luxury seating suites, locker rooms, toilet facilities and press boxes, which are clearly part of the overall uses of the facility. There may also be offices, food concession stands and merchandise stands which by their use are different occupancies, but are probably within the accessory occupancy limits established in Section 508.2 of the IBC. Because of the multitiered design of most Group A-4 and A-5 occupancies, the limit for accessory occupancies of 10 percent of the story will need to be creatively applied. There may be full-fledged restaurants that are in the same building, but may be open to guests not limited to those attending an event. A Group A-2 occupancy designation is likely the most appropriate classification, and the mixed occupancy conditions would most typically be addressed under the accessory occupancy provisions of Section 508.2 of the IBC.

**[BG] Business Group B.** Business Group B occupancy includes, among others, the use of a building or structure, or a portion thereof, for office, professional or service-type transactions, including storage of records and accounts. Business occupancies shall include, but not be limited to, the following:

- Airport traffic control towers
- Ambulatory care facilities
- Animal hospitals, kennels and pounds
- Banks
- Barber and beauty shops
- Car wash
- Civic administration
- Clinic-outpatient
- Dry cleaning and laundries: pick-up and delivery stations and self-service
- Educational occupancies for students above the 12th grade
- Electronic data processing
- Food processing establishments and commercial kitchens not associated with restaurants, cafeterias and similar dining facilities not more than 2,500 square feet (232 m<sup>2</sup>) in area.
- Laboratories: testing and research
- Motor vehicle showrooms
- Post offices
- Print shops
- Professional services (architects, attorneys, dentists, physicians, engineers, etc.)
- Radio and television stations

Telephone exchanges

Training and skill development not in a school or academic program (This shall include, but not be limited to, tutoring centers, martial arts studios, gymnastics and similar uses regardless of the ages served, and where not classified as a Group A occupancy).

- ❖ The risks to life safety in the business occupancy classification are relatively low. Exposure to the potential effects of fire is limited because business-type facilities most often have low fuel loads, are normally occupied only during the daytime and, with some exceptions, are usually occupied for a set number of hours. The occupants, because of the nature of the use, are typically alert, ambulatory, conscious, aware of their surroundings and generally familiar with the building's features, particularly the means of egress. Historically, this occupancy has one of the better fire safety records for the protection of life and property.

This section identifies the general characteristics and lists examples of occupancies that are classified in Group B. Note that the description recognizes the need for limited storage spaces that are incidental to office occupancies. The accessory storage classified as a Group B occupancy is limited by Section 311.1.1 of the IBC to be no more than 10 percent of a given story of a building. Colleges (educational occupancies for students above grade 12) may have spaces that have an occupant load of more than 50 in a room, but are ancillary to the place of education and used only for programs directly associated with training and education programs (see Section 303.4 of the IBC). For college buildings, similar to other office buildings, if there are spaces with occupant loads of greater than 50, such as cafeterias or lecture halls, by the character of the space and the level of fire hazard, they would be appropriately classified as Group A-2 or A-3, respectively (see IBC Section 302.1). When lecture facilities for large groups (i.e., occupant load of 50 or more) are located within the same building where classrooms with an occupant load less than 50 are found, the building is a mixed occupancy (Groups A-3 and B) and is subject to the provisions of Section 508.

While civic administration covers a broad range of state and local government buildings, many such buildings will have a variety of uses and need to be considered under mixed occupancy provisions. Frequently police stations will include jails or holding cells. Fire stations will be a mix of offices, parking and maintenance facilities for the fire engines and living spaces for the fire fighters. Often a meeting room that is open to the public is also included. This type of facility is a mix of Group A, B, R and S occupancies.

Ambulatory care facilities are those used to provide medical, or similar care, on less than a 24-hour basis to patients who are rendered incapable of self-preservation (see the definition of that term). Frequently

called “day surgery centers” or “ambulatory surgical centers,” ambulatory care facilities perform procedures that render care recipients (patients) temporarily incapable of self-preservation due to the use of nerve blocks, sedation or anesthesia. Due to the condition of the care recipients, the need for medical staff to stabilize the patients before evacuation and the use of medical gases, such as oxygen and nitrous oxide, these types of facilities pose greater fire and life safety hazards than other business occupancies. Accordingly, additional fire protection and means of egress requirements specific to ambulatory care are provided in Section 422 of the IBC.

Facilities that provide medical services for inpatient care where the care recipients (patients) stay for more than 24 hours would be classified as Group I-2. Buildings used as sleep clinics would be classified as Group B since these spaces are not typical dwelling or sleeping units where people live, the occupants are assumed to be capable of self-preservation and the occupants are not living in a supervised environment. Although the patients in a sleep clinic may be sleeping, they can be easily awakened and alerted to an emergency as compared to the patients at an ambulatory care facility.

The code distinguishes between food processing operations that are not directly associated with a restaurant based on size. Those operations 2,500 square feet or smaller fall under the Group B classification. A small catering business would fall under this classification. Other food-related businesses that don't provide a space for their product to be eaten on site, such as a take-out pizza store and neighborhood bakery, would also fall under this classification. A commercial kitchen or food processing facility larger than 2,500 square feet would be classified as a Group F occupancy.

Training and skill development is classified as a Group B occupancy due to the similarity in use of spaces to education above the 12th grade and with professional consultation. Often unions provide training facilities for their members so they can keep up with new materials and updates of regulations. Other facilities can provide one-on-one tutoring such as remedial reading or math skills for students. Training or skill development can include those whose ages are typically associated with grades 12 or earlier. The determination of the appropriate classification requires the building official to consider whether the training is given as part of a traditional educational program. Examples provided by the code allow a range of size in the numbers receiving the training from a one-on-one tutoring situation to large classes of children learning martial arts or ballet. The presence of children does not automatically mean a classification as a Group E. Where the occupant load of a training classroom or space exceeds 50 occupants, a Group A classification may be appropriate for the space, especially if the space is to be used for different activities at different times. If the training room is

used for a martial arts competition, with spectators, on an evening or weekend, then a Group A designation should also be considered.

**[BG] Educational Group E.** Educational Group E occupancy includes, among others, the use of a building or structure, or a portion thereof, by six or more persons at any one time for educational purposes through the 12th grade.

- ❖ The risks to life safety in this occupancy vary with the composition of the facilities and also with the ages of the occupants. In general, children require more safeguards than do older, more mature persons.

This section identifies the criteria for classification of a building in Group E. The two fundamental characteristics of a Group E facility are as follows:

1. The facility is occupied by more than five persons (excluding the instructor); and
2. The purpose of the facility is for educating persons at the 12th-grade level and below, but not including more than five occupants 2<sup>1</sup>/<sub>2</sub> years of age or younger.

It is common for a school to also have gymnasiums (Group A-3), auditoriums (Group A-1), libraries (Group A-3) and offices (Group B). Storage rooms might be classified as either a Group S-1 occupancy, or if less than 10 percent of a story, Group E (see Section 311.1.1 of the IBC). When this occurs, the building is considered as a mixed occupancy condition and is subject to the provisions of Section 508. In accordance with Section 303.1.3 of the IBC, assembly spaces, such as the gymnasium, auditorium, library and cafeteria, do not have to be considered separate occupancies if used for school purposes (see commentary below). For such assembly functions to be considered part of the primary Group E occupancy, the assembly functions must be ancillary and supportive to the educational operation of the building.

Occupancies used for the education of persons above the 12th grade level are not included in Group E. These facilities are occupied by adults who are not expected to require special supervision, direction or instruction in a fire or other emergency.

**[BG] Accessory to places of religious worship.** Religious educational rooms and religious auditoriums, which are accessory to places of religious worship in accordance with Section 508.3.1 of the *International Building Code* and have *occupant loads* of less than 100 per room or space shall be classified as Group A-3 occupancies.

- ❖ In places of religious worship, worship halls, religious educational rooms and religious auditoriums are often all provided in the same building complex. Such religious educational rooms and auditoriums are not to be considered separate occupancies (i.e., Group E). Where such rooms are used at certain times for other than as a religious auditorium or for religious

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education, Section 302 requires that the requirements of each occupancy be applied.

**[BG] Group E, day care facilities.** This group includes buildings and structures or portions thereof occupied by more than five children older than 2½ years of age who receive educational, supervision or *personal care services* for less than 24 hours per day.

- ❖ Group E day care occupancies include facilities intended to be used for the care and supervision of more than five children older than 2½ years of age where individual care is for a period of less than 24 hours per day. Day care centers are a special concern since they are generally occupied by preschool children who are less capable of responding to an emergency. The hazards found in a day care center are far greater than in normal educational facilities, not so much because of the occupant or fuel load, but because of the inability of the occupants to respond.

Children 2½ years of age or younger usually are not able to recognize an emergency situation, respond appropriately or simply be able to egress without assistance; thus, facilities that have more than five children 2½ years of age or younger are classified as child care facilities and considered to be Group I-4 unless the provisions of one of the sub-classifications of that group allow for a different classification.

Locations where child care may be provided that would not be considered Group E, I-4 or I-2 are addressed in Sections 305.2.1 through 305.2.3 of the IBC.

**[BG] Within places of worship.** Rooms and spaces within places of worship providing such care during religious functions shall be classified as part of the primary occupancy.

- ❖ Cry rooms and other types of child care areas within places of worship that are used for this purpose during a religious function need not be classified as Group E day care facilities. Such rooms and spaces may take on the classification of the primary occupancy, which in most cases would be Group A-3. The limited occupant load makes the need for classification as a Group E occupancy unnecessary. If the child care areas are used when there is not a service or other religious function going on simultaneously, such as for child day care during the week, the religious facility would be a mixed use building (see IBC commentary, Section 305.2 or 308.6).

**[BG] Five or fewer children.** A facility having five or fewer children receiving such care shall be classified as part of the primary occupancy.

- ❖ Where a child care facility has no more than five children receiving care at any one time, the classification of the main occupancy may extend to the child care use. The limited number of occupants requiring care

services does not warrant classification as a separate and distinct occupancy from that of the major use.

**[BG] Five or fewer children in a dwelling unit.** A facility such as the above within a dwelling unit and having five or fewer children receiving such care shall be classified as a Group R-3 occupancy or shall comply with the *International Residential Code*.

- ❖ Where the child care services are performed within a single-family dwelling or within a dwelling unit of a two-family dwelling, residential provisions are applicable provided the number of children receiving care does not exceed five. The facility may be classified under the IBC as a Group R-3 occupancy or may be regulated under the provisions of the IRC. Where such a use occurs within a dwelling unit of a Group R-2 multifamily building, it is expected that the child care facility be considered as an extension of the primary Group R-2 classification as with five or fewer children.

**[BG] Factory Industrial Group F.** Factory Industrial Group F occupancy includes, among others, the use of a building or structure, or a portion thereof, for assembling, disassembling, fabricating, finishing, manufacturing, packaging, repair or processing operations that are not classified as a Group H high-hazard or Group S storage occupancy.

- ❖ The purpose of this definition is to identify the characteristics of occupancies that are classified in the factory industrial group and to differentiate Groups F-1 and F-2. Because of the vast number of diverse manufacturing and processing operations in the industrial community, it is more practical to classify such facilities by their level of hazard rather than by their function. In industrial facilities, experience has shown that the loss of life or property is most directly related to fire hazards, particularly the fuel load contributed by the materials being fabricated, assembled or processed.

Statistics show that property losses are comparatively high in factory and industrial occupancies, but the record of fatalities and injuries from fire has been remarkably low. This excellent life safety record can, in part, be attributed to fire protection requirements of the code.

This definition requires that all structures that are used for fabricating, finishing, manufacturing, packaging, assembling or processing products or materials are to be classified in either Group F-1 (moderate hazard) or F-2 (low hazard). These classifications are based on the relative level of hazard for the types of materials that are fabricated, assembled or processed. Where the products and materials in a factory present an extreme fire, explosion or health hazard, such facilities are classified in Group H. It should be noted that the term "Group F" is not a specific occupancy, but is a term that collectively applies to Groups F-1 and F-2.

**[BG] Factory Industrial F-1 Moderate-hazard occupancy.** Factory industrial uses that are not classified as Factory Industrial F-2 Low Hazard shall be classified as F-1 Moderate Hazard and shall include, but not be limited to, the following:

Aircraft (manufacturing, not to include repair)  
 Appliances  
 Athletic equipment  
 Automobiles and other motor vehicles  
 Bakeries  
 Beverages; over 16-percent alcohol content  
 Bicycles  
 Boats  
 Brooms or brushes  
 Business machines  
 Cameras and photo equipment  
 Canvas or similar fabric  
 Carpets and rugs (includes cleaning)  
 Clothing  
 Construction and agricultural machinery  
 Disinfectants  
 Dry cleaning and dyeing  
 Electric generation plants  
 Electronics  
 Engines (including rebuilding)  
 Food processing and commercial kitchens not associated with restaurants, cafeterias and similar dining facilities more than 2,500 square feet (232 m<sup>2</sup>) in area.  
 Furniture  
 Hemp products  
 Jute products  
 Laundries  
 Leather products  
 Machinery  
 Metals  
 Millwork (sash and door)  
 Motion pictures and television filming (without spectators)  
 Musical instruments  
 Optical goods  
 Paper mills or products  
 Photographic film  
 Plastic products  
 Printing or publishing  
 Refuse incineration  
 Shoes  
 Soaps and detergents  
 Textiles  
 Tobacco  
 Trailers  
 Upholstering  
 Wood; distillation  
 Woodworking (cabinet)

- ❖ Structures classified in Group F-1 (moderate hazard) are occupied for the purpose of the fabrication, finishing, manufacturing, packaging, assembly or processing of materials that are combustible or that use

combustible products in the production process. Food processing facilities and commercial kitchens that are 2,500 square feet or smaller in area fall under the Group B occupancy category (see Section 304.1 of the IBC).

**[BG] Factory Industrial F-2 Low-hazard Occupancy.** Factory industrial uses involving the fabrication or manufacturing of noncombustible materials that, during finishing, packaging or processing do not involve a significant fire hazard, shall be classified as Group F-2 occupancies and shall include, but not be limited to, the following:

Beverages; up to and including 16-percent alcohol content  
 Brick and masonry  
 Ceramic products  
 Foundries  
 Glass products  
 Gypsum  
 Ice  
 Metal products (fabrication and assembly)

- ❖ Structures classified in Group F-2 (low hazard) are occupied for the purpose of the fabrication, manufacturing or processing of noncombustible materials. It is acceptable for noncombustible products to be packaged in a combustible material, provided that the fuel load contributed by the packaging is negligible when compared to the amount of noncombustible product. The use of a significant amount of combustible material to package or finish a noncombustible product, however, will result in a Group F-1 (moderate-hazard factory and industrial) classification.

To distinguish when the presence of combustible packaging constitutes a significant fuel load, possibly requiring the reclassification of the building or structure as Group F-1, a reasonable guideline to follow is the "single-thickness" rule, which is when a noncombustible product is put in one layer of packaging material.

Examples of acceptable conditions in Group F-2 are:

- Vehicle engines placed on wood pallets for transportation after assembly;
- Washing machines in corrugated cardboard boxes; and
- Soft-drink glass bottles packaged in pressed paper boxes.

Occupancies involving noncombustible items packaged in more than one layer of combustible packaging material are most appropriately classified in Group F-1.

Typical examples of packaging that would result in a Group F-1 classification are:

- Chinaware wrapped in corrugated paper and placed in cardboard boxes;
- Glassware set in expanded foam forms and placed in cardboard boxes; and

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- Fuel filters individually packed in pressed paper boxes, placed by the gross in a cardboard box and stacked on a pallet for transportation.

Factories and industrial facilities often have offices and areas where large quantities of materials are kept in the same building as manufacturing operations, fabrication processes and assembly processes. The stock areas are classified as either Group S-1 or S-2, depending on the combustibility of the materials stored. Areas used for offices that do not qualify as accessory occupancies (see Section 508.2 of the IBC) are classified in Group B. When these combinations of occupancies occur, as well as other combinations of occupancies, the building is subject to the mixed occupancy provisions in Section 508 of the IBC.

**High-hazard Group H.** High-hazard Group H occupancy includes, among others, the use of a building or structure, or a portion thereof, that involves the manufacturing, processing, generation or storage of materials that constitute a physical or health hazard in quantities in excess of those allowed in *control areas* complying with Section 5003.8.3, based on the maximum allowable quantity limits for *control areas* set forth in Tables 5003.1.1(1) and 5003.1.1(2). Hazardous occupancies are classified in Groups H-1, H-2, H-3, H-4 and H-5 and shall be in accordance with this code and the requirements of Section 415 of the *International Building Code*. Hazardous materials stored or used on top of roofs or canopies shall be classified as outdoor storage or use and shall comply with this code.

- ❖ This occupancy classification identifies the various types of facilities contained in the high-hazard occupancy groups, e.g., those facilities where the storage of materials or the operations are deemed to be extremely hazardous to life and property, especially when they involve the use of significant amounts of highly combustible, flammable or explosive materials, regardless of their composition (i.e., solids, liquids, gases or dust). Although they are not explosive or highly flammable, other hazardous materials, such as corrosive liquids, highly toxic materials and poisonous gases, still present an extreme hazard to life. Many materials possess multiple hazards, whether physical or health related.

There is a wide range of high-hazard operations in the industrial community; therefore, it is more practical to categorize such facilities in terms of the degree of hazard they present, rather than attempt to define a facility in terms of its function. This method is similar to that used to categorize Group F factory and Group S storage occupancies.

Group H is handled as a separate classification because it represents an unusually high degree of hazard that is not found in the other occupancies. It is important to isolate those industrial or storage operations that pose the greatest dangers to life and property and to reduce such hazards by providing systems or elements of protection through the regula-

tory provisions of building codes. There are numerous provisions and exceptions throughout the code that cannot be used when one or more Group H occupancies are present.

Operations that, because of the materials utilized or stored, cause a building or portion of a building to be classified as a high-hazard occupancy are identified in this section. While buildings classified as Group H may not have a large occupant load, the unstable chemical properties of the materials contained on the premises constitute an above-average fuel load and serve as a potential danger to the surrounding area.

The dangers created by the high-hazard materials require special consideration for the abatement of the danger. The classification of a material as high hazard is based on information derived from National Fire Protection Association (NFPA) standards and the Code of Federal Regulations (DOL 29 CFR).

The wide range of materials utilized or stored in buildings creates an equally wide range of hazards to the occupants of the building, the building proper and the surrounding area. Since these hazards range from explosive to corrosive conditions, the high-hazard occupancy has been broken into four subclassifications: Groups H-1 through H-4. A fifth category, Group H-5, is used to represent structures that contain hazardous production material (HPM) facilities. Each of these subclassifications addresses materials that have similar characteristics and the protection requirements attempt to address the hazard involved. These subclassifications are defined by the properties of the materials involved with only occasional reference to specific materials. This performance-based criterion may involve additional research to identify a hazard, but it is the only way to remain current in a rapidly changing field. MSDS will be a major source for information.

Additional information on hazardous materials can be found in Section 415 as well as the commentary to the code.

This definition and Section 307.1 of the IBC acknowledge that a building is not classified as a high-hazard occupancy unless the MAQs per control area as prescribed in Tables 5003.1.1(1) and 5003.1.1(2) [IBC Tables 307.1(1) and 307.1(2)] are exceeded, subject to the applicable control area provisions of Section 5003.8.3 (IBC Section 414.2). The maximum quantity limitations per control area prescribed in Tables 5003.1.1(1) and 5003.1.1(2) [IBC Tables 307.1(1) and 307.1(2)] have been determined to be relatively safe when maintained in accordance with the code. Therefore, a building containing less than the MAQs specified would not be classified as a Group H occupancy but, rather, as the occupancy group it most nearly resembles. The materials in these tables are defined in detail in this chapter.

Section 5003.8.3 (IBC Section 414.2) establishes the control area concept for regulating hazardous materials. This concept would allow the maximum

allowable quantities of hazardous materials per control area in Tables 5003.1.1(1) and 5003.1.1(2) [IBC Tables 307.1(1) and 307.1(2)] to be exceeded within a given building without classifying the building as a high-hazard occupancy by utilizing a multiple control area approach. The permitted number of control areas, maximum percentage of allowable quantities of hazardous materials per control area and degree of fire separation between control areas are regulated by Section 5003.8.3 (IBC Section 414.2) (see the definition of "Control area" and the commentary to Section 5003.8.3).

This definition and Section 307.1 of the IBC also clarify that hazardous materials outside of the building envelope should be classified as outdoor storage. As such, hazardous material quantities on roofs or canopies are not included in evaluating the occupancy classification of a building or structure. Canopies used to support gaseous hydrogen systems must comply with Section 406.7.2.1 of the IBC.

**Uses other than Group H.** The storage, use or handling of hazardous materials as described in one or more of the following items shall not cause the occupancy to be classified as Group H, but it shall be classified as the occupancy that it most nearly resembles:

1. Buildings and structures occupied for the application of flammable finishes, provided that such buildings or areas conform to the requirements of Chapter 24 of this code and Section 416 of the *International Building Code*.
  2. Wholesale and retail sales and storage of flammable and *combustible liquids* in mercantile occupancies conforming to Chapter 57.
  3. Closed piping system containing flammable or *combustible liquids* or gases utilized for the operation of machinery or equipment.
  4. Cleaning establishments that utilize *combustible liquid* solvents having a *flash point* of 140°F (60°C) or higher in *closed systems* employing equipment *listed* by an *approved* testing agency, provided that this occupancy is separated from all other areas of the building by 1-hour *fire barriers* in accordance with Section 707 of the *International Building Code* or 1-hour *horizontal assemblies* in accordance with Section 711 of the *International Building Code*, or both.
  5. Cleaning establishments that utilize a liquid solvent having a *flash point* at or above 200°F (93°C).
  6. Liquor stores and distributors without bulk storage.
  7. Refrigeration systems.
  8. The storage or utilization of materials for agricultural purposes on the premises.
  9. Stationary batteries utilized for facility emergency power, uninterruptible power supply or telecommunication facilities, provided that the batteries are equipped with safety venting caps and ventilation is provided in accordance with the *International Mechanical Code*.
  10. *Corrosive* personal or household products in their original packaging used in retail display.
  11. Commonly used *corrosive* building materials.
  12. Buildings and structures occupied for aerosol storage shall be classified as Group S-1, provided that such buildings conform to the requirements of Chapter 51.
  13. Display and storage of nonflammable solid and nonflammable or noncombustible liquid hazardous materials in quantities not exceeding the *maximum allowable quantity per control area* in Group M or S occupancies complying with Section 5003.8.3.5.
  14. The storage of black powder, smokeless propellant and small arms primers in Groups M and R-3 and special industrial explosive devices in Groups B, F, M and S, provided such storage conforms to the quantity limits and requirements of this code.
- ❖ The exceptions list indicates uses and conditions that are exempt from a high-hazard (Group H) classification because of the building's construction, use, the packaging of materials, the quantity of materials or the precautions taken to prevent fire. Even if a high-hazard material meets one of the exceptions, its storage and use must comply with the applicable provisions of the code and Section 414 of the IBC.
- There are 14 cases where facilities would not be classified a Group H because of the specific type of material; how it is expected to be used or stored, or both; the building's construction and use; the packaging of materials; the quantity of materials or the precautions taken to prevent fire. Even if a high-hazard material meets one of these 14 cases, its storage and use must comply with the applicable provisions of Section 414 of the IBC and this code.
- Item 1 exempts spray painting and similar operations within buildings from being classified as a high-hazard occupancy. This exception requires that all such operations, as well as the handling of flammable finishes, are in accordance with the provisions of Section 416 of the IBC and Chapter 24 of the code; therefore, an adequately protected typical paint spray booth in a factory (Group F-1) would not result in a high-hazard occupancy classification for either the building or the paint spray area.
- Item 2 relies on the provisions of Section 5704.3.4.1 to regulate the storage of flammable and combustible liquids for wholesale and retail sales and storage in mercantile occupancies. The overall permitted amount of flammable and combustible liquids is dependent on the class of liquid, storage arrangement, container size and level of sprinkler protection. For nonsprinklered buildings, the maximum allowable quantity per control area permitted by Table

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5704.3.4.1 is 1,600 gallons (6057 L) of Class IB, IC, II, and IIIA liquids with a maximum of 60 gallons (227 L) of Class IA liquids. Depending on storage and ceiling heights, buildings equipped with a sprinkler system with a minimum design density for an Ordinary Hazard Group 2 occupancy may have an aggregate total of 7,500 gallons (28 391 L) of Class IB, IC, II, and IIIA liquids with a maximum of 60 gallons (227 L) of Class IA liquids. The quantities of Class IB, IC, II and IIA liquids could be further increased depending on the potential storage conditions and enhanced degree of sprinkler protection (see Section 5703.3.4.1 for additional design information). Again, it should be noted, that despite the increased quantities which far exceed the base quantity limitations of Table 5003.1.1(1) [IBC Table 307.1(1)], compliance with this item would result in the building not being classified as a Group H occupancy.

Item 3 exempts from Group H classification closed systems that are used exclusively for the operation of machinery or equipment. The closed piping systems, which are essentially not open to the atmosphere, keep flammable or combustible liquids from direct exposure to external sources of ignition as well as prevent the users from coming in direct contact with liquids or harmful vapors. This item would include systems such as oil-burning equipment, piping for diesel fuel generators and LP-gas cylinders for use in forklift trucks.

Item 4 allows cleaning establishments that utilize a closed system for all combustible liquid solvents with a flash point at or above 140°F (60°C) to be classified as something other than Group H. The reference to using equipment listed by an approved testing laboratory does not mean that the entire system needs to be approved, but rather the individual pieces of equipment. As with any mechanical equipment or appliance, it should bear the label of an approved agency and be installed in accordance with the manufacturer's installation instructions (see the IMC).

Item 5 covers cleaning establishments that use solvents that have very high flash points [at least 200°F (93°C)] and that are exceedingly difficult to ignite. Such liquids can be used openly, but with due care.

Item 6 exempts all retail liquor stores and liquor distribution facilities from the high-hazard occupancy classification, even though most of the contents are considered combustible liquids. The item takes into account that alcoholic beverages are packaged in individual containers of limited size.

Item 7 refers to refrigeration systems that utilize refrigerants that may be flammable or toxic. Refrigeration systems do not alter the occupancy classification of the building, provided they are installed in accordance with the IMC. The IMC has specific limitations on the quantity and type of refrigerants that can be used, depending on the occupancy classification of the building.

Item 8 addresses materials that are used for agri-

cultural purposes, such as fertilizers, pesticides, and fungicides, when used on the premises. Agricultural materials stored for direct or immediate use are not usually of large enough quantity that would constitute a large fuel load or an exceptionally hazardous condition. A group H classification is not appropriate for these situations.

Item 9 addresses battery storage rooms when used as part of an operating system, such as for providing standby power. The batteries used in installations of this type do not represent a significant health, safety or fire hazard. The electrolyte and battery casing contribute little fuel load to a fire. The release of hydrogen gas during the operation of battery systems is minimal. Ventilation in accordance with the IMC will disperse the small amounts of liberated hydrogen. This exception also assumes that rooms containing stationary storage battery systems are in compliance with Section 608 and the enclosure requirements of Table 509 of the IBC.

Without Item 10, certain products that technically are corrosive could cause grocery stores and other mercantile occupancies to be inappropriately classified as Group H-4. This item allows the MAQ in Table 5003.1.1(2) [IBC Table 307.1(2)] for corrosives to be exceeded in the retail display area. This would include such things as bleaches, detergents and other household cleaning supplies in normal-size containers.

Item 11 exempts the storage or manufacture of commonly used building materials, such as Portland cement, from being inappropriately classified as Group H.

Item 12 exempts from a Group H classification those buildings and structures used for the storage of aerosol products, provided they are protected in accordance with the provisions of Chapter 51 and NFPA 30B and the code. The aerosol storage requirements of the code referred to in this item are based on the provisions of NFPA 30B. Compliance with this item exempts buildings from complying with the code provisions for Group H, provided the storage of aerosol products complies with the applicable separation, storage limitations and sprinkler design requirements specified in the code and NFPA 30B.

Item 13 permits certain products found in mercantile and storage occupancies, which may be comprised of hazardous materials, to exceed the MAQ of Tables 5003.1.1(1) and 5003.1.1(2) [IBC Tables 307.1(1) and 307.1(2)]. The products, however, must be comprised of nonflammable solids or liquids that are nonflammable or noncombustible. Materials could include swimming pool chemicals, which are typically Class 2 or 3 oxidizers or industrial corrosive cleaning agents (see commentary, Section 5003.8.3.5).

Item 14 permits the base maximum allowable quantity per control area of black powder, smokeless propellant and small arms primers in Group M and R-3 occupancies to be exceeded, provided the material is stored in accordance with Chapter 56. The require-

ments are based on the provisions in NFPA 495. Similarly, special industrial explosive devices are found in a number of occupancies other than Group H (Groups B, F, M and S). Storage of these devices in accordance with the code is not required to have a high-hazard occupancy classification. Power drivers are commonly used in the construction industry, and there are stocks of these materials maintained for sale and use by the trade. The automotive airbag industry has evolved with the use of these devices, and they are located in automotive dealerships and personal use vehicles throughout society. The code currently exempts up to 50 pounds (23 kg) of these materials from regulation under Chapter 56.

**High-hazard Group H-1.** Buildings and structures containing materials that pose a *detonation* hazard shall be classified as Group H-1. Such materials shall include, but not be limited to, the following:

Detonable pyrophoric materials

Explosives:

Division 1.1

Division 1.2

Division 1.3

Division 1.4

Division 1.5

Division 1.6

Organic peroxides, unclassified detonable

Oxidizers, Class 4

Unstable (reactive) materials, Class 3 detonable, and Class 4

- ❖ The contents of occupancies in Group H-1 present a detonation hazard. Examples of materials that create this hazard are listed in the definition. The definitions for Group H-1 materials are listed in Section 5602 and defined in Chapter 2. Because of the explosion hazard potential associated with Group H-1 materials, occupancies in Group H-1, which exceed the MAQ indicated in Table 5003.1.1(1) [IBC Table 307.1(1)], are required to be located in detached one-story buildings without basements (see commentary to Section 5003.8.2 and IBC Sections 415.6.2, 415.7 and 508.3). Group H-1 occupancies cannot be located in a mixed occupancy building.

**Occupancies containing explosives not classified as H-1.** The following occupancies containing explosive materials shall be classified as follows:

1. Division 1.3 explosive materials that are used and maintained in a form where either confinement or configuration will not elevate the hazard from a mass fire hazard to mass explosion hazard shall be allowed in Group H-2 occupancies.
2. Articles, including articles packaged for shipment, that are not regulated as a Division 1.4 explosive under Bureau of Alcohol, Tobacco, Firearms and Explosives regulations, or unpackaged articles used in process operations that do not propagate a *detona-*

*tion* or deflagration between articles shall be allowed in H-3 occupancies.

- ❖ There are certain explosive materials that pose a hazard level less than that anticipated for a Group H-1 occupancy. A Group H-2 classification is permitted for Division 1.3 explosive materials used or maintained under conditions where the hazard level will not rise from that of a mass fire hazard to a mass explosion hazard. A Group H-3 occupancy classification is permitted for packaged and unpackaged articles not regulated as Division 1.4 explosives by the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF), as well as unpackaged articles used in process operations, provided there is no concern regarding the propagation of a detonation or deflagration between the articles during process operations.

**High-hazard Group H-2.** Buildings and structures containing materials that pose a *deflagration* hazard or a hazard from accelerated burning shall be classified as Group H-2. Such materials shall include, but not be limited to, the following:

Class I, II or IIIA flammable or *combustible liquids* that are used or stored in normally open containers or systems, or in closed containers or systems pressurized at more than 15 pounds per square inch gauge (103.4 kPa)

*Combustible dusts* where manufactured, generated or used in such a manner that the concentration and conditions create a fire or explosion hazard based on information prepared in accordance with Section 414.1.3 of the *International Building Code*

*Cryogenic fluids*, flammable

Flammable gases

Organic peroxides, Class I

Oxidizers, Class 3, that are used or stored in normally open containers or systems, or in closed containers or systems pressurized at more than 15 pounds per square inch gauge (103.4 kPa)

Pyrophoric liquids, solids and gases, nondetonable

Unstable (reactive) materials, Class 3, nondetonable

Water-reactive materials, Class 3

- ❖ The contents of occupancies in Group H-2 present a deflagration or accelerated burning hazard. Examples of materials that create this hazard are listed. The definitions for Group H-2 materials are contained in Chapter 2 also. Because of the severe fire or reactivity hazard associated with these types of materials, proper classification is essential in determining the applicable requirements with regard to the mitigation of these hazards.

**High-hazard Group H-3.** Buildings and structures containing materials that readily support combustion or that pose a *physical hazard* shall be classified as Group H-3. Such materials shall include, but not be limited to, the following:

Combustible fibers, other than densely packed baled cotton, where manufactured, generated or used in

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such a manner that the concentration and conditions create a fire or explosion hazard based on information prepared in accordance with Section 414.1.3 of the *International Building Code*

Consumer fireworks, 1.4G (Class C, Common)

Cryogenic fluids, oxidizing

Flammable solids

Organic peroxides, Class II and III

Oxidizers, Class 2

Oxidizers, Class 3, that are used or stored in normally closed containers or systems pressurized at 15 pounds per square inch gauge (103 kPa) or less

Oxidizing gases

Unstable (reactive) materials, Class 2

Water-reactive materials, Class 2

- ❖ The contents of occupancies in Group H-3 present a hazard inasmuch as they contain materials that readily support combustion or that present a physical hazard. Examples of materials that create this hazard are listed in the definition. The definitions for Group H-3 materials are contained in Chapter 2 also. While Group H-3 materials are generally less of a fire or reactivity hazard than Group H-2 materials, they still present a greater physical hazard than materials not currently regulated as high hazard.

**High-hazard Group H-4.** Buildings and structures containing materials that are *health hazards* shall be classified as Group H-4. Such materials shall include, but not be limited to, the following:

*Corrosives*

Highly toxic materials

Toxic materials

- ❖ The contents of occupancies in Group H-4 present a hazard inasmuch as they contain materials that are health hazards. Examples of these hazards are listed in this definition. The definitions for Group H-4 materials are contained in Chapter 2 also. While reference is made to chemicals that cause these hazards, the MSDS for these chemicals, which are furnished by the applicant, will need considerable subjective evaluation.

Some materials falling into the category of health hazard may also present a physical hazard and would, therefore, require the structure to be designed for multiple hazards in accordance with Section 5001.1 of the code and Section 307.8 of the IBC.

**High-hazard Group H-5.** Semiconductor fabrication facilities and comparable research and development areas in which hazardous production materials (HPM) are used and the aggregate quantity of materials is in excess of those listed in Tables 5003.1.1(1) and 5003.1.1(2) shall be classified as Group H-5. Such facilities and areas shall be designed and constructed in accordance with Section 415.11 of the *International Building Code*.

- ❖ HPM includes flammable liquids and gases, corrosives, oxidizers and, in many instances, highly toxic materials (see the definition for "Hazardous production material"). In determining the applicable require-

ments of other sections of the code, HPM facilities are considered to be Group H-5 occupancies. It is intended that the quantities of materials permitted in Table 2704.2.2.1 will take precedence over Tables 5003.1.1(1) and 5003.1.1(2).

**[BG] Institutional Group I.** Institutional Group I occupancy includes, among others, the use of a building or structure, or a portion thereof, in which care or supervision is provided to persons who are or are not capable of self-preservation without physical assistance or in which persons are detained for penal or correctional purposes or in which the liberty of the occupants is restricted. Institutional occupancies shall be classified as Group I-1, I-2, I-3 or I-4.

- ❖ Institutional occupancies are comprised of two basic types. The first, Group I-1, I-2 and I-4, relates to facilities that provide personal care, custodial care or medical care for people who, due to age; physical limitations; diseases; mental disabilities; or other infirmities, need a supervised environment (see the commentary for the definitions of "Custodial care," "Medical care" and "Personal care service"). This includes persons who are ambulatory and are capable of self-preservation as well as those who are restricted in their mobility or are totally immobile to the extent that they are incapable of self-preservation and therefore may need assistance to evacuate during an emergency situation, such as a fire. The IFC also addresses the idea of a defend-in-place protection option for hospitals and nursing homes (see the commentary for the definition of "Incapable of self-preservation" and Sections 403 and 404). The second type, Group I-3, relates primarily to detention and correctional facilities. Since security is the major operational consideration in these kinds of facilities, the occupants (inmates) are under some form of supervision and restraint and may be rendered incapable of self-preservation without direct intervention from staff in emergency situations due to locked cells and exits.

The degree of hazards in each type of institutional facility identified in this section varies respective to each kind of occupancy. The code addresses each occupancy separately and the regulatory provisions throughout the code provide the proper means of protection so as to produce an acceptable level of safety to life and property.

Groups I-1, I-2 and I-3 are further divided into "conditions" relative to unique aspects of the respective occupancies. Group I-1 and R-4 are closely related and are primarily distinguished by the number of persons residing in the facility (see Section 308.3).

Another of the distinguishing characteristics between the different Group I occupancies and other occupancies is when care is provided for a length of time exceeding 24-hours. The intent is that this criteria is not specific to the hours of operation of the facility, but the length of time that care is provided for the patients, residents or those in day care. For example, an outpatient clinic that is open 24 hours a day is a

Group B occupancy provided care recipients are treated as outpatients and there are no in-patients that would stay at the facility 24 hours or longer. Another example would be a “day care” facility that is open 24 hours to serve workers who work any shift and need to have children in “day care” while they work. Provided that individual children receive care for less than 24 hours, the occupancy would be classified as a Group I-4 or possibly a Group E.

Each individual facility will have unique characteristics or a combination of characteristics that should be considered when classifying it to one occupancy and condition or another. For example, some of the newer care facilities are offering a combination of care levels to allow for persons to age-in-place within the same complex. A facility could easily have a mix of occupancies such as one wing providing full-time nursing care (Group I-2 Condition 1), a second wing may provide assisted living care for residents with dementia so they may need direct physical contact from staff to react to an emergency (Group I-1 Condition 2), and yet a third wing may provide custodial care where residents are capable of responding to an emergency on their own (Group I-2 Condition 1). Health care and custodial care facilities are subject to many state and some local regulations. Such regulations may be a determining factor in deciding which IBC occupancy classification is appropriate.

**[BG] Institutional Group I-1.** Institutional Group I-1 occupancy shall include buildings, structures or portions thereof for more than 16 persons, excluding staff, who reside on a 24-hour basis in a supervised environment and receive custodial care. Buildings of Group I-1 shall be classified as one of the occupancy conditions indicated below. This group shall include, but not be limited to, the following:

- Alcohol and drug centers
- Assisted living facilities
- Congregate care facilities
- Group homes
- Halfway houses
- Residential board and care facilities
- Residential board and custodial care facilities
- Social rehabilitation facilities

- ❖ Group I-4 and R-4 occupancies are similar facilities that differ only by the number of residents receiving care. Group I-1 and R-4 occupancies are based on four characterizations described in the occupancy classification: both are facilities where custodial care is provided, there is 24-hour-a day supervision and the occupancy is either Condition 1 or Condition 2. The difference is the number of persons receiving care and residing in such facilities: Group I-1 has greater than 16 residents; Group R-4 has six to 16 persons. Note that Group I-1 and R-4 occupancies are limited facilities where custodial care is provided and not where medical care is provided (see the commentary to “Custodial care” and “Medical care”). Both Group I-1 and R-4 occupancies list the same eight

generic uses as example uses falling under the Group I-1/R-4 umbrella. Of these eight, only “Group home” is defined (see commentary to this definition). Some of these terms may be used in state and local regulations of care facilities. Caution should be taken before assuming that a state-defined “assisted living” facility should be classified under the IBC as a Group I-1 and R-4 occupancy.

Both Groups I-1 and R-4 include “conditions” to cover the variety of acuity and ability levels of custodial care recipients. Group I-1 Condition 1 and Group R-4 Condition 1 occupancies match requirements for previous editions of the code for Groups I-1 and R-4, before conditions were included. The intent of the conditions was to address the concerns that some residents may need limited assistance or verbal direction to evacuate. The building protection offered for Groups I-1 and R-4 occupancies in previous editions of the code is maintained in Condition 1. Some additional requirements were added for Condition 2. Note that this is custodial care. Where nursing care is provided, the facility is a Group I-2 Condition 1. The Condition 1 care recipients may be slower during evacuation but all are capable of emergency evacuation without any physical assistance from others; however, they require no more than only minor verbal queuing from others during emergencies, as might be expected in the general population. Condition 2 custodial care recipients are also slower to evacuate and include any care recipients who may require limited assistance during evacuation. Group I-1 Condition 2 and Group R-4 Condition 2 integrates additional protection features, such as smoke barriers to subdivide the building and increased automatic sprinkler requirements.

In Group I-1 Condition 2 and Group R-4 Condition 2 facilities, assistance with evacuation can occur either because of care recipients’ physical or mental limitations, or both. The Condition 2 assistance with evacuation includes help getting out of bed into a wheelchair or walker, or help initiating ambulation. It includes continued physical assistance getting out of the building from a sleeping room, apartment or other rooms during an emergency. Assistance with evacuation includes assisting persons who may have resistance or confusion in response to an alarm, or require help with instructions. It can also include help for persons with short periods of impaired intermittent consciousness due to medications or illness. Custodial care Group I-1 Condition 2 and Group R-4 Condition 2 evacuation assistance is limited and does not include moving occupants in beds or stretchers during emergencies, as is allowed in Group I-2 medical care.

How individual state licensing agencies name, classify and regulate many of the uses listed in Groups I-1 and R-4 vary significantly from state to state and may not line up with the IBC classifications. It is for this reason that Group I-1 and R-4 lists of uses are included under the general occupancy classification and not under each “condition.” The building

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permit applicant should confirm how the specific state licensing regulations correlate to the code's care type, occupancy, condition, evacuation capability and number of persons receiving care. The permit application drawings should identify the five criteria, while specifically noting that the state licensing regulations limit occupants to only include Condition 1 criteria or allow Condition 2 criteria. Most assisted living facilities and many residential board and care facilities will be classified as Group I-1 Condition 1 or R-4 Condition 1. Generally, almost all specially designated Alzheimer's/memory care facilities providing custodial care will be classified as Group I-1 Condition 2 or Group R-4 Condition 2, due to the inability of some residents to recognize how to respond to an emergency situation. Note that nursing facilities with specialized dementia wings that provide medical care would be classified as Group I-2 Condition 1. Also, it is important to keep in mind that facilities that may be classified initially as Group I-1 Condition 1 (capable of self-preservation) or R-4 Condition 1 can very easily need to be reclassified as a Group I-1/R-4 Condition 2 or as a Group I-2 Condition 1 if the abilities of the persons receiving care change over time. Therefore, it is essential for the proponents of a new facility to present to the building official information regarding the full range of patients and residents expected at a facility both initially and over time.

The occupant load for occupancy classification purposes refers to the number of care recipients only. The number of guests or staff is not included. Note however, that the number of guests and staff is included for means of egress purposes.

For clarification purposes, a dormitory or apartment complex that houses only elderly people and has a nonmedically trained live-in manager is not classified as an institutional occupancy but, rather, as a residential occupancy (see the Group R definitions). A critical phrase in the code to consider when evaluating this type of facility is "live in a supervised residential environment." Such dormitories or apartment complexes may contain features, such as special emergency call switches, that are located in each dwelling unit, and that are monitored by health center staff. These emergency call switches are a convenience and do not necessarily indicate infirmity of the care recipients.

**[BG] Condition 1.** This occupancy condition shall include buildings in which all persons receiving custodial care who, without any assistance, are capable of responding to an emergency situation to complete building evacuation.

- ❖ See the general commentary to Group I-1 occupancies.

**[BG] Condition 2.** This occupancy condition shall include buildings in which there are any persons receiving custodial care who require limited verbal or

physical assistance while responding to an emergency situation to complete building evacuation.

- ❖ See the general commentary to Group I-1 occupancies.

**[BG] Six to 16 persons receiving custodial care.** A facility housing not fewer than six and not more than 16 persons receiving custodial care shall be classified as Group R-4.

- ❖ Any building that has the characteristics of a Group I-1 occupancy but that has more than five and not more than 16 persons receiving custodial care is classified as Group R-4 (see Section 310.6). Ninety-eight percent of households in the U.S. have less than 16 occupants; thus the limit of 16 is considered appropriate for a residential occupancy. Similar to Group I-1, Group R-4 is also divided into a Condition 1 and Condition 2.

**[BG] Five or fewer persons receiving custodial care.** A facility with five or fewer persons receiving custodial care shall be classified as Group R-3 or shall comply with the *International Residential Code* provided an *automatic sprinkler system* is installed in accordance with Section 903.3.1.3 or with Section P2904 of the *International Residential Code*.

- ❖ Any building that has the characteristics of a Group I-1 occupancy (either Condition 1 or Condition 2, or both) but has five or fewer persons receiving custodial care is classified as Group R-3 (see Section 310.5) or may be constructed in accordance with the *International Residential Code*® (IRC®) (see IBC Section 310.5.1). When the code allows compliance in accordance with the IRC, the only requirements that would apply would be those of the IRC, including the installation of automatic sprinkler protection. The intent is to allow persons to be cared for in a residential or home environment, often under the care of family members. Please note similar provisions for Group E occupancies as well as Groups I-2 and I-4.

**[BG] Institutional Group I-2.** Institutional Group I-2 occupancy shall include buildings and structures used for medical care on a 24-hour basis for more than five persons who are not capable of self-preservation. This group shall include, but not be limited to, the following:

- Foster care facilities
- Detoxification facilities
- Hospitals
- Nursing homes
- Psychiatric hospitals

- ❖ An occupancy classified in Group I-2 is characterized by three conditions: it is a health care facility where the level of care offered is medical care, there is 24-hour-a-day medical supervision for the individuals receiving care and patients/residents require physical assistance by staff or others to reach safety in an emergency situation (see the definitions for "24-hour basis," "Custodial care" and "Medical care," and the

five facility examples listed). Where a facility offers medical care instead of custodial care, it is assumed that residents may not be capable of self-preservation. This assessment of the level of care provided needs to be taken with caution and reliance on other state and federal guidelines and associated regulations may be necessary. Also, it is important to keep in mind that facilities that may be classified initially as Group I-1 Condition 1 (capable of self-preservation) or R-4 Condition 1 can very easily need to be reclassified as a Group I-1/R-4 Condition 2 or as a Group I-2 Condition 1 if the abilities of the persons receiving care change over time. Therefore, it is essential for the proponents of a new facility to present information to the building official regarding the full range of patients and residents expected at a facility both initially and over time.

Due to the diversification of how medical care is provided in the five characteristic occupancies currently specified in the IBC for Group I-2 occupancies, the Group I-2 occupancy has been split into two basic conditions: Condition 1, long-term care (nursing homes) and Condition 2, short-term care (hospitals). Although both of these subsets are based on medical treatment and are occupancies within which the occupants are protected with a defend-in-place method of safety, changes in the delivery of care in the two different conditions has changed in the past 10-20 years. Some examples of these changes include:

- Within hospitals, there has been a general increase in the floor area per patient due to the increase in diagnostic equipment and the movement towards single-occupant patient rooms.
- Within nursing homes, there has been a trend to provide more residential-type accommodations, such as group/suite living, gathering areas and cooking facilities in residential areas.

The most common examples of facilities classified in Group I-2 are hospitals (Condition 2) and nursing homes (Condition 1). Other facilities included are detoxification facilities, foster care facilities and psychiatric hospitals. How individual state licensing agencies name, classify and regulate many of the uses listed in Groups I-2 varies significantly from state to state and may not line up with the IBC classifications. It is for this reason that the Group I-2 list of uses is included under the general occupancy classification and not under each “condition.”

The benefit to the “condition” concept is that a majority of code requirements will still apply to all Group I-2 occupancies such as mechanical systems, property maintenance and rehabilitation, but will provide for the opportunity for specific code requirements that apply to the different levels of care and acuity that are found in different facility types; thus allowing for the establishment of specific code

requirements that are based on the operation of the facility.

It is not uncommon to find dining rooms (Group A-2), staff offices (Group B), gift shops (Group M), laundries (Group F) and other nonmedically related areas in buildings otherwise classified as Group I-2. Where such other occupancies occur, the building is considered as a mixed occupancy and subject to the provisions of Section 508. In addition to the general requirements contained in this section, Section 407 contains specific requirements for Group I-2.

**[BG] Occupancy Conditions.** Buildings of Group I-2 shall be classified as one of the following occupancy conditions:

- ❖ A distinction is made between Condition 1 and Condition 2 for Group I-2 occupancies. Section 407 of the IBC provides many requirements that apply to both conditions under the Group I-2 occupancy.

**[BG] Condition 1.** This occupancy condition shall include facilities that provide nursing and medical care but do not provide emergency care, surgery, obstetrics, or in-patient stabilization units for psychiatric or detoxification, including, but not limited to, nursing homes and foster care facilities.

- ❖ The principal use in this category is nursing homes. Typically facilities providing long-term medical care but not the types of care typically found in hospitals. Foster care facilities, by Chapter 2 definition are those where children up to 2½ years old receive care. Foster care for more than five infants and toddlers would also be classified as Group I-2 Condition 1. Foster care facilities that provide care for five or more children older than 2½ would typically be Group I-1/R-4 Condition 1, based on supervised living and capability of the residents.

**[BG] Condition 2.** This occupancy condition shall include facilities that provide nursing and medical care and could provide emergency care, surgery, obstetrics, or inpatient stabilization units for psychiatric or detoxification, including, but not limited to, hospitals.

- ❖ Hospitals and psychiatric hospitals are both included in the Condition 2 category of the I-2 occupancy. Treatment is usually for periods longer than 24 hours and provides medical care not typically available in long-term nursing care facilities.

**[BG] Five or fewer persons receiving medical care.** A facility with five or fewer persons receiving medical care shall be classified as Group R-3 or shall comply with the *International Residential Code* provided an *automatic sprinkler system* is installed in accordance with Section 903.3.1.3 or with Section P2904 of the *International Residential Code*.

- ❖ Any facility that has the characteristics of a Group I-2 occupancy but does not have more than five persons receiving care at any one time is to be classified as a Group R-3 occupancy. As an option, the facility may

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be designed and constructed under the provisions of the IRC, provided the building has a sprinkler system. The intent is to allow persons to be cared for in a residential, or home, environment, often under the care of family members. The persons receiving the care do not need to be capable of self-preservation. The sprinkler system is to comply with the requirements for an NFPA 13D system or those of Section P2904 of the IRC. Please note similar provisions for Group E occupancies as well as Groups I-1 and I-4.

**[BG] Institutional Group I-3.** Institutional Group I-3 occupancy shall include buildings and structures which are inhabited by more than five persons who are under restraint or security. A Group I-3 facility is occupied by persons who are generally incapable of self-preservation due to security measures not under the occupants' control. This group shall include, but not be limited to, the following:

- Correctional centers
- Detention centers
- Jails
- Pre-release centers
- Prisons
- Reformatories

Buildings of Group I-3 shall be classified as one of the following occupancy conditions:

- ❖ An occupancy classified in Group I-3 is characterized by three conditions: it is a location where persons are under restraint or where security is closely supervised, there are more than five such persons and they are not capable of self-preservation because the conditions of confinement are not under their control (i.e., they require assistance by the facilities' staff to reach safety in an emergency situation). For occupancy classification purposes, the provision refers to the number of persons being secured or restrained only. The number of guests or staff is not included. Please note, however, that the number of guests and staff is included for means of egress purposes.

Buildings that have these characteristics but that contain no more than five persons who are being secured or restrained are to be classified based upon the function to which they are associated. For example, the small holding cell in a Group B police station having only the one cell would simply be classified as a portion of the Group B occupancy. Regardless of the occupancy classification, the means of egress provisions for places of restraint are still applicable (see Chapter 10).

It is recognized that not all Group I-3 occupancies have the same level of restraint; thus, to distinguish these different levels, the code defines five different conditions of occupancy based on the degree of access to the exit discharge.

**[BG] Condition 1.** This occupancy condition shall include buildings in which free movement is allowed from sleeping areas and other spaces where access or occupancy is permitted to the exterior via *means of*

*egress* without restraint. A Condition 1 facility is permitted to be constructed as Group R.

- ❖ Condition 1 areas are those where the occupants have unrestrained access to the exterior of the building. As such, a key or remote-control release device is not needed for any occupant to reach the exterior of the building (exit discharge) at any time. These types of buildings are referred to as "low-security facilities." A work-release center is a typical Condition 1 facility. Because of the lack of restraint associated with a Condition 1 building, it resembles a residential use more than a detention facility and, therefore, is permitted to be classified in Group R (see the definitions for "Group R" in this chapter).

**[BG] Condition 2.** This occupancy condition shall include buildings in which free movement is allowed from sleeping areas and any other occupied smoke compartment to one or more other smoke compartments. Egress to the exterior is impeded by locked *exits*.

- ❖ Condition 2 areas are those in which the movement of occupants is not controlled within the exterior walls of the building (i.e., the occupants have unrestrained access within the building). As such, there is free movement by the occupants between smoke compartments (as created by smoke barriers); however, the occupants must rely on someone else to allow them to exit the building to the area of discharge.

**[BG] Condition 3.** This occupancy condition shall include buildings in which free movement is allowed within individual smoke compartments, such as within a residential unit comprised of individual *sleeping units* and group activity spaces, where egress is impeded by remote-controlled release of *means of egress* from such smoke compartment to another smoke compartment.

- ❖ Condition 3 areas are those in which free movement by the occupants is permitted within an individual smoke compartment; however, movement of occupants from one smoke compartment (as created by smoke barriers) to another smoke compartment and from within the building to the exterior (exit discharge) is controlled by remote-release locking devices. As such, the occupants in the facility are dependent on the staff for their release from each smoke compartment or to the exterior (exit discharge).

**[BG] Condition 4.** This occupancy condition shall include buildings in which free movement is restricted from an occupied space. Remote-controlled release is provided to permit movement from *sleeping units*, activity spaces and other occupied areas within the smoke compartment to other smoke compartments.

- ❖ Condition 4 areas are those in which the movement of restrained persons from any room or space within a smoke compartment (as created by smoke barriers) to another smoke compartment or to the exterior (exit discharge) is controlled by remote release locking devices. Any movement within the facility requires

activation of a remote control lock system to release the designated area. The persons being restrained or secured within a Condition 4 area must rely on an activation system in the event of an emergency in order to evacuate the area.

Condition 4 facilities most often are penal facilities where the restrained persons are considered relatively safe to handle in large groups. As such, many persons can be released simultaneously from their individual sleeping areas when they need to travel to dining areas or move to another area.

**[BG] Condition 5.** This occupancy condition shall include buildings in which free movement is restricted from an occupied space. Staff-controlled manual release is provided to permit movement from *sleeping units*, activity spaces and other occupied areas within the smoke compartment to other smoke compartments.

- ❖ Condition 5 areas are those in which the persons being secured or restrained are not allowed free movement to any other room or space within a smoke compartment (as created by smoke barriers) to another smoke compartment or to the exterior (exit discharge) unless the locking device controlling their area of confinement is manually released by a staff member. Once released from an individual space, a staff member is responsible for unlocking all doors from that location to the next smoke compartment. This is the most restrictive occupancy condition, as each secured person must be released on an individual basis and escorted to other areas.

Condition 5 facilities are most often used for maximum security or solitary confinement areas where the persons are considered to be dangerous to others, including staff members, and cannot safely be handled in large groups.

**[BG] Institutional Group I-4, day care facilities.** Institutional Group I-4 shall include buildings and structures occupied by more than five persons of any age who receive custodial care for less than 24 hours by persons other than parents or guardians, relatives by blood, marriage, or adoption, and in a place other than the home of the person cared for. This group shall include, but not be limited to, the following:

Adult day care  
Child day care

- ❖ Facilities that contain provisions for the custodial care of more than five persons of any age are classified as Group I-4 (see definitions of “Custodial care” and “Personal care service”). Group I-4 facilities are less restrictive in some of the requirements (e.g., height and area) than the other Group I occupancies. Group I-4 facilities are intended to be used to provide care for less than 24 hours. Day care facilities are not intended to be a full-time residence for the people receiving care. The staff members are assumed not to be related to the individuals in the day care facilities. The premise of the provisions is that the numbers receiving care are exclusive of staff. The care

recipients in a Group I-4 occupancy are not expected to respond to an emergency without physical assistance from others. Group I-4 occupancies include both adult day care and child day care.

Adult care facilities are assumed to be for people other than children who require some type of custodial care (i.e., nonmedical). A facility where adults gather for social activities such as a community center or a YMCA is not an adult care facility (Group I) and would be regulated under other provisions of the code (Group A-3 or B). The classification of Group I-4 for an adult day care facility does not apply to facilities that provide personal care services for adults who are capable of responding to an emergency unassisted. In that case, the facility is simply classified into the occupancy group it most resembles. A facility providing a similar degree of custodial care for infants and toddlers on less than a 24-hour-per-day basis would be considered as a Group I-4 day care facility.

**[BG] Classification as Group E.** A child day care facility that provides care for more than five but not more than 100 children 2½ years or less of age, where the rooms in which the children are cared for are located on a *level of exit discharge* serving such rooms and each of these child care rooms has an *exit* door directly to the exterior, shall be classified as Group E.

- ❖ Children 2½ years of age or less (i.e., infants and toddlers) typically are not capable of independently responding to an emergency and must be led or carried to safety. Under such circumstances, the infants and toddlers are considered nonambulatory. Therefore, a Group I-4 classification is given to those facilities where six or more infants and toddlers receive custodial care for less than 24 hours per day. A similar condition is found in foster care facilities (Group I-2 Condition 1) where infants and toddlers stay for extended periods of time. The distinguishing factor between the two occupancies is the amount of time the facility provides care for each individual. Group I-2 facilities provide care on a 24-hour basis, while in Group I-4 facilities individual care must be less than 24 hours. It is also assumed that medical care is not present in Group I-4 facilities.

A child care facility in which the number of infants and toddlers is greater than five but not more than 100 is permitted to be classified as Group E, provided the infants and toddlers are all located in rooms on the level of exit discharge that serves such rooms and all of the rooms have exit doors directly to the exterior. This exception is only applicable to rooms and spaces used for child care and is not intended to apply to accessory spaces such as restrooms, offices and kitchens. Many day care facilities primarily catering to those under primary school age tend to divide the children into three general categories based on state laws and regulations. These include infant, toddler and preschool.

Some variations do occur in that larger day care

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facilities will have transition rooms for mobile infants or pre-K oriented rooms for those entering kindergarten. But, basically, there is a mixture of children 2½ years or younger and older children. The older children can automatically be in a facility classified as a Group E occupancy, but for the younger children, the exception as discussed above would need to be applied to classify the entire occupancy as Group E. The total number of children can exceed 100 and the Group E classification is retained, provided that the number of children 2½ years or younger is limited to 100 or fewer. The infant and toddler rooms would need to have exits directly to the outside on the level of exit discharge. If the exception is not applied, the entire facility would need to be classified as Group I-4 or a mixed occupancy classification would be necessary.

By permitting the facility to be classified as Group E, the building would not be required to be sprinklered unless the fire area was greater than 12,000 square feet (115 m<sup>2</sup>). A Group I-4 facility would be required to be sprinklered regardless of the area. But as a Group E occupancy, panic hardware would be required in rooms and spaces exceeding 50 occupants.

**[BG] Within a place of religious worship.** Rooms and spaces within places of religious worship providing such care during religious functions shall be classified as part of the primary occupancy.

- ❖ The Group I-4 provisions do not apply to places of religious worship simply providing care services during worship and related religious functions. If the space is used at other times simply as a day care facility, then it would be classified as Group I-4 or E, as applicable.

**[BG] Five or fewer occupants receiving care.** A facility having five or fewer persons receiving custodial care shall be classified as part of the primary occupancy.

- ❖ Where five or fewer persons receive custodial care in a facility other than a dwelling unit, the classification of the care area is to be consistent with that of the primary occupancy. The limited number of care recipients reduces the hazard level to the point that classification as a Group I-4 occupancy is not warranted.

**[BG] Five or fewer occupants receiving care in a dwelling unit.** A facility such as the above within a *dwelling unit* and having five or fewer persons receiving custodial care shall be classified as a Group R-3 occupancy or shall comply with the *International Residential Code*.

- ❖ Buildings that have five or fewer persons receiving custodial care within a dwelling unit are to be classified as Group R-3, or shall be constructed in accordance with the IRC. The assumption is that this type of activity is possible in a residential environment

where one or more family members require the high level of care required by Group I-4. Please note similar provisions for Group E occupancies, as well as Groups I-1 and I-2.

**[BG] Mercantile Group M.** Mercantile Group M occupancy includes, among others, the use of a building or structure or a portion thereof, for the display and sale of merchandise, and involves stocks of goods, wares or merchandise incidental to such purposes and accessible to the public. Mercantile occupancies shall include, but not be limited to, the following:

- Department stores
- Drug stores
- Markets
- Motor fuel-dispensing facilities
- Retail or wholesale stores
- Sales rooms

- ❖ Group M (mercantile) occupancies normally involve the display and sale of large quantities of combustible merchandise, and the fuel load in such facilities can be relatively high, potentially exposing the occupants (customers and sales personnel) to a high degree of fire hazard. Mercantile operations often attract large crowds (particularly in large department stores and covered malls and especially during weekends and holidays). There are two factors that alleviate the risks to life safety: the occupant load normally has a low-to-moderate density and the occupants are alert, mobile and able to respond in an emergency situation. The degree of openness and the organization of the retail displays found in most mercantile occupancies is generally orderly and does not present an unusual difficulty for occupant evacuation.

Contained in the definition are general descriptions of the kinds of occupancies that are classified in Group M. Mercantile buildings most often have both a moderate occupant load and a high fuel load, which are in the form of furnishings and the goods being displayed, stored and sold.

The key characteristics that differentiate occupancies classified in Group M from those in Group B are the larger quantity of goods or merchandise available for sale and the lack of familiarity of the occupants with the building, particularly its means of egress. To be classified in Group M, the goods that are on display must be accessible to the public. If a patron sees an item for sale, then that item is generally available for purchase at that time (i.e., there is a large stock of goods). If a store allows people to see the merchandise but it is not available on the premises, such as an automobile showroom, then the occupancy classification of business (Group B) should be considered. A mercantile building is accessible to the public, many of whom may not be regular visitors. A business building, however, is primarily occupied by regular employees who are familiar with the building arrangement and, most importantly, the exits. This awareness of the building and the exits can be an important factor in a fire emergency.

Where storage rooms are limited to a maximum of 100 square feet in area, Section 311.1.1 of the IBC allows such rooms to still be considered part of the primary occupancy, provided that the aggregate of such rooms does not exceed 10 percent of the story. Therefore many mercantile stores with stockroom areas will be considered a mixed use building for height and area, construction type and sprinkler requirements. Note that Table 508.4 of the IBC does not require a fire-resistance rating on the separation between Group M and S-1.

Automotive, fleet-vehicle, marine and self-service motor fuel-dispensing facilities, also defined in this chapter of the code, are classified in the mercantile occupancy group, as are the convenience stores often associated with such occupancies. Quick-lube, tune-up, muffler and tire shops are not included in this classification. Those facilities that typically conduct automotive service and repair work are treated as a repair garage (Group S-1), also defined in this chapter of the code.

Simply because a building containing a mercantile-type occupancy has a dense occupant load does not necessitate the need to classify the building as an assembly occupancy unless the activity includes an assembly-type area where purchasing of goods is a group activity versus individual shoppers independently considering and purchasing merchandise. For example, a building in which auction sales occur may have a highly concentrated occupant load where the sales occur but the definition describes mercantile occupancies as “the use of a building or structure or portion thereof for the display and sale of merchandise and involves stocks of goods, wares or merchandise incidental to such purposes and accessible to the public.” However, in an auction, the activity is dominated by an assembly use of the space as people gather to conduct and participate in the auction. As such, auction spaces need to be assigned a Group A-3 occupancy (IBC Committee Interpretation No. 38-03). The presence of highly concentrated occupant loads does not in itself mandate an assembly use classification unless the activity is assembly in nature versus large numbers of people pursuing individual activities of acquisition.

**[BG] Residential Group R.** Residential Group R includes, among others, the use of a building or structure, or a portion thereof, for sleeping purposes when not classified as an Institutional Group I or when not regulated by the *International Residential Code* in accordance with Section 101.2 of the *International Building Code*.

❖ Residential occupancies represent some of the highest fire safety risks of any of the occupancies listed in Chapter 3 of the IBC. There are several reasons for this condition:

- Structures in the residential occupancy house the widest range of occupant types, i.e., from infants to the aged, for the longest periods of time. As such, residential occupancies are more

susceptible to the frequency of careless acts of the occupants; therefore, the consequences of exposure to the effects of fire are the most serious.

- Most residential occupants are asleep approximately one-third of every 24-hour period. When sleeping, they are not likely to become immediately aware of a developing fire. Also, if awakened from sleep by the presence of fire, the residents often may not immediately react in a rational manner which could delay their evacuation.
- The fuel load in residential occupancies is often quite high, both in quantity and variety. Also, in the construction of residential buildings, it is common to use extensive amounts of combustible materials.
- Another portion of the fire problem in residential occupancies relates to the occupants’ lack of vigilance in the prevention of fire hazards. In their own domicile or residence, people tend to relax and are often prone to allow fire hazards to go unabated; thus, in residential occupancies, fire hazards tend to accrue over an extended period of time and go unnoticed or are ignored.

Most of the nation’s fire problems occur in Group R buildings and, in particular, one- and two-family dwellings, which account for more than 80 percent of all deaths from fire in residential occupancies and about two-thirds of all fire fatalities in all occupancies. One- and two-family dwellings also account for more than 80 percent of residential property losses from fire and more than one-half of all property losses from fire.

Because of the relatively high fire risk and potential for loss of life in buildings classified in Groups R-1 (hotels and motels) and R-2 (apartments and dormitories), the code has stringent provisions for the protection of life in these occupancies. Group R-3 occupancies, however, are not generally considered to be in the same domain and, thus, are not subject to the same level of regulatory control as is provided in other occupancies. Group R-3 facilities are one- or two-family dwellings where the occupants are generally more familiar with their surroundings, and, because they are single units or duplexes, tend to pose a lower risk of injury or death.

Because of the growing trend to care for people in a residential environment, residential care/assisted living facilities are also classified as Group R. Specifically, these facilities are classified as Group R-4. “Mainstreaming” people who are recovering from alcohol or drug addiction and people who are developmentally disabled is reported to have therapeutic and social benefits. A residential environment often fosters this mainstreaming.

Buildings in Group R are described herein. A building or part of a building is considered to be a residential occupancy if it is intended to be used for

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sleeping accommodations (including residential care/assisted living facilities) and is not an institutional occupancy. Institutional occupancies are similar to residential occupancies in many ways; however, they differ from each other in that institutional occupants are in a supervised environment and, in the case of Group 1-2 and 1-3 occupancies, are under some form of restraint or physical limitation that makes them incapable of complete self-preservation. The number of these occupants who are under supervision or are incapable of self-preservation is the distinguishing factor for being classified as an institutional or residential occupancy.

The term “Group R” refers collectively to the four individual residential occupancy classifications: Groups R-1, R-2, R-3 and R-4. These classifications are differentiated in the code based on the following criteria: (1) whether the occupants are transient or nontransient in nature; (2) the type and number of dwellings contained in a single building; and (3) the number of occupants in the facility.

**[BG] Residential Group R-1.** Residential Group R-1 occupancies containing *sleeping units* where the occupants are primarily transient in nature, including:

- Boarding houses (transient) with more than 10 occupants
- Congregate living facilities (transient) with more than 10 occupants
- Hotels (transient)
- Motels (transient)

❖ R-1: The key characteristic of Group R-1 that differentiates it from other Group R occupancies is the number of transient occupants (i.e., those whose length of stay is not more than 30 days).

The most common building types classified in Group R-1 are hotels, motels and boarding houses. Group R-1 occupancies do not typically have cooking facilities in the unit. When a unit is not equipped with cooking facilities, it does not meet the definition of a “Dwelling unit” in Chapter 2 of the code. When this occurs, such units are treated as sleeping units for the application of code provisions. Sleeping units are required to be separated from each other by fire partitions and horizontal assemblies (see IBC Sections 420, 708 and 711). A recent trend in development is the construction of “extended-stay hotels.” While these units may have all of the characteristics of a typical dwelling unit (i.e., cooking, living, sleeping, eating, sanitation), the length of stay is still typically not more than 30 days. As such, these buildings would still be classified as Group R-1. If the length of stay is more than 30 days, these buildings would be classified as Group R-2. If a hotel offers its rooms for short-term housing (i.e., more than 30 days), the facility must comply with the provision for both Group R-1 and R-2.

Other occupancies are often found in buildings classified in Group R-1. These occupancies include nightclubs (Group A-2), restaurants (Group A-2), gift

shops (Group M), health clubs (Group A-3) and storage facilities (Group S-1). When this occurs, the building is a mixed occupancy and is subject to the provisions of Section 508 of the IBC.

Transient congregate living facilities and boarding houses with 10 or fewer occupants can be constructed to the standards of Group R-3 occupancies rather than the general category of Group R-1. The primary intent of this provision is to permit bed and breakfast-type facilities to be established in existing single-family (one-family) structures. In comparison to the provision under Group R-2 which permits congregate living facilities with fewer than 16 nontransient occupants to be built as a Group R-3, the Group R-3 “transient” facility is limited to 10 or fewer occupants in reflection of the limited number of occupants.

Lodging houses, while transient in nature and potentially having more than 10 occupants, are specifically listed under Group R-3. Lodging houses are defined and are typically bed-and-breakfast-type facilities.

**[BG] Residential Group R-2.** Residential Group R-2 occupancies containing *sleeping units* or more than two *dwelling units* where the occupants are primarily permanent in nature, including:

- Apartment houses
- Boarding houses (nontransient) with more than 16 occupants
- Congregate living facilities (nontransient) with more than 16 occupants
- Convents
- Dormitories
- Fraternities and sororities
- Hotels (nontransient)
- Live/work units
- Monasteries
- Motels (nontransient)
- Vacation timeshare properties

❖ The length of the occupants’ stay plus the arrangement of the facilities provided are the basic factors that differentiate occupancies classified in Group R-2 from other occupancies in Group R. The occupants of facilities or areas classified in Group R-2 are primarily nontransient, capable of self-preservation and share their means of egress in whole or in part with other occupants outside of their sleeping area or dwelling unit. Building types ordinarily classified in Group R-2 include apartments, boarding houses (when the occupants are not transient) and nontransient congregate living facilities, such as dormitories, where there are more than 16 occupants.

Individual dwelling units in Group R-2 are either rented by tenants or owned by the occupants. The code does not make a distinction between either type of tenancy. Residential condominiums are treated in the code the same as Group R-2 apartments. Such condominiums are based on shared ownership of a building and related facilities. While an individual owner will have exclusive rights to a certain unit, the

building, the lot the building sits upon, parking, common recreational facilities and similar features are owned in common by all the owners of individual dwelling units. In most cases condominiums do not establish separate lots and the walls between units are not setting on lot lines. Another type of shared ownership is referred to as a “co-op,” short for cooperative. Occasionally a condominium will establish actual lots and lot lines distinguishing individual ownership. When the dwelling unit is located on a separate parcel of land, lot lines defining the parcel exist and the requirements for fire separation must be met.

Dormitories are generally associated with university or college campuses for use as student housing, but this is changing rapidly. Many dormitories are now being built as housing for elderly people who wish to live with other people their own age and who do not need 24-hour-a-day medical supervision. The only difference between the dormitory that has just been described and the dormitory found on a college campus is the age of its occupants. If the elderly people must have 24-hour-a-day medical supervision (i.e., a nurse or doctor on the premises), the building is no longer considered a residential occupancy but an institutional occupancy and would have to comply with the applicable provisions of the code for the appropriate Group I occupancy.

Similar to Group R-1, individual rooms in dormitories are sleeping units. When college classes are not in session, the rooms in dormitories are sometimes rented out for periods of less than 30 days to convention attendees and other visitors. When dormitories undergo this type of transient use, they more closely resemble Group R-1. A style of dormitory design that is being used more frequently is one where there are groups of sleeping units around a common living space, including shared bathrooms and sometimes a kitchen or kitchenette. At this time, the code does not indicate if these groups of rooms should be addressed as separate sleeping units or as a dwelling unit except for when counting units for determining the number of Accessible units required (see Section 1107.6.2.3.1 of the IBC).

Buildings containing dormitories often contain other occupancies, such as cafeterias or dining rooms (Group A-2), recreation rooms (Group A-3), offices (Group B) and meeting rooms (Group A-3). When this occurs, the building is considered a mixed occupancy and is subject to the provisions of Section 508 of the IBC.

Included in the listing of Group R-2 are live/work units. A live/work unit is a dwelling unit or sleeping unit in which a significant portion of the space includes a nonresidential use operated by the tenant. Reflecting a growing trend in urban neighborhoods and the reuse of existing buildings, live/work units must comply with the provisions of Section 419 of the IBC.

The intent of the congregate living facility reference is to better define when a congregate living facility is

operating as a single-family home. Blended families are now commonplace and not necessarily defined strictly by blood or marriage. Small boarding houses, convents, dormitories, fraternities, sororities, monasteries and nontransient hotels and motels may be small enough to operate as a single-family unit and would be permitted to be constructed as Group R-3 occupancies as intended by the code. The threshold of 16 persons is consistent with the results of the most recent census, which showed that 98 percent of households in the U.S. that identified themselves as a single family have less than 16-occupants. The 16 occupant limit is also consistent with the limits of an NFPA 13D sprinkler system.

**[BG] Residential Group R-3.** Residential Group R-3 occupancies where the occupants are primarily permanent in nature and not classified as Group R-1, R-2, R-4 or I, including:

- Boarding houses (nontransient) with 16 or fewer occupants
- Boarding houses (transient) with 10 or fewer occupants
- Buildings that do not contain more than two *dwelling units*
- Care facilities that provide accommodations for five or fewer persons receiving care
- Congregate living facilities (nontransient) with 16 or fewer occupants
- Congregate living facilities (transient) with 10 or fewer occupants
- Lodging houses with five or fewer guest rooms

- ❖ Group R-3 facilities include all detached one- and two-family dwellings and multiple (three or more) single-family dwellings (townhouses) more than three stories in height. Those buildings three or less stories in height are not classified as Group R-3 and are regulated by the IRC. Each pair of dwelling units in multiple single-family dwellings greater than three stories in height must be separated by fire walls (see Section 706 of the IBC) or by two exterior walls (see Table 602 of the IBC) in order to be classified as Group R-3. (Duplexes, buildings with two dwelling units, must be detached from other structures in order to be regulated by the IRC). A duplex attached to another duplex would be required to comply with the code and be classified as Group R-2 or R-3, depending on the presence of fire walls.

Buildings that are classified as Group R-3, while limited in height, are not limited in the allowable area per floor as indicated in Table 506.2.

Buildings that are one- and two-family dwellings and multiple single-family dwellings less than three stories in height and that contain another occupancy (e.g., Groups B, M, I-4) must be regulated as a mixed occupancy in accordance with the code and are not permitted to be regulated by the provisions of the IRC. However, some mixed use dwelling units may qualify as live/work units under Section 419 and be classified as a Group R-2 occupancy.

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In addition, boarding houses and congregate living facilities with no more than 16 nontransient occupants or no more than 10 transient occupants are to be classified as Group R-3.

Group R-3 occupancies include small care facilities where care is provided to five or fewer persons. The intent is to allow persons to be cared for in a residential, or home, environment, often under the care of family members that is typical within a single-family-type home. Allowances for the Group R-3 classification of smaller care facilities are established in Group E, Group I-1, Group I-2 and Group I-4. Because the intent is to accommodate persons who might otherwise be in other group occupancies, including Group I-2, the Group R-3 care facility is not limited to only persons who are capable of self-preservation. The only limit is the number receiving care, not the total number of occupants in the dwelling unit. If two people are receiving care, and the rest of the family includes four others, totaling six occupants in the dwelling does classify the dwelling as a Group R-3 occupancy.

Lodging houses with five or fewer guest rooms can be classified as a Group R-3 occupancy or, under Section 310.5.2 of the IBC, can be constructed under the provisions of the IRC. The definition of "Lodging house" allows the rental of guest rooms to transients, provided that there are one or more occupants who are permanent in nature. While Section 310.5.2 requires owner occupancy of the dwelling unit in order for it to be built in compliance with the IRC, there is no owner occupancy requirement for lodging houses that comply with Group R-3 requirements. The broad intent of the lodging house provisions is to allow bed-and-breakfast and similar facilities under the Group R-3 category, even though transient housing generally falls under the Group R-1 classification. The limit is set to the number of guest rooms. There is no specified limit on the number of guests, the number of residents, or the combination of both.

**[BG] Care facilities within a dwelling.** Care facilities for five or fewer persons receiving care that are within a single-family dwelling are permitted to comply with the *International Residential Code* provided an *automatic sprinkler system* is installed in accordance with Section 903.3.1.3 or Section P2904 of the *International Residential Code*.

- ❖ The Group R-3 definition already states that care facilities that accommodate five or fewer persons receiving care can be classified as a Group R-3 occupancy. The definitions of Group E, Group I-1, Group I-2 and Group I-4 each state the option of providing the care of five or fewer persons within a structure regulated under the IRC. The intent is to allow persons to be cared for in a residential, or home, environment, often under the care of family members that is typical within a single-family-type home. As stated for those care facilities allowed within the Group R-3 occupancy, the persons receiving care in a building

designed according to the IRC are not limited to those who are capable of self-preservation. Similar to those for Groups I-1 and I-2, this definition specifies that such an IRC-regulated facility must be provided with an automatic sprinkler system.

**[BG] Lodging houses.** Owner-occupied *lodging houses* with five or fewer guest rooms shall be permitted to be constructed in accordance with the *International Residential Code*.

- ❖ This section allows bed-and-breakfast-type hotels that are both owner-occupied and have five or fewer rooms to rent to be constructed under the IRC. There is no occupant load limitations for this option as there are for boarding houses or congregate residences. See the commentary to the definition of "Group R-3 occupancies."

**[BG] Residential Group R-4.** Residential Group R-4 shall include buildings, structures or portions thereof for more than five but not more than 16 persons, excluding staff, who reside on a 24-hour basis in a supervised residential environment and receive custodial care. Buildings of Group R-4 shall be classified as one of the occupancy conditions indicated below. This group shall include, but not be limited to, the following:

- Alcohol and drug centers
- Assisted living facilities
- Congregate care facilities
- Group homes
- Halfway houses
- Residential board and care facilities
- Social rehabilitation facilities

Group R-4 occupancies shall meet the requirements for construction as defined for Group R-3, except as otherwise provided for in the *International Building Code*.

- ❖ Where five to 16 residents live in a supervised environment and receive custodial care, such a facility is classified as Group R-4. Ninety-eight percent of households in the U.S. that identified themselves as single family have less than 16 occupants. The 16-occupant limit is also consistent with the limits of an NFPA 13D sprinkler system. Thus the limit to the number of residents to 16 was established as an appropriate limit considering that this facility will operate similar to a single-family home. Under federal housing laws regarding nondiscrimination, families cannot be determined by blood or marriage. If a Group R-4 occupancy is expanded or allowed to have more than 16 care recipients, the facility needs to be reclassified as a Group I-1 occupancy. The number of persons used in the determination includes those who receive care and is not intended to include staff.

Similar to Group I-1, a Group R-4 occupancy is also one of two conditions. In a Condition 1 facility, care recipients may be slower during evacuation but are capable of self-preservation. In a Condition 2 facility, care recipients may require limited assistance with evacuation during emergency situations. See also the commentary in Section 308.3 for Group

I-1 for a further detailed explanation of both Group I-1 and R-4 custodial care occupancies (also see the definition of “Custodial care”).

Group R-4 facilities must satisfy the construction requirements of Group R-3. Facilities with five or fewer persons receiving care will be either a Group R-3 occupancy (see Section 310.5), or can be built under the IRC (see Section 310.5.1).

**[BG] Condition 1.** This occupancy condition shall include buildings in which all persons receiving custodial care, without any assistance, are capable of responding to an emergency situation to complete building evacuation.

- ❖ See the commentary to the definition of “Group R-4 occupancies.”

**[BG] Condition 2.** This occupancy condition shall include buildings in which there are any persons receiving custodial care who require limited verbal or physical assistance while responding to an emergency situation to complete building evacuation.

- ❖ See the commentary to the definition of “Group R-4 occupancies.”

**[BG] Storage Group S.** Storage Group S occupancy includes, among others, the use of a building or structure, or a portion thereof, for storage that is not classified as a hazardous occupancy.

- ❖ This definition requires that all structures (or parts thereof) designed or occupied for the storage of moderate- and low-hazard materials are to be classified in either Group S-1 (moderate hazard) or S-2 (low hazard). Small storage areas are inherent in almost any activity or occupancy.

The life safety problems in structures used for storage of moderate- and low-hazard materials are minimal because the number of people involved in a storage operation is usually small and normal work patterns require the occupants to be dispersed throughout the facility. The problems of fire safety, particularly as they relate to the protection of stored contents, are directly associated with the amount and combustibility of the materials (including packaging) that are housed on the premises.

Storage facilities typically contain significant amounts of combustible or noncombustible materials that are kept in a common area. Because of the combustion, flammability or explosive characteristics of certain materials, a structure (or portion thereof) that is used to store high-hazard materials which exceed the MAQs, or that does not meet one of the exceptions identified in Section 307.1 of the IBC, cannot be classified as Group S and is to be classified as Group H, high-hazard uses, and is to comply with Section 307 of the IBC.

Storage occupancies consist of two basic types: Groups S-1 and S-2, which are based on the properties of the materials being stored. The distinction between Groups S-1 and S-2 is similar to that

between Groups F-1 and F-2, as outlined in those definitions.

**[BG] Accessory storage spaces.** A room or space used for storage purposes that is less than 100 square feet (9.3 m<sup>2</sup>) in area and accessory to another occupancy shall be classified as part of that occupancy. The aggregate area of such rooms or spaces shall not exceed the allowable area limits of Section 508.2 of the *International Building Code*.

- ❖ This provision allows small storage rooms to be classified in the same occupancy group as the primary occupancy of a space. There are two limits, each space is limited to 100 square feet, and the aggregate of such spaces on any story is limited to 10 percent of the floor area. These small storage spaces could occur in any other occupancy, such as a Group B office building, a Group E classroom or a Group M retail store. Individual spaces in excess of 100 square feet would be classified as an S occupancy and the provisions of mixed occupancies (see Section 508) would come into play. Section 508.2 limits accessory occupancies on any story to 10 percent of the area of that story. The area of storage spaces would need to be totaled to determine if they can be classified as part of the main occupancy or may, in part, need to be classified as a Group S occupancy. As a separated mixed-use building, Table 508.4 does not require a separation between S-1 and F-1, B or M. Table 509 for incidental uses would require storage rooms in Group I-2 and ambulatory care facilities with an area over 100 square feet to be separated by fire barrier or horizontal assemblies with a fire-resistance rating of at least 1 hour.

**[BG] Moderate-hazard storage, Group S-1.** Storage Group S-1 occupancies are buildings occupied for storage uses that are not classified as Group S-2, including, but not limited to, storage of the following:

- Aerosols, Levels 2 and 3
- Aircraft hangar (storage and repair)
- Bags: cloth, burlap and paper
- Bamboos and rattan
- Baskets
- Belting: canvas and leather
- Books and paper in rolls or packs
- Boots and shoes
- Buttons, including cloth covered, pearl or bone
- Cardboard and cardboard boxes
- Clothing, woolen wearing apparel
- Cordage
- Dry boat storage (indoor)
- Furniture
- Furs
- Glues, mucilage, pastes and size
- Grains
- Horns and combs, other than celluloid
- Leather
- Linoleum
- Lumber

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Motor vehicle repair garages complying with the maximum allowable quantities of hazardous materials listed in Table 5003.1.1(1) (see Section 406.8 of the *International Building Code*)

Photo engravings

Resilient flooring

Silks

Soaps

Sugar

Tires, bulk storage of

Tobacco, cigars, cigarettes and snuff

Upholstery and mattresses

Wax candles

- ❖ Buildings in which combustible materials are stored and that burn with ease are classified in Group S-1, moderate-hazard storage occupancies. Examples of the kinds of materials that, when stored, are representative of occupancies classified in Group S-1 are listed in the definition.

As defined by the code, a repair garage is any structure used for servicing or repairing motor vehicles. Therefore, regardless of the extent of work done (e.g., quick-lube, tune-up, muffler and tire shops, painting, body work, engine overhaul), repair garages are classified as Group S-1 and must be in compliance with Section 406.8 of the IBC. In addition, to avoid a Group H classification, the amounts of hazardous materials in the garage must be less than the MAQ indicated in Tables 5003.1.1(1) and 5003.1.1(2) [IBC Tables 307.1(1) and 307.1(2)] of the code.

Aircraft hangars for storage, repair or both would be classified as Group S-1. This classification correlates with the actual use of such hangars which very frequently would include some level of repair work and also works with the requirements of NFPA 409. Aircraft hangars accessory to one- and two-family structures remain a Group U occupancy.

**[BG] Low-hazard storage, Group S-2.** Storage Group S-2 occupancies include, among others, buildings used for the storage of noncombustible materials such as products on wood pallets or in paper cartons with or without single thickness divisions; or in paper wrappings. Such products are permitted to have a negligible amount of plastic trim, such as knobs, handles or film wrapping. Storage uses shall include, but not be limited to, storage of the following:

Asbestos

Beverages up to and including 16-percent alcohol in metal, glass or ceramic containers

Cement in bags

Chalk and crayons

Dairy products in nonwaxed coated paper containers

Dry cell batteries

Electrical coils

Electrical motors

Empty cans

Food products

Foods in noncombustible containers

Fresh fruits and vegetables in nonplastic trays or

containers

Frozen foods

Glass

Glass bottles, empty or filled with noncombustible liquids

Gypsum board

Inert pigments

Ivory

Meats

Metal cabinets

Metal desks with plastic tops and trim

Metal parts

Metals

Mirrors

Oil-filled and other types of distribution transformers

Parking garages, open or enclosed

Porcelain and pottery

Stoves

Talc and soapstones

Washers and dryers

- ❖ Buildings in which noncombustible materials are stored are classified as Group S-2, low-hazard storage occupancies. It is acceptable for stored noncombustible products to be packaged in combustible materials as long as the quantity of packaging is kept to an insignificant level.

As seen in Group F-1 and F-2 classifications, it is important to be able to distinguish when the presence of combustible packaging constitutes a significant fuel load. As such, a fuel load might require the building to be classified in Group S-1, moderate-hazard storage. A simple guideline to follow is the “single-thickness” rule, which is when a noncombustible product is put in one layer of packaging material.

Examples of materials qualified for storage in Group S-2 storage facilities are as follows:

- Vehicle engines placed on wood pallets for transportation after assembly.
- Washing machines in corrugated cardboard boxes.
- Soft-drink glass bottles packaged in pressed paper boxes.

Structures used to store noncombustible materials packaged in more than one layer of combustible packaging material are to be classified in Group S-1.

Examples of materials that, because of packaging, do not qualify for classification in Group S-2 are:

- Chinaware wrapped in corrugated paper and placed in cardboard boxes.
- Glassware set in expanded foam forms and placed in a cardboard box.
- Fuel filters individually packed in pressed paper boxes, placed by the gross in a cardboard box and then stacked on a wood pallet for transportation.

An area often related to Group S occupancies is Chapter 32, which regulates high-piled combustible

storage [storage over 12 feet (3658 mm) in height or 6 feet (1829 mm) if the material is considered high hazard]. Chapter 32 of the IFC is focused on not only the type of materials being stored but also the height and configuration of such storage. It is important to note that not all Group S occupancies will contain high-piled storage and that high-piled storage is not limited to Group S occupancies. High-piled storage can be found in occupancies such as Group H or F.

Open and enclosed parking garages are classified as Group S-2 occupancies as long as no repair activities occur in such buildings, as discussed in the commentary for this definition. A garage in a fire station, for example, that undertakes maintenance and repairs limited to cleaning, hose change, water fill, fire equipment upgrades or wheel removal for repair off premise would not constitute the same hazard associated with repair garages and would be appropriately classified as Group S-2.

**[BG] Miscellaneous Group U.** Buildings and structures of an accessory character and miscellaneous structures not classified in any specific occupancy shall be constructed, equipped and maintained to conform to the requirements of this code commensurate with the fire and life hazard incidental to their occupancy. Group U shall include, but not be limited to, the following:

Agricultural buildings

Aircraft hangar, accessory to a one- or two-family residence (see Section 412.5 of the *International Building Code*)

Barns

Carports

Fences more than 6 feet (1829 mm) high

Grain silos, accessory to a residential occupancy

Greenhouses

Livestock shelters

Private garages

Retaining walls

Sheds

Stables

Tanks

Towers

- ❖ This definition identifies the characteristics of occupancies classified in Group U. Structures that are classified in Group U are typically accessory to another building or structure and are not more appropriately classified in another occupancy. Miscellaneous storage buildings accessory to detached one- and two-family dwellings and multiple single-family dwellings (townhouses) not more than three stories in height, however, are intended to be designed and built in accordance with the IRC.

Structures classified as Group U, such as fences, equipment, foundations, retaining walls, etc., are somewhat outside the primary scope of the code (i.e., means of egress, fire resistance). They are not usually considered to be habitable or occupiable. Nevertheless, many code provisions do apply and need to

be enforced (e.g., structural design and material performance).

Structures housing accessory equipment that is part of a utility or communications system are often classified as Group U occupancies when there is no intent that these structures be occupied except for servicing and maintaining the equipment within the structure. A pumphouse for a water or sewage system or an equipment building at the base of a telecommunications tower are examples of such buildings.

Group U occupancies are subject to the same structural loadings such as snow loads as other occupancies. This definition establishes that occupancies classified as utility and miscellaneous structures shall be constructed, equipped and maintained to conform to the code requirements that are commensurate with the fire and life hazards incidental to their occupancy. The structural design requirements for roofs are the minimum deemed necessary to withstand such elements. Allowing construction of a building with an accessory occupancy that could reasonably be expected to collapse under the snow loads known to prevail in certain area is not in the best interest of public safety.

**[BG] OCCUPANT LOAD.** The number of persons for which the *means of egress* of a building or portion thereof is designed.

- ❖ In addition to the limitation on the maximum occupant load for a space, the code also requires the determination of the occupant load that is to be utilized for the design of the means of egress system. The number for the floor area per occupant (occupant load factor) in Table 1004.1.2 reflects common and traditional occupant densities based on the empirical data for the density of similar spaces. This occupant load is also utilized to determine the required number of plumbing fixtures (see Chapter 29 of the IBC) and when automatic sprinkler systems or fire alarm and detection systems are required (see Chapter 9).

**OPEN BURNING.** The burning of materials wherein products of combustion are emitted directly into the ambient air without passing through a stack or chimney from an enclosed chamber. Open burning does not include road flares, smudgepots and similar devices associated with safety or occupational uses typically considered open flames, *recreational fires* or use of portable outdoor fireplaces. For the purpose of this definition, a chamber shall be regarded as enclosed when, during the time combustion occurs, only apertures, ducts, stacks, flues or chimneys necessary to provide combustion air and permit the escape of exhaust gas are open.

- ❖ Open burning is any burning that takes place in an unenclosed space. Examples include burning of leaves or grass clippings, burning construction debris and fires built on the ground for warmth in cold weather. The burning of wood scraps in a steel drum or in a piece of culvert over which a supply of construction sand can be dumped and kept thawed is

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common practice on construction sites in cold climates and could be evaluated by the fire code official as being an allowable “occupational use” as mentioned in the definition. The definition has also been revised to clarify that the use of portable outdoor fireplaces (also known as patio fireplaces) is specifically excluded, thus eliminating the confusion that previously existed as to how to treat those devices. See also the definition of “Recreational fire.”

**[BE] OPEN-ENDED CORRIDOR.** An interior *corridor* that is open on each end and connects to an exterior *stairway* or *ramp* at each end with no intervening doors or separation from the *corridor*.

❖ Breezeway configurations are common in hotels and apartment buildings, especially in areas where being open to the outside air is considered an amenity. By essentially being open to the outside, the intent and level of safety is similar to an exterior egress balcony (see Section 1027.6, Exception 4 for requirements).

**OPEN MALL.** See “Covered mall building.”

**OPEN MALL BUILDING.** See “Covered mall building.”

**[BG] OPEN PARKING GARAGE.** A structure or portion of a structure with the openings as described in Section 406.5.2 of the *International Building Code* on two or more sides that is used for the parking or storage of private motor vehicles as described in Section 406.5 of the *International Building Code*.

❖ Open parking garages are defined as having uniformly distributed openings on no less than two sides totaling no less than 40 percent of the building perimeter. The aggregate area of the openings is to be a minimum of 20 percent of the total wall area of all perimeter walls (see the commentary to Section 406.5.2 of the IBC).

**OPEN SYSTEM.** The use of a solid or liquid hazardous material involving a vessel or system that is continuously open to the atmosphere during normal operations and where vapors are liberated, or the product is exposed to the atmosphere during normal operations. Examples of open systems for solids and liquids include dispensing from or into open beakers or containers, dip tank and plating tank operations.

❖ This definition is related primarily to hazardous materials use. Generally, an open system is one that will normally be open to the atmosphere; for example, a dip tank or dispensing or mixing of hazardous materials. Open systems are inherently more hazardous than closed systems. When evaluating the MAQs of hazardous materials and the associated requirements, open systems are more heavily regulated.

**OPERATING BUILDING.** A building occupied in conjunction with the manufacture, transportation or use of *explosive materials*. Operating buildings are separated from one another with the use of intraplant or intraline distances.

❖ Magazines are used for storage of explosive materials. Manufacturing or operating buildings used for the storage of explosives are not magazines and are not intended to be used for storage, although at times

there may be storage incidental to the manufacturing function. This definition is included here to clarify this difference.

**OPERATING LINE.** A group of buildings, facilities or workstations so arranged as to permit performance of the steps in the manufacture of an *explosive* or in the loading, assembly, modification and maintenance of ammunition or devices containing *explosive materials*.

❖ This term is used by those engaged in the storage and manufacture of explosive materials, as well as with the regulators of these materials, including the DOD. The term is also consistent with terminology used by the DOD and the Institute of Makers of Explosives (IME). The term “operating line” is defined in relationship to operating buildings that may be grouped in such a manner so as to create a manufacturing process.

**OPERATING PRESSURE.** The pressure at which a system operates.

❖ This term is self-explanatory and is used in Chapters 9, 31, 55 and 60 of the code.

**ORGANIC COATING.** A liquid mixture of binders such as alkyd, nitrocellulose, acrylic or oil, and flammable and combustible solvents such as hydrocarbon, ester, ketone or alcohol, which, when spread in a thin film, convert to a durable protective and decorative finish.

❖ “Organic coatings” are defined as flammable and combustible paints and other protective or decorative coatings.

**ORGANIC PEROXIDE.** An organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms have been replaced by an organic radical. Organic peroxides can present an explosion hazard (*detonation* or *deflagration*) or they can be shock sensitive. They can also decompose into various unstable compounds over an extended period of time.

**Class I.** Describes those formulations that are capable of *deflagration* but not *detonation*.

**Class II.** Describes those formulations that burn very rapidly and that pose a moderate reactivity hazard.

**Class III.** Describes those formulations that burn rapidly and that pose a moderate reactivity hazard.

**Class IV.** Describes those formulations that burn in the same manner as ordinary combustibles and that pose a minimal reactivity hazard.

**Class V.** Describes those formulations that burn with less intensity than ordinary combustibles or do not sustain combustion and that pose no reactivity hazard.

**Unclassified detonable.** Organic peroxides that are capable of *detonation*. These peroxides pose an extremely high-explosion hazard through rapid explosive decomposition.

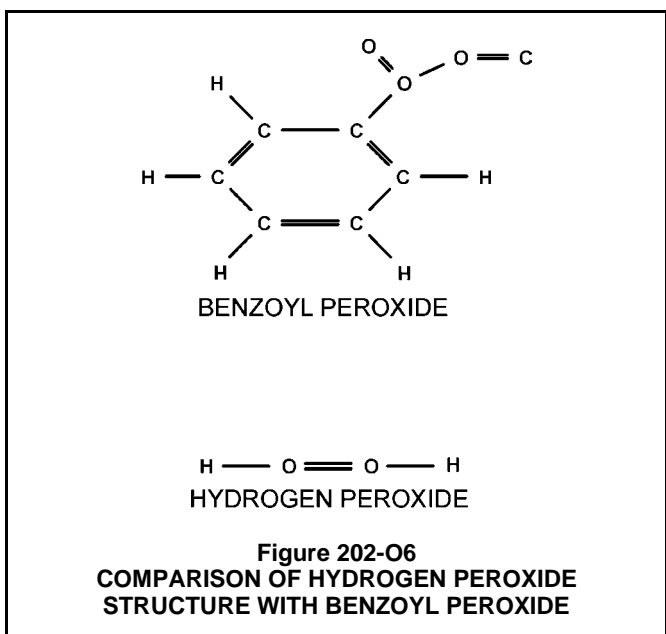
❖ The chemical structure of organic peroxides differs from that of hydrogen peroxide (an oxidizer) in that an

organic radical replaces the hydrogen atoms. Commentary Figure 202-O6 shows an example of this chemical structure in which a benzoyl radical ( $C_6H_5CO$ ) in the widely used Class I organic peroxide benzoyl peroxide replaces the hydrogen atoms in hydrogen peroxide ( $H_2O_2$ ). Organic chemicals are all carbon based. As a result, organic peroxides pose varying degrees of fire or explosion hazards in addition to their oxidizing properties.

The classification system in this chapter (see Commentary Figure 202-O7) is derived from a system developed by the Society of the Plastics Industry (Bulletin 19A).

**OUTDOOR CONTROL AREA.** An outdoor area that contains hazardous materials in amounts not exceeding the maximum allowable quantities of Table 5003.1.1(3) or Table 5003.1.1(4).

❖ This term refers to a storage area that is exposed to the elements (wind, rain, snow, etc.) that cannot exceed the MAQ listed in the code and the IBC. See Tables 5003.1.1(3), 5003.1.1(4) and Sections 5001 and 5003 of the code, and Section 414.6 in the IBC.



**OUTPATIENT CLINIC.** See “Clinic, outpatient.”

**OVERCROWDING.** A condition that exists when either there are more people in a building, structure or portion thereof than have been authorized or posted by the *fire code official*, or when the *fire code official* determines that a threat exists to the safety of the occupants due to persons sitting and/or standing in locations that may obstruct or impede the use of *aisles*, passages, *corridors*, *stairways*, *exits* or other components of the *means of egress*.

❖ This definition notes that an unsafe condition exists when the actual number of people present in a building or a building space exceeds the maximum allowable occupant load of that building or space as determined and posted on the premises by the fire code official. Section 1004 of the code would allow a maximum occupant load of one person per every 5 square feet ( $0.5 \text{ m}^2$ ) of building area, as long as the egress components provide sufficient capacity for such a load. When that egress capacity is exceeded, then overcrowding exists. The definition also recognizes that, even though the number of occupants in a building or space may not be excessive, the inability of occupants to use the egress elements due to blockage by patrons is also a life safety hazard.

**[A] OWNER.** Any person, agent, operator, entity, firm or corporation having any legal or equitable interest in the property; or recorded in the official records of the state, county or municipality as holding an interest or title to the property; or otherwise having possession or control of the property, including the guardian of the estate of any such person, and the executor or administrator of the estate of such person if ordered to take possession of real property by a court.

❖ This term defines the person or other legal entity who is responsible for a building and its compliance with code requirements.

**OXIDIZER.** A material that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of combustible materials and, if heated or contaminated, can result in vigorous self-sustained decomposition.

**Class 4.** An oxidizer that can undergo an explosive reaction due to contamination or exposure to thermal or physical shock and that causes a severe increase in the burning

IFC	DOTn 49 CFR, PART 173.128(b)	HAZARD DESCRIPTION
Unclassified detonatable	Type A	Detonation hazard when confined
Class I	Type B	Deflagration hazard when confined
Class II	Type C and Type D	Mass fire hazard similar to flammable liquid <sup>a</sup>
Class III	Type E	Fire hazard similar to combustible liquid
Class IV	Type F	Little or no fire or reactivity hazard
Class V	Type G	No fire or reactivity hazard

a. Moderate detonation or deflagration hazard when heated under confinement.

**Figure 202-O7**  
**COMPARISON OF ORGANIC PEROXIDE CLASSIFICATION SYSTEMS**

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rate of combustible materials with which it comes into contact. Additionally, the oxidizer causes a severe increase in the burning rate and can cause spontaneous ignition of combustibles.

**Class 3.** An oxidizer that causes a severe increase in the burning rate of combustible materials with which it comes in contact.

**Class 2.** An oxidizer that will cause a moderate increase in the burning rate of combustible materials with which it comes in contact.

**Class 1.** An oxidizer that does not moderately increase the burning rate of combustible materials.

- ❖ The classification of oxidizers had its origins in the provisions of NFPA 430 and is consistent with Department of Transportation (DOT) hazardous materials regulations. Oxidizers, whether a solid, liquid or gas, yield oxygen or another oxidizing gas during a chemical reaction or readily react to oxidize combustibles and increase their burning rate. This characteristic is a result of the enrichment of the air to more than 21-percent oxygen content.

This enrichment is a hazard because an ordinary combustible material that will burn freely at the atmospheric oxygen level of 21 percent will burn more rapidly at higher concentrations of oxygen. The rate of reaction varies with the class of oxidizer. Specific classification of oxidizers is important because of the varying degree of hazard. Examples of oxidizers include liquid hydrogen peroxide, nitric acid, sulfuric acid and solids, such as sodium chlorite, chromic acid and calcium hypochlorite. Many commercially available swimming pool chemicals are examples of Class 2 or 3 oxidizers.

**OXIDIZING CRYOGENIC FLUID.** An oxidizing gas in the cryogenic state.

- ❖ This definition is provided to correlate with the title of Chapter 63 and Section 6304.2.1.1, which is consistent with code-style improvement of providing hazard-specific requirements in material-specific chapters in addition to the general material chapters, in this case Chapter 55. The primary focus of the oxidizing cryogenic fluid provisions in this chapter is liquid oxygen.

**OXIDIZING GAS.** A gas that can support and accelerate combustion of other materials more than air does.

- ❖ Oxidizing gases present essentially the same hazard characteristics as solids and liquids. Examples of oxidizing gases are oxygen, ozone and the oxides of nitrogen, fluorine and chlorine.

**OZONE-GAS GENERATOR.** Equipment which causes the production of ozone.

- ❖ Ozone is considered a highly toxic gas. Ozone generators are addressed separately in Section 6005 because the code has traditionally dealt with the storage and use of hazardous materials, but not the generation.

**[BE] PANIC HARDWARE.** A door-latching assembly incorporating a device that releases the latch upon the application of a force in the direction of egress travel. See also "Fire exit hardware."

- ❖ Panic hardware is commonly used in educational and assembly-type spaces where the number of occupants who would use a doorway during a short time frame in an emergency is high in relation to an occupancy with a less dense occupant load, such as an office building. The hardware is required so that the door can be easily opened during an emergency when pressure on a door from a crush of people could render normal hardware inoperable. Not all types of panic hardware are permitted on doors required to be fire-protection rated (see the definition for "Fire exit hardware" and Section 1010.1.10).

**PASS-THROUGH.** An enclosure installed in a wall with a door on each side that allows chemicals, HPM, equipment, and parts to be transferred from one side of the wall to the other.

- ❖ A pass-through is similar to a sally port and is used to store and receive HPM for the fabrication area. The pass-through must be separated from the exit access corridor by fire-resistance-rated construction, including a fire-resistance-rated, self-closing fire door on each side, and be sprinklered.

**[BG] PENTHOUSE.** An enclosed, unoccupied rooftop structure used for sheltering mechanical and electrical equipment, tanks, elevators and related machinery, and vertical shaft openings.

- ❖ Any enclosed structure that is located above the surrounding roof surfaces can be considered a penthouse as long as it meets the criteria within Section 1510.2 of the IBC. By complying with these requirements, the penthouse is considered to not contribute to the height of the building, either in number of stories or feet above grade plane. If the proposed penthouse does not meet these requirements, it must be considered as an additional story of the building or structure.

**PERMISSIBLE EXPOSURE LIMIT (PEL).** The maximum permitted 8-hour time-weighted-average concentration of an air-borne contaminant. The exposure limits to be utilized are those published in DOL 29 CFR Part 1910.1000. The Recommended Exposure Limit (REL) concentrations published by the U.S. National Institute for Occupational Safety and Health (NIOSH), Threshold Limit Value-Time Weighted Average (TLV-TWA) concentrations published by the American Conference of Governmental Industrial Hygienists (ACGIH), Workplace Environmental Exposure Level (WEEL) Guides published by the American Industrial Hygiene Association (AIHA), and other *approved*, consistent measures are allowed as surrogates for hazardous substances not *listed* in DOL 29 CFR Part 1910.1000.

- ❖ The PEL is a maximum time-weighted concentration at which 95 percent of exposed, healthy adults suffer no adverse effects over a 40-hour workweek. The lower the PEL, the more toxic the substance.

**[A] PERMIT.** An official document or certificate issued by the *fire code official* that authorizes performance of a specified activity.

- ❖ The permit constitutes a license issued by the fire code official to proceed with a specific activity, such as construction of a building or conducting a certain type of business, in accordance with all applicable laws.

For the IBC and IRC, the “building official” is identified as the person responsible for issuing the permit. For the IFC, the “fire code official” is identified as the person responsible. For other I-Codes, the “code official” is identified as the person responsible.

**[A] PERSON.** An individual, heirs, executors, administrators or assigns, and also includes a firm, partnership or corporation, its or their successors or assigns, or the agent of any of the aforesaid.

- ❖ Corporations and other organizations listed in the definition are treated as persons under the law. Also, when the code provides for a penalty (see Section 109.4), the definition makes it clear that the individuals responsible for administering the activities of these various organizations are subject to these penalties.

**[BG] PERSONAL CARE SERVICE.** The care of persons who do not require medical care. Personal care involves responsibility for the safety of the persons while inside the building.

- ❖ Persons who need personal care may need supervision, but they are capable of self-preservation. See the commentary to Occupancy Group E day care.

Care facilities encompass a full spectrum of occupant acuity and support services and span a wide range of occupancy types including Groups E, I and R. There are three types of care defined in the codes: personal, custodial and medical. On the lower end of the care spectrum (i.e., personal care) is when occupants are supervised but do not need custodial or medical care. Where occupants may be elderly or impaired (i.e., custodial care), they may need occasional daily living assistance, such as cooking and cleaning. While occupants may take longer to evacuate than average, they are capable of self-preservation. On the opposite end of the care spectrum, persons receiving care may be completely bedridden and dependant on medical gases and emergency power to maintain life (i.e., medical care). The level of care provided describes the condition and capabilities of an occupant which then indicates appropriate standards for protection systems and building. See also the definitions for “24-hour basis,” “Custodial care,” “Detoxification facilities,” “Foster care facilities,” “Group home,” “Hospitals and psychiatric hospitals,” “Medical care,” “Nursing home” and “Incapable of self-preservation.”

**PESTICIDE.** A substance or mixture of substances, including fungicides, intended for preventing, destroying, repelling

or mitigating pests and substances or a mixture of substances intended for use as a plant regulator, defoliant or desiccant. Products defined as drugs in the Federal Food, Drug and Cosmetic Act are not pesticides.

- ❖ Typically, pesticides are ranked in the toxic category of health hazards. They are primarily used to control a variety of pests.

**[BE] PHOTOLUMINESCENT.** Having the property of emitting light that continues for a length of time after excitation by visible or invisible light has been removed.

- ❖ Examples of photoluminescent material are paint and tape that are charged by exposure to light. When the lights are turned off, the product will “glow” in the dark. Products utilized to meet the requirements for luminous egress path markings in high-rise buildings (see Section 403.5.5 of the IBC and Section 1025) or exit signs (see Section 1013.5) may be photoluminescent or self-luminous. A variety of materials can comply with the referenced standards for egress path markings—UL 1994, *Standard for Safety of Low Level Path Marking and Lighting Systems* and ASTM E 2072, *Standard Specification for Photoluminescent (Phosphorescent) Safety Markings—and for signs—UL 924, Standard for Safety Emergency Lighting and Power Equipment.*

**PHYSICAL HAZARD.** A chemical for which there is evidence that it is a *combustible liquid, cryogenic fluid, explosive, flammable* (solid, liquid or gas), *organic peroxide* (solid or liquid), *oxidizer* (solid or liquid), *oxidizing gas, pyrophoric* (solid, liquid or gas), *unstable (reactive) material* (solid, liquid or gas) or *water-reactive material* (solid or liquid).

- ❖ Materials posing a detonation or deflagration hazard, or materials that readily support combustion, are considered physical hazards. Structures containing materials posing a physical hazard exceeding maximum allowable quantities are classified in Group H-1, H-2 or H-3. Materials posing a physical hazard may also present a health hazard.

**PHYSIOLOGICAL WARNING THRESHOLD.** A concentration of air-borne contaminants, normally expressed in parts per million (ppm) or milligrams per cubic meter (mg/m<sup>3</sup>), that represents the concentration at which persons can sense the presence of the contaminant due to odor, irritation or other quick-acting physiological responses. When used in conjunction with the permissible exposure limit (PEL), the physiological warning threshold levels are those consistent with the classification system used to establish the PEL. See the definition of “Permissible exposure limit (PEL).”

- ❖ The term “physiological warning properties” is not defined. From a practical standpoint, the physiological warning properties are represented by a concentration of a contaminant that allows the average individual to sense its presence by a body warning signal including, but not limited to, odor, irritating effects such as stinging sensations, coughing, scratchy feeling in the throat, running of the eyes or nose and similar signals.

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There may be a wide variability reported for some of the more common threshold levels including that of olfactory perception. Variations that may be encountered are due to a number of factors including the methods used in their determination, the population exposed and others. The requirements for gas detection established in the code are tied to the permissible exposure limit (PEL), and there are several methods for determining the PEL inherent in the definition of that term. Including this definition intends to link the determination of the physiological warning threshold level to the data used to determine the PEL. For example, the PEL as established by 29 CFR is primarily based on data developed by the American Conference of Governmental Industrial Hygienists (ACGIH) called “threshold limit values (TLVs)” as referenced in the definition of “Permissible exposure limit (PEL)”. To substantiate the TLVs (PELs), the ACGIH publishes the Documentation of the Threshold Limit Values (TLVs®) and Biological Exposure Indices (BEIs®) where the user is provided with data used in their establishment. The significant commercially available toxic and highly toxic gases with published TLVs are listed by ACGIH, and perception thresholds are provided. These warning properties are considered, as evidenced by the documentation when the TLV and hence the PEL is established. It is appropriate that the data used in the base documents be used as the basis for determining the threshold level when such data is available. The use of data from other sources may be used in the absence of data within the system used for the establishment of the PEL, but where such data has been considered in determining the PEL such data should take precedent. By providing a definition for physiological warning threshold level and guidance as to how it is to be applied, the code user is given guidance that carries out the intent of the provisions for gas detection that have been established in the code. See the commentary to Section 6004.2.2.10 for further discussion of gas detection.

**PIER.** A structure built over the water, supported by pillars or piles, and used as a landing place, pleasure pavilion or similar purpose.

❖ A pier extends from land over the water to facilitate the loading and unloading of marine vessels with both people and cargo. Many piers also have commercial operations located on them. Piers are typically longer than they are wide and may be constructed of concrete, wood or other combustible materials. When wood materials are used, they are usually heavily coated or pressure treated with preservatives. Exposure to weather will cause the wood materials to dry out and be susceptible to ignition. Wood piers, being elevated structures, will burn freely due to the configuration and amount of exposed material available to burn.

**PLACE OF RELIGIOUS WORSHIP.** See “Religious worship, place of.”

**[M] PLENUM.** An enclosed portion of the building structure, other than an occupiable space being conditioned, that is designed to allow air movement and thereby serve as part of an air distribution system.

❖ A plenum is part of an air distribution system and is usually concealed within the building construction. Plenums can be used for supply, return, exhaust, relief and ventilation air. They can occur in ceiling, attic or under-floor spaces, in mechanical equipment rooms (air handler rooms) and in stud and joist cavities. The definition clarifies that plenums are uninhabitable, unoccupiable cavities and interstitial spaces only; an unoccupiable room or space is not a plenum (see the commentary to Section 602 of the IMC for restrictions on the use of plenums).

**PLOSOPHORIC MATERIAL.** Two or more unmixed, commercially manufactured, prepackaged chemical substances including oxidizers, flammable liquids or solids, or similar substances that are not independently classified as *explosives* but which, when mixed or combined, form an *explosive* that is intended for blasting.

❖ Plosophoric materials, or plosophors, also are known as two-component or binary explosives. When plosophoric materials are mixed or combined at the point of use, the procedures recommended by the manufacturer should be strictly enforced. Mixed or combined plosophoric materials must be transported, stored and used in the same manner as explosives.

**PLYWOOD AND VENEER MILLS.** Facilities where raw wood products are processed into finished wood products, including waferboard, oriented strandboard, fiberboard, composite wood panels and plywood.

❖ Veneer mills are unique because the milling is done with knives rather than saws. Veneer logs are often air dried for an extended period of time before processing.

**PORTABLE OUTDOOR FIREPLACE.** A portable, outdoor, solid-fuel-burning fireplace that may be constructed of steel, concrete, clay or other noncombustible material. A portable outdoor fireplace may be open in design, or may be equipped with a small hearth opening and a short chimney or chimney opening in the top.

❖ This definition describes a fairly recent innovation that has often been treated as open burning. These devices function similar to a masonry or factory-built indoor fireplace except that they are portable, solid fuel-burning fireplaces designed to provide ambience and warmth in outdoor settings. They come in many styles and designs, both open and enclosed. Some designs are constructed of steel with screening around the firebox while others are made of concrete or clay with a small hearth opening and are equipped

with a short chimney or simply a chimney opening. Still others function as a fire pit on legs. The design will typically include a stand or legs to elevate the fire-box above the surface upon which it is placed to provide clearance to combustible materials. Sections 307.4.3 and 307.5 of the code contain specific clearance and attendance requirements for these devices. See also the definitions of “Open burning” and “Recreational fire.”

**POWERED INDUSTRIAL TRUCK.** A forklift, tractor, platform lift truck or motorized hand truck powered by an electrical motor or internal combustion engine. Powered industrial trucks do not include farm vehicles or automotive vehicles for highway use.

❖ This kind of vehicle includes forklift trucks and other similar vehicles used to move stock in warehouses, industrial buildings, large retail spaces, storage yards and loading docks. These vehicles are not licensed for highway travel and do not include farm machinery.

**[BE] POWER-ASSISTED DOOR.** Swinging door that opens by reduced pushing or pulling force on the door-operating hardware. The door closes automatically after the pushing or pulling force is released, and functions with decreased forces. See also “Low energy power-operated door” and “Power-operated door.”

❖ There are basically three different types of doors that provide some type of power assistance for entry: low energy power-operated doors, power-assisted doors and power-operated doors. The power-assisted door is typically a side-swinging door that has the additional feature of powered assistance to move the door to the open position. When a door has power assistance, the force or effort it takes to open the door while it is being pushed or pulled is reduced as long as a user maintains pressure on the hardware. When the hardware is released, the door will move to the closed position. Power-assisted doors are typically used when a door is an unusual size or weight. The low-energy power-assisted door and power-assisted door both are operated by the user touching something; therefore, they both must comply with BMHA156.19.

**[BE] POWER-OPERATED DOOR.** Swinging, sliding, or folding door that opens automatically when approached by a pedestrian or opens automatically upon an action by a pedestrian. The door closes automatically and includes provisions such as presence sensors to prevent entrapment. See also “Low energy power-operated door” and “Power-assisted door.”

❖ There are basically three different types of doors that provide some type of power assistance for entry: low energy power-operated doors, power-assisted doors and power-operated doors. The power-operated door can be a sliding, hinged or side-swinging door that operates automatically by either a motion sensor or sensor mat when someone approaches the door. Power-operated doors are most commonly installed at the busy entrances of commercial buildings. As a

door with hands-free operation, the power-operated door must comply with BMHA156.10.

**PRESSURE VESSEL.** A closed vessel designed to operate at pressures above 15 psig (103 kPa).

❖ A pressure vessel used to contain hazardous materials must comply with the ASME *Boiler and Pressure Vessel Code* (BPVC), in accordance with Section 5003.2.1. Pressure vessels are constructed as cylindrical or spherical structures because such a design is safer, more economical, and it is easier to construct a vessel in these shapes to control axial and circumferential stresses. Pressure vessels can be constructed for either a horizontal (see Commentary Figure 202-P1) or vertical orientation (see Commentary Figure 202-P2). The design, construction and examination requirements for pressure vessels that are used for hazardous materials are contained in Section VIII, Division 1, of the BPVC, which sets forth requirements for unfired pressure vessels with design pressures up to 3,000 pounds per square inch gauge (psig) (20 685 kPa). For pressures over 3,000 psig (20 685 kPa), the alternative design rules in Division 2 or 3 of BPVC Section VIII must be applied. Pressure vessels are not listed by nationally recognized testing laboratories. Instead, when a pressure vessel is fabricated in accordance with the BPVC, the fabricator will employ an authorized inspector to perform examinations of the vessel to ensure it is constructed in accordance with the BPVC and the approved design drawings. The authorized inspector also verifies the proper materials of construction are selected, that welders have the appropriate certifications based on the welding methods used and that welds are performed in accordance with the approved welding procedures. The BPVC requires that all pressure vessels be equipped with a nameplate welded at a conspicuous location directly onto the shell of the vessel (or



**Figure 202-P1**  
**INSULATED HORIZONTAL PRESSURE VESSEL**

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onto a welded bracket if the pressure vessel will be insulated) that demonstrates the vessel was constructed in accordance with the requirements of ASME. In addition to the pressure vessel's nameplate, ASME also requires that a Manufacturer's Data Report for Pressure Vessels (ASME Form U-1) be prepared by the manufacturer to document the construction of the vessel and its compliance with the applicable edition of the BPVC. It is quite common in the establishment of new construction processes to purchase and install used pressure vessels. Given the safety factors required by the BPVC, properly selected and maintained pressure vessels can easily perform for decades provided they are operated within their design temperature and pressures, and are properly designed for external loads. Fire code officials should utilize the nameplate in conjunction with ASME Form U-1 to confirm that the installed vessel is constructed to the BPVC and use this documentation to demonstrate compliance with Section 5003.2.1. Pressure vessels that are not equipped with a nameplate should not be approved unless they are evaluated by a qualified engineer. In such instances, a technical report and opinion should be obtained in accordance with Section 104.7.2.



Figure 202-P2  
VERTICAL PRESSURE VESSEL

**PRIMARY CONTAINMENT.** The first level of containment, consisting of the inside portion of that container which

comes into immediate contact on its inner surface with the material being contained.

- ❖ In most cases, this definition pertains to those components of tanks, portable tanks and containers that are the main mechanism for the containment of liquid (the basic walls of the tank, portable tank or container). The term "secondary containment" refers to the containment provided when the primary containment fails.

**[BG] PRIVATE GARAGE.** A building or portion of a building in which motor vehicles used by the tenants of the building or buildings on the premises are stored or kept, without provisions for repairing or servicing such vehicles for profit.

- ❖ In Section 406 of the IBC, the code regulates two types of garages: private and public. Public garages are further separated into open or enclosed garages. Private garages are limited in size by Section 406.3 of the IBC and can be accessory to either residential or nonresidential uses. The definition is intended to help distinguish private garages from public garages. Carports are also addressed in Section 406.3 of the IBC.

**PROCESS TRANSFER.** The transfer of flammable or *combustible liquids* between tank vehicles or tank cars and process operations. Process operations may include containers, tanks, piping and equipment.

- ❖ The transfer of flammable or combustible liquids during any process operation may include the introduction of the flammable or combustible liquids into or within the process operation.

**PROPELLANT.** The liquefied or *compressed gas* in an aerosol container that expels the contents from an aerosol container when the valve is actuated. A propellant is considered flammable if it forms a flammable mixture with air, or if a flame is self-propagating in a mixture with air.

- ❖ The amount of flammable propellant content is important in properly classifying aerosol products, since it affects the overall chemical heat of combustion value. Common flammable propellants are hydrocarbons, such as butane, propane, isobutane or a combination of these.

**PROXIMATE AUDIENCE.** An audience closer to pyrotechnic devices than allowed by NFPA 1123.

- ❖ The separation distance of the pyrotechnic devices and the audience permitted by NFPA 1123 is in relationship to the shell size of the mortar. NFPA 1126 addresses the requirements for proximate audiences.

**[B] PSYCHIATRIC HOSPITALS.** See "Hospitals."

**PUBLIC TRAFFIC ROUTE (PTR).** Any public street, road, highway, navigable stream or passenger railroad that is used for through traffic by the general public.

- ❖ See the commentary to the definition of "Quantity-Distance (Q-D)."

**[BE] PUBLIC-USE AREAS.** Interior or exterior rooms or spaces that are made available to the general public.

❖ This term is utilized to describe all interior and exterior spaces or rooms that may be occupied by the general public for any amount of time. Spaces that are utilized by the general public may be located in facilities that are publicly or privately owned. Examples include the lobby in an office building, a high-school gymnasium with assembly seating, an open-air stadium, a multipurpose room, an exposition hall, a restaurant dining room, a health club, etc. (see also the commentary to the definitions of “Common use” and “Employee work area”).

**[A] PUBLIC WAY.** A street, alley or other parcel of land open to the outside air leading to a street, that has been deeded, dedicated or otherwise permanently appropriated to the public for public use and which has a clear width and height of not less than 10 feet (3048 mm).

❖ The public way marks the termination of the exit discharge portion of the means of egress system. It is the final destination for occupants, and is presumed to be safe from the emergency occurring in the structure or it will directly connect to other routes so that occupants can move a distance away from the danger. The 10-foot (3048 mm) width is consistent with the exit discharge requirements in Section 1028.

**PYROPHORIC.** A chemical with an autoignition temperature in air, at or below a temperature of 130°F (54°C).

❖ The definition is derived from DOL 29 CFR Part 1910.1200. Pyrophoric materials, whether in a gas, liquid or solid form, are capable of spontaneous ignition at low temperatures. Pyrophoric materials, regardless of their physical state, may spontaneously ignite when exposed to air at normal or slightly elevated temperatures, even in small quantities. Many pyrophoric materials are also highly reactive with water. While even moist air may increase the possibility of ignition, the application of water may cause an explosive reaction (see commentary, Chapter 67).

**PYROTECHNIC ARTICLE.** A pyrotechnic device for use in the entertainment industry, which is not classified as fireworks.

❖ This definition refers to articles containing substances or a mixture of substances designed to produce heat, light, sound or smoke or a combination of such effects for theatrical purposes.

**PYROTECHNIC COMPOSITION.** A chemical mixture that produces visible light displays or sounds through a self-propagating, heat-releasing chemical reaction which is initiated by ignition.

❖ This definition parallels the definition in NFPA 1124, referenced in Section 5605.1. The term is used in the definition of “Display, 1.3G fireworks,” and is the basis for establishing the allowable amounts in Table 5604.3.

**PYROTECHNIC SPECIAL EFFECT.** A visible or audible effect for entertainment created through the use of pyrotechnic materials and devices.

❖ Pyrotechnic special effects are widely used in motion-picture production to create all types of effects involving explosions, fires, light, smoke and sound concussions. The types of pyrotechnic materials used include flash powder, flash paper, gun cotton, black powder (gunpowder), smokeless powder, detonator explosives and many more. They are used in bullet hits (squibs), blank cartridges, flash pots, fuses, mortars, smoke pots, sparkle pots, etc.

The main problems of pyrotechnics include prematurely triggering the pyrotechnic effect; use of larger quantities or more dangerous materials than needed; causing a fire; lack of adequate fire-extinguishing capabilities and, of course, inadequately trained and experienced pyrotechnic operators. As a result of these risks, all pyrotechnic special effects are regulated at the federal, state and local level.

**PYROTECHNIC SPECIAL-EFFECT MATERIAL.** A chemical mixture used in the entertainment industry to produce visible or audible effects by combustion, *deflagration* or *detonation*. Such a chemical mixture predominantly consists of solids capable of producing a controlled, self-sustaining and self-contained exothermic chemical reaction that results in heat, gas sound, light or a combination of these effects. The chemical reaction functions without external oxygen.

❖ Pyrotechnic special effects materials are Division 1.3 explosives. They will burn but not explode, unless confined. Examples are black powder and pellet powder, safety fuses, igniters, igniter cord, fuse lighters, Division 1.3 special fireworks and Division 1.3 composite solid propellants.

**PYROTECHNICS.** Controlled exothermic chemical reactions timed to create the effects of heat, hot gas, sound, dispersion of aerosols, emission of visible light or a combination of such effects to achieve the maximum effect from the least volume of pyrotechnic composition.

❖ This definition describes special devices that are used to create entertainment, exhibition, demonstration or simulation through the controlled use of flame, sounds, aerosols or other special effects before a proximate audience (see Section 5608 and NFPA 1126).

**QUANTITY-DISTANCE (Q-D).** The quantity of *explosive material* and separation distance relationships providing protection. These relationships are based on levels of risk considered acceptable for the stipulated exposures and are tabulated in the appropriate Q-D tables. The separation distances specified afford less than absolute safety:

**Inhabited building distance (IBD).** The minimum separation distance between an operating building or magazine containing *explosive materials* and an inhabited building or site boundary.

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**Intermagazine distance (IMD).** The minimum separation distance between magazines.

**Intraline distance (ILD) or Intraplant distance (IPD).** The distance to be maintained between any two operating buildings on an *explosives* manufacturing site when at least one contains or is designed to contain *explosives*, or the distance between a magazine and an operating building.

**Minimum separation distance ( $D_o$ ).** The minimum separation distance between adjacent buildings occupied in conjunction with the manufacture, transportation, storage or use of *explosive materials* where one of the buildings contains *explosive materials* and the other building does not.

- ❖ This definition (with subdefinitions) correlates with tables to be used for distance determination, and also with the terminology used by those engaged in the storage and manufacture of explosive materials as well as with the regulators of these materials, including the DOD. The term is also consistent with terminology used by the DOD and the IME. The terms will bring a consistent set of terminologies to the code.

The definition “Quantity-Distance (Q-D)” is the relationship between a quantity of explosive material and the minimum separation distances required. The use of Q-D relationships to establish building siting is fundamentally used in the planning and occupancy of buildings used to contain explosive materials. Section 5601.2.3 (permit restrictions) authorizes the fire code official to limit the quantity of explosives at any given location. The limitations on quantity are typically derived based on the location of the explosives. The distances required vary depending on the sensitivity of the receptor. Distances are generally greater where the public or those not engaged in the manufacturing process are involved.

The subelements of the definition include terms that typically appear (or should appear) on building and site plans that are used to confirm that the siting for the structure used to contain the explosive material (building or magazine) is properly located. Acronyms (e.g., IBD, ILD, IMD, etc.) are typically used to describe the distance used to separate the explosives from receptors such as inhabited buildings, public traffic or transportation routes (highways), other storage (magazines) and the like.

Notwithstanding the tabular distance established by the Q-D tables integral to the explosives industry, there are occasions where ancillary buildings are needed to be constructed that do not contain explosive materials per se, where the ancillary building will encroach on the building containing explosive materials.  $D_o$  is a fire separation distance, and not unlike that used by the IBC to determine the location of “detached buildings.” As the buildings regulated by the Q-D tables are required to be detached, a minimum separation distance is established. This distance is noted in Tables 5601.8.1(1) through 5601.8.1(3) with 50 feet (15 240 mm) established as

the minimum for buildings containing materials with mass fire and fire hazards, and 60 feet (18 288 mm) established as the minimum for buildings containing materials with mass explosion hazards. From a practical standpoint, the  $D_o$  distances will apply only to facilities where the explosive quantities are near the minimums as the distances are increased rapidly with increases in material content.

The term “intraline” is used in this chapter in the definition of “Operating, building,” and in Note a to Table 5605.3. The term “intraline distance (ILD)” (intra = within the line) is used synonymously with intraplant distance (IPD), although there are differences applied on military sites for the purpose of separating different operating lines. For example, on military sites, it is common to separate one operating line from another by the inhabited building distance. On the other hand, on commercial sites, it is common to produce multiple product lines within an associated building group and to separate the various buildings within the group by IPD. By equating the terms “IPD” and “ILD,” commercial uses are provided with a level of protection that is designed to address building safety that is not product specific, but is designed to address the explosive nature of materials involved.

The term “intraplant” is used in the title of Section 5605.3, Table 5605.3 and in the definition of “Operating building.” It is a unique term, and as such requires the supporting definition included here.

**RAILWAY.** A steam, electric or other railroad or railway that carries passengers for hire.

- ❖ The definition of “Railway” is intended to minimize the exposure of passengers to danger if an explosion occurs involving an explosives magazine.

**[BE] RAMP.** A walking surface that has a running slope steeper than one unit vertical in 20 units horizontal (5-percent slope).

- ❖ This definition is needed to determine the threshold at which the ramp requirements apply to a walking surface. Walking surfaces steeper than specified in the definition are subject to the ramp requirements in Sections 1012 and 1029.

**RAMP, EXIT ACCESS.** See “Exit access ramp.”

**RAMP, EXTERIOR EXIT.** See “Exterior exit ramp.”

**RAMP, INTERIOR EXIT.** See “Interior exit ramp.”

**RAW PRODUCT.** A mixture of natural materials such as tree, brush trimmings, or waste logs and stumps.

**READY BOX.** A weather-resistant container with a self-closing or automatic-closing cover that protects fireworks shells from burning debris. Tarpaulins shall not be considered as ready boxes.

- ❖ After delivery and prior to the display, shells must be separated according to size and their designation as salutes. Any display fireworks that will be temporarily stored at the display site during the fireworks display must be stored in ready boxes separated according to size and their designation as salutes.

**[A] RECORD DRAWINGS.** Drawings (“as built”) that document the location of all devices, appliances, wiring, sequences, wiring methods and connections of the components of a fire alarm system as installed.

- ❖ To verify that the system has been installed to comply with the code and applicable referenced standards, complete as-built drawings of the fire alarm system must be available on site for review.

**RECREATIONAL FIRE.** An outdoor fire burning materials other than rubbish where the fuel being burned is not contained in an incinerator, outdoor fireplace, portable outdoor fireplace, barbeque grill or barbeque pit and has a total fuel area of 3 feet (914 mm) or less in diameter and 2 feet (610 mm) or less in height for pleasure, religious, ceremonial, cooking, warmth or similar purposes.

- ❖ This kind of fire includes ordinary campfires and other small fires used for the activities listed. The definition has also been revised to clarify that the use of portable outdoor fireplaces (also known as patio fireplaces) is specifically included thus eliminating the confusion that previously existed as to how to treat those devices. See also the definition of “Open burning.”

**REDUCED FLOW VALVE.** A valve equipped with a restricted flow orifice and inserted into a *compressed gas* cylinder, portable tank or stationary tank that is designed to reduce the maximum flow from the valve under full-flow conditions. The maximum flow rate from the valve is determined with the valve allowed to flow to atmosphere with no other piping or fittings attached.

- ❖ This is a valve that allows the maximum flow rate from a container to be reduced. For the reduction to be accurate, the maximum flow rate of a container must be known. The maximum flow rate must be determined without any piping or fittings attached to the container. This ensures that the reduction valve can actually achieve what is intended.

**REFINERY.** A plant in which flammable or *combustible liquids* are produced on a commercial scale from crude petroleum, natural gasoline or other hydrocarbon sources.

- ❖ A refinery is the facility that produces flammable or combustible liquids from raw materials.

**REFRIGERANT.** The fluid used for heat transfer in a refrigeration system; the refrigerant absorbs heat and transfers it at a higher temperature and a higher pressure, usually with a change of state.

- ❖ The refrigerant is the working fluid in refrigeration and air-conditioning systems. In vapor refrigeration cycles, refrigerants absorb heat from the load side at the evaporator and reject heat at the condenser. Aside from having suitable thermodynamic properties, the selection of a refrigerant must also take into consideration chemical stability, flammability, toxicity and environmental compatibility. Refrigeration is a result of the physical laws of vaporization (evaporation) of liquids. Basically, evaporation of liquid refrigerant is an endothermic process and condensing of vapors is an exothermic process.

erant is an endothermic process and condensing of vapors is an exothermic process.

**[M] REFRIGERATING (REFRIGERATION) SYSTEM.** A combination of interconnected refrigerant-containing parts constituting one closed refrigerant circuit in which a refrigerant is circulated for the purpose of extracting heat.

- ❖ Such systems include, at minimum, a pressure-imposing element or generator, an evaporator, a condenser and interconnecting piping. A single piece of equipment can contain multiple refrigeration systems (circuits).

**[A] REGISTERED DESIGN PROFESSIONAL.** An architect or engineer, registered or licensed to practice professional architecture or engineering, as defined by the statutory requirements of the professional registration laws of the state in which the project is to be constructed.

- ❖ This term is used throughout the code where a special level of expertise and knowledge is required. The definition clearly notes that each state defines its own professional registration laws. Legal qualifications for engineers and architects are established by the state having jurisdiction. Licensing and registration of engineers and architects are accomplished by written or oral examinations offered by states or by reciprocity (licensing in other states).

**[BG] RELIGIOUS WORSHIP, PLACE OF.** A building or portion thereof intended for the performance of religious services.

- ❖ This term has been added to the code for the purpose of making the code more broadly applicable to the worship facilities of all religions. Major religions for the world include Christianity, Islam, Hinduism, Buddhism and Judaism, which use different terms to describe the main space used for religious services. The intent in the code is for the same application for all similar types of religious facilities. The term also makes it clear that it defines the room or sanctuary for the performance of religious worship services and not retreat complexes, rectories, convents and classroom or office areas.

**REMOTE EMERGENCY SHUTOFF DEVICE.** The combination of an operator-carried signaling device and a mechanism on the tank vehicle. Activation of the remote emergency shutoff device sends a signal to the tanker-mounted mechanism and causes fuel flow to cease.

- ❖ This definition describes an important safety device used in the mobile fueling operation regulated by Section 5706.5.4.5 and describes a portable device that a tank vehicle driver may use to prevent an overfill spill during mobile fueling when the driver is out of immediate reach of the tanker shutoff controls (see commentary, Section 5706.5.4.5).

**REMOTE SOLVENT RESERVOIR.** A liquid solvent container enclosed against evaporative losses to the atmosphere during periods when the container is not being utilized, except for a solvent return opening not larger than 16 square

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inches (10 322 mm<sup>2</sup>). Such return allows pump-cycled used solvent to drain back into the reservoir from a separate solvent sink or work area.

- ❖ A remote solvent reservoir is the storage of flammable or combustible liquid in a container that is not in the same control area as the machine using the flammable or combustible liquid. The remote solvent reservoir is connected to the machine by piping or tubing.

**REMOTELY LOCATED, MANUALLY ACTIVATED SHUTDOWN CONTROL.** A control system that is designed to initiate shutdown of the flow of gases or liquids that is manually activated from a point located some distance from the delivery system.

- ❖ See the commentary to the definitions for “Emergency shutoff valves.”

**REPAIR GARAGE.** A building, structure or portion thereof used for servicing or repairing motor vehicles.

- ❖ A repair garage may be part of a motor fuel-dispensing facility. The fuel-dispensing area will comply with the motor fuel-dispensing facility sections of this chapter and the repair garage area will comply with the repair garage section (see Section 2311) of this chapter. A marine pleasure craft dealership with a boat repair area will be classified as a repair garage. Motor vehicle repair garages are classified in occupancy Group S-1 by the IBC.

**RESIN APPLICATION AREA.** An area where reinforced plastics are used to manufacture products by hand lay-up or spray-fabrication methods.

- ❖ Glass fiber is used for reinforcement of plastics or polymers, and the resulting products are typically called glass fiber reinforced plastics or polymers (GFRP). It is common to use the acronym FRP (fiber reinforced polymers), which is applicable to all fiber-reinforced plastics or polymers.

**RESPONSIBLE PERSON.** A person trained in the safety and fire safety considerations concerned with hot work. Responsible for reviewing the sites prior to issuing permits as part of the hot work permit program and following up as the job progresses.

- ❖ This is the person designated to administer the hot work program (see that term’s definition in this section) in Section 3503. Without this definition, the term “responsible person” is a vague descriptor. The definition includes the scope of responsibilities for this person.

**RETAIL DISPLAY AREA.** The area of a Group M occupancy open for the purpose of viewing or purchasing merchandise offered for sale. Individuals in such establishments are free to circulate among the items offered for sale which are typically displayed on shelves, racks or the floor.

- ❖ Products containing aerosol propellants range from hair spray to paint to pesticides, lubricants and adhesives. Most often, products of this kind are grouped on shelves, but may also be set out in aisle displays

of stacked cartons with the top carton being “display cut” to show the product. A display cut carton, according to Section 3.3.26.2 of NFPA 30B, is a type of packaging in which the top and portions of the sides and front of the carton are removed to expose the product to the consumer.

**ROLL COATING.** The process of coating, spreading and impregnating fabrics, paper or other materials as they are passed directly through a tank or trough containing flammable or *combustible liquids*, or over the surface of a roller revolving partially submerged in a flammable or *combustible liquid*.

- ❖ Roll-coating methods apply material to flat work pieces, usually paper, cardboard, cloth or thin metals, using liquid-coated cylinders or rollers. Coating material may be applied to the rollers by rotating them in an open trough or pan or applying liquid to the space between two rollers. Please note that for this term to apply anywhere in the code, the tank or trough must contain flammable or combustible liquids.

The requirements in this chapter are for protection against, and mitigation in case of, a fire. In this case, the flammable vapors are typically heavier than air and may travel and spread a long distance unnoticed before reaching a potential ignition source and causing a vapor explosion or fire. In case of a fire within the tank or trough, there are additional concerns. The liquids are typically not water miscible and may overflow when the sprinkler system is activated or during the manual fire-fighting stages. This could spread the fire and liquids even farther.

**RUBBISH (TRASH).** Combustible and noncombustible waste materials, including residue from the burning of coal, wood, coke or other combustible material, paper, rags, cartons, tin cans, metals, mineral matter, glass crockery, dust and discarded refrigerators, and heating, cooking or incinerator-type appliances.

- ❖ The term “rubbish” is normally associated with combustible waste. In this code the term is much broader and would include noncombustible waste, such as metals. Generally, the scope of this definition includes anything that has been discarded.

**SAFETY CAN.** An *approved* container of not more than 5-gallon (19 L) capacity having a spring-closing lid and spout cover so designed that it will relieve internal pressure when subjected to fire exposure.

- ❖ Safety cans are commonly used where limited quantities of flammable and combustible liquids are required for manufacturing or research. The basic purpose of a safety can is to provide a safe and convenient means of transporting, dispensing and storing up to 5 gallons (19 L) of flammable and combustible liquids. All listed safety cans, regardless of material of construction, are required to be constructed as leak-tight containers. They must automatically vent any vapor if subjected to fire exposure at a pressure of 3 to 5 psig (20 685 to 34 475 kPa gauge) to prevent the container from being subjected to a deflagration

resulting from the increased vapor pressure of the liquid. Openings on safety cans must close automatically after being filled or dispensing a liquid. Finally, all listed safety cans must be designed so that a two-dimensional fire that could occur during dispensing cannot reach the pour opening and potentially extend into the safety can. This is commonly prevented by installing a flame arrestor in the container's inlet and outlet openings.

UL (Underwriters Laboratories) lists safety cans using UL 30 for metallic cans and UL 1313 for non-metallic cans. Factory Mutual (FM) Global also issues listings and approvals for metallic and nonmetallic safety cans. UL and FM both limit the volume of metallic safety cans to 5 gallons (19 L) or less—non-metallic safety cans are permitted to have a volume of 6.6 gallons (25 L). UL assigns a designation to safety cans based on the number of openings at the top of the container and container appurtenances. A Type I safety can, as shown in Commentary Figure 202-S1, is commonly a single-spout can designed for filling containers or tanks with large receiving openings. A Type II safety can, as shown in Commentary Figure 202-S2, has an integral flexible dispensing hose to control the transfer of the liquid. These safety cans have a second opening that serves as a pressure-vacuum vent which is also used to fill the safety can with liquid. Also see the commentary to Table 5003.1.1(1) and Section 5003.9.10.

**[BE] SCISSOR STAIRWAY.** Two interlocking *stairways* providing two separate paths of egress located within one *exit* enclosure.

- ❖ A scissor or interlocking stairway is sometimes used in high-rise buildings or to increase exit capacity of a stairwell enclosure. In this configuration, two independent stairway paths are located within the same exit

enclosure and may or may not be visually open to one another. When interlocking stairways are separated from each other with compliant fire barriers and horizontal assemblies, they are not considered scissor stairways (see Section 1007.1.1).

**SECONDARY CONTAINMENT.** That level of containment that is external to and separate from primary containment.

- ❖ If a spill or leak from the primary means of containment occurs, an additional level of containment may be necessary to isolate the hazardous materials from adjoining areas or the environment.

**SEED COTTON.** See “Cotton.”

**SEGREGATED.** Storage in the same room or inside area, but physically separated by distance from *incompatible materials*.

- ❖ The mixture of two or more chemicals can create a toxic or explosive chemical that is more dangerous than any of the individual chemicals. When chemicals are stored in the same room or storage area it is important to segregate them either by distance or by curbs that will prevent the chemicals from mixing in the case of a discharge.

**[BF] SELF-CLOSING.** As applied to a fire door or other opening, means equipped with an *approved* device that will ensure closing after having been opened.

- ❖ A self-closing opening protective refers to a fire or smoke door assembly equipped with a listed closer for doors that must be maintained in the normally closed position. When the door is opened and released, the self-closing feature returns the door to the closed position. It is important to distinguish between the terms “self-closing” and “automatic closing” because they are not interchangeable. “Automatic closing” refers to an opening protective that is



**Figure 202-S1  
TYPE I SAFETY CAN**  
Photo courtesy of  
Justrite Manufacturing Co., LLC, Des Plaines, IL



**Figure 202-S2  
TYPE II SAFETY CAN**  
Photo courtesy of  
Justrite Manufacturing Co., LLC, Des Plaines, IL

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normally in the open position (see Section 716.5.9.2 of the IBC). Opening protectives with automatic closers are often held open and then returned to the closed position upon activation of fire detectors or smoke detectors or loss of power, which automatically releases the hold-open device allowing the door to close.

**[BE] SELF-LUMINOUS.** Illuminated by a self-contained power source, other than batteries, and operated independently of external power sources.

❖ Self-luminous products do not need an outside light source to charge them like photoluminescent materials do. Products utilized to meet the requirements for luminous egress path markings in high-rise buildings (see Section 403.5.5 of the IBC and Section 1025) or exit signs (see Section 1011.5) may be photoluminescent or self-luminous. A variety of materials can comply with the referenced standards, for egress path markings—UL 1994 and ASTM E2072—and for signs—UL 924.

**SELF-PRESERVATION, INCAPABLE OF.** See “Incapable of self-preservation.”

**SELF-SERVICE MOTOR FUEL-DISPENSING FACILITY.** That portion of motor fuel-dispensing facility where liquid motor fuels are dispensed from fixed *approved* dispensing equipment into the fuel tanks of motor vehicles by persons other than a motor fuel-dispensing facility attendant.

❖ A self-service motor fuel-dispensing facility may be attended or, with the approval of the fire code official, unattended. A self-service motor fuel-dispensing facility is a facility where the fuel is dispensed by

someone other than an employee of the facility operator. Motor fuel-dispensing facilities are classified in occupancy Group M by the IBC.

**SEMICONDUCTOR FABRICATION FACILITY.** A building or a portion of a building in which electrical circuits or devices are created on solid crystalline substances having electrical conductivity greater than insulators but less than conductors. These circuits or devices are commonly known as semiconductors.

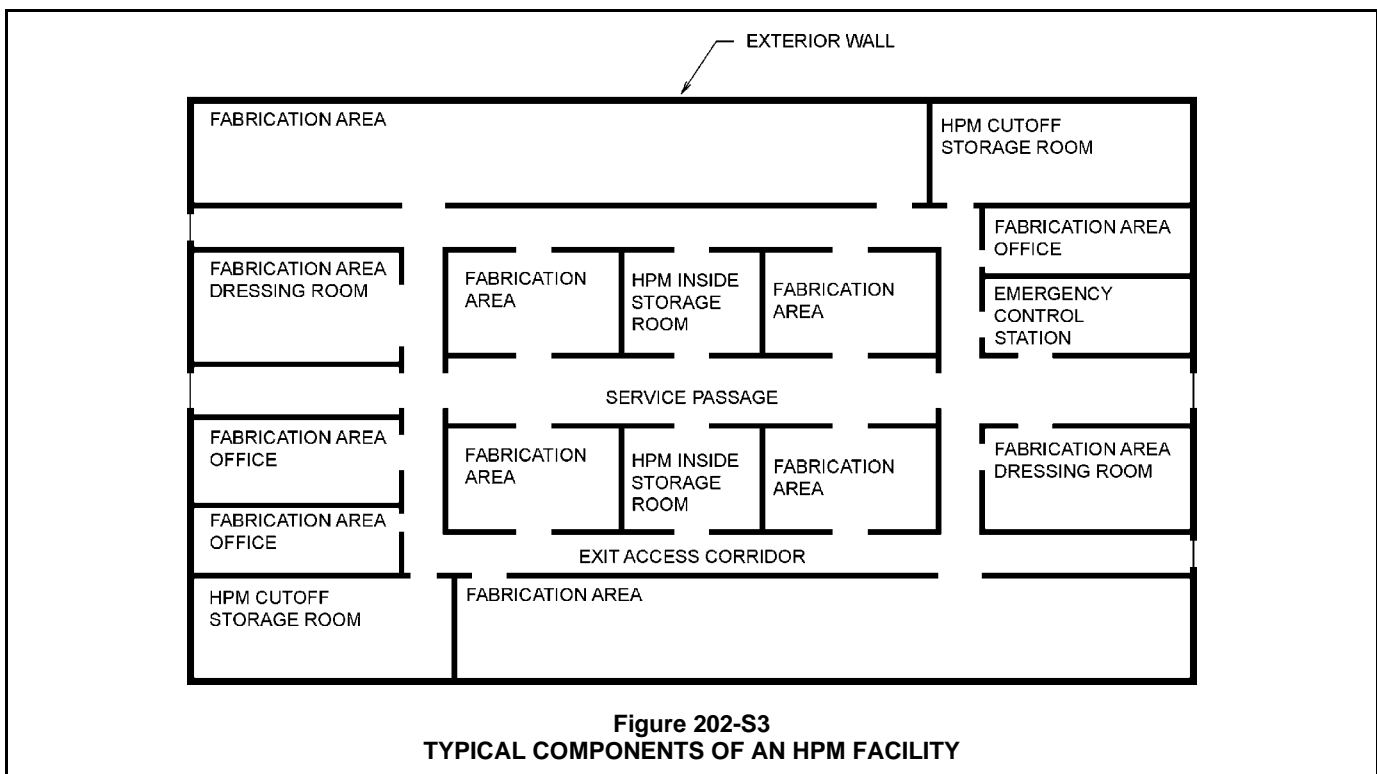
❖ A semiconductor fabrication facility is a building or a portion of a building where semiconductors are produced. See Commentary Figure 202-S3 for an example of a typical floor plan of a semiconductor fabrication facility.

**SERVICE CORRIDOR.** A fully enclosed passage used for transporting HPM and purposes other than required *means of egress*.

❖ Though HPM facility occupants may be exposed to limited HPM quantities during the course of their employment, their means of egress are protected from the HPM hazards by confining the HPM being transferred to its own passageway. A service corridor is required only when the HPM must be carried from a storage room or external area to a fabrication area through a passageway.

**SHELF STORAGE.** Storage on shelves less than 30 inches (762 mm) deep with the distance between shelves not exceeding 3 feet (914 mm) vertically. For other shelving arrangements, see the requirements for rack storage.

❖ To be considered shelf storage, the shelving must be no deeper than 30 inches (762 mm) and must be sep-



**Figure 202-S3**  
**TYPICAL COMPONENTS OF AN HPM FACILITY**

arated by no more than 3 feet (914 mm) vertically. Further, shelf storage units must be separated horizontally by aisles not less than 30 inches (762 mm) wide to reduce the transfer of fire from one shelf unit across the aisle to another. The aisles also allow convenient access for fire department personnel to combat a fire and for salvage and debris removal after an incident.

**SINGLE-STATION SMOKE ALARM.** An assembly incorporating the detector, the control equipment and the alarm-sounding device in one unit, operated from a power supply either in the unit or obtained at the point of installation.

❖ A single-station smoke alarm is a self-contained alarm device that detects visible or invisible particles of combustion. Its function is to detect a fire in the immediate area of the detector location. Single-station smoke alarms are individual units with the capability to stand alone. Where the single-station smoke alarms are interconnected with other single-station devices they would be considered a multiple-station smoke alarm system. Single-station smoke alarms are not capable of notifying or controlling any other fire protection equipment or systems. They may be battery powered, directly connected to the building power supply or a combination of both. Single-station smoke alarms must be built to comply with UL 217 and are to be installed as required by Section 907.2.11.

**[BG] SITE.** A parcel of land bounded by a *lot line* or a designated portion of a public right-of-way.

❖ This definition establishes, for application of code requirements, the property within the boundaries of the site that is under the control of the owner. The owner can be held responsible for code compliance of the site and all facilities on it. Note that legal property lines do not always constitute site boundaries (i.e., malls, condominiums, townhouses). A site could contain multiple legal “lot” divisions.

**[BG] SITE-FABRICATED STRETCH SYSTEM.** A system, fabricated on site and intended for acoustical, tackable or aesthetic purposes, that is composed of three elements:

1. A frame constructed of plastic, wood, metal or other material used to hold fabric in place;
2. A core material (infill, with the correct properties for the application); and
3. An outside layer, comprised of a textile, fabric or vinyl, that is stretched taut and held in place by tension or mechanical fasteners via the frame.

❖ Site-fabricated stretch systems are interior finish materials that are pulled taut across walls or ceilings with a frame that holds a fabric and core. These systems are now being used extensively because they can stretch to cover decorative walls and ceilings with unusual looks and shapes. The systems consist of three parts: a fabric (or vinyl), a frame and an infill core material. This type of product is not exclusive to

any particular manufacturer. It is important to point out that these materials are not curtains or drapes because they are not free hanging like curtains. See the commentary to Section 803.10.

**SKY LANTERN.** An unmanned device with a fuel source that incorporates an open flame in order to make the device airborne.

❖ This definition coordinates with Section 308.1.6, which prohibits the use of sky lanterns. This definition simply clarifies what is considered a sky lantern. Sky lanterns have the potential to start structure fires and wildfires. The two aspects of sky lanterns that are cause for concern are the open flame and that they freely float in the air without the ability for control from the ground. Typically they are also made of combustible materials such as paper.

**[BG] SLEEPING UNIT.** A room or space in which people sleep, which can also include permanent provisions for living, eating, and either sanitation or kitchen facilities but not both. Such rooms and spaces that are also part of a *dwelling unit* are not sleeping units.

❖ This definition is included to coordinate the Fair Housing Act Guidelines with the code. The definition for “Sleeping unit” clarifies the differences between sleeping units and dwelling units. In addition, using the term “sleeping unit” for spaces where people sleep will replace a multitude of other terms (i.e., patient room, cell, guest room) so that there is consistent application across occupancies. Some examples of sleeping units are hotel guestrooms, dormitories, bedrooms in boarding houses, patient sleeping rooms in hospitals, nursing homes or assisted living facilities, or housing cells in a jail. Another example would be a studio apartment with a kitchenette (i.e., countertop microwave, sink, refrigerator). Since the cooking arrangements are not the traditional permanent appliances (i.e., a cooktop, range or oven), this configuration would be considered a sleeping unit, and not a dwelling unit. As defined in the code, a dwelling unit must contain permanent facilities for living, sleeping, eating, cooking and sanitation.

**SMALL ARMS AMMUNITION.** A shotgun, rifle or pistol cartridge and any cartridge for propellant-actuated devices. This definition does not include military ammunition containing bursting charges or incendiary, trace, spotting or pyrotechnic projectiles.

❖ Small arms ammunition consists of cylindrical casings containing a small amount of smokeless powder. These items are usually designed to propel a missile or bullet at a target, but they may also be used in explosive actuated devices, such as nail guns and riveters. Individual cartridges are typically packed in paperboard boxes shipped in cardboard cartons. In a fire, these articles pose no mass detonation hazard and only a moderate (low-velocity) projectile hazard. The ATF definition of “Ammunition” also includes percussion caps and  $\frac{3}{32}$ -inch (2.4 mm) and other external burning pyrotechnic hobby fuses. Black powder

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ammunition and black powder are not included in this definition.

**SMALL ARMS PRIMERS.** Small percussion-sensitive *explosive* charges, encased in a cap, used to ignite propellant powder.

❖ “Small arm primers” and “percussion caps” mean primers used for small arms ammunition.

**SMOKE ALARM.** A single- or multiple-station alarm responsive to smoke. See also “Single-station smoke alarm” and “Multiple-station smoke alarm.”

❖ This is a general term that applies to both single- and multiple-station smoke alarms that are not part of an automatic fire detection system. It is the generic term for any device that both detects the products of combustion and initiates an alarm signal for occupant notification.

**[BF] SMOKE BARRIER.** A continuous membrane, either vertical or horizontal, such as a wall, floor, or ceiling assembly, that is designed and constructed to restrict the movement of smoke.

❖ A smoke barrier is a fire-resistance-rated assembly that is different from a fire partition, fire barrier or fire wall. Smoke barriers include walls and floor/ceiling assemblies that are constructed with a 1-hour fire-resistance rating and are one of the components in a smoke compartment. In Group I-2 and I-3 occupancies, smoke barriers are intended to create adjacent smoke compartments to which building occupants can be safely and promptly relocated during a fire, thus preventing the need to have complete and immediate egress from the building. For these occupancies, complete egress from the building would not be practical in most cases, due to restrictions on the mobility of the occupants. To maintain tenability in the adjacent smoke compartment, the smoke barrier is therefore intended to resist the spread of fire and hinder the movement of smoke. Smoke barriers are also used to compartment a building into separate smoke control zones when using the provisions of Section 909. The construction requirements for a smoke barrier provide resistance to the transmission of smoke.

**[BG] SMOKE COMPARTMENT.** A space within a building enclosed by *smoke barriers* on all sides, including the top and bottom.

❖ Smoke compartments create spaces that protect occupants from the products of combustion produced by a fire in an adjacent smoke compartment and to restrict smoke to the compartment of fire origin.

**[BF] SMOKE DAMPER.** A *listed* device installed in ducts and air transfer openings designed to resist the passage of smoke. The device is installed to operate automatically, controlled by a smoke detection system, and where required, is capable of being positioned from a *fire command center*.

❖ Similar to a fire damper, smoke dampers are intended to restrict the passage of smoke through ducts or openings in structural assemblies such as

smoke barriers and corridor walls. They are also installed in smoke control systems. The smoke leakage rates of these devices are used to classify them in accordance with UL 555S. See also the commentary to the definitions of “Damper” and “Fire damper.”

**SMOKE DETECTOR.** A *listed* device that senses visible or invisible particles of combustion.

❖ These devices are considered early warning devices and have saved many people from smoke inhalation and burns. Smoke detectors have a wide range of uses, from sophisticated fire detection systems for industrial and commercial uses to residential. A smoke detector is a device, typically listed in accordance with UL 268, that activates a fire alarm system. These system smoke detectors contain only the components required to detect the products of combustion and activate a fire alarm system and are, therefore, different from single- and multiple-station smoke alarms.

Smoke detectors typically consist of two types: ionization and photoelectric. An ionization detector contains a small amount of radioactive material that ionizes the air in a sensing chamber and causes a current to flow through the air between two charged electrodes. When smoke enters the chamber, the particles cause a reduction in the current. When the level of conductance decreases to a preset level, the detector responds with an alarm.

A photoelectric smoke detector consists primarily of a light source, a light beam and a photosensitive device. When smoke particles enter the light beam, they reduce the light intensity in the photosensitive device. When obscuration reaches a preset level, the detector initiates an alarm.

**[BG] SMOKE-DEVELOPED INDEX.** A comparative measure, expressed as a dimensionless number, derived from measurements of smoke obscuration versus time for a material tested in accordance with ASTM E 84.

❖ The ASTM E84 test method of measuring the density of smoke emitted from combustible materials determines the smoke-developed index. This value is only comparative and provides only a relative understanding of smoke generation potential. The smoke-developed index is sometimes abbreviated as SDI.

**[BE] SMOKE-PROTECTED ASSEMBLY SEATING.** Seating served by means of egress that is not subject to smoke accumulation within or under a structure.

❖ An example of smoke-protected assembly seating is an open outdoor grandstand or an indoor arena with a smoke control system. The code has less stringent requirements for certain aspects of smoke-protected assembly seating than for seating that is not smoke protected, since occupants are subject to less hazard from the accumulation of smoke and fumes during a fire event. For example, an assembly dead-end aisle is permitted to be longer for a smoke-protected assembly area. For smoke control system requirements, see Section 909.

**SMOKELESS PROPELLANTS.** Solid propellants, commonly referred to as smokeless powders, used in small arms ammunition, cannons, rockets, propellant-actuated devices and similar articles.

- ❖ This term refers to a propellant explosive from which there is little or no smoke when fired, including smokeless powder for cannons and smokeless powder for small arms.

**[BF] SMOKEPROOF ENCLOSURE.** An *interior exit stairway* designed and constructed so that the movement of the products of combustion produced by a fire occurring in any part of the building into the enclosure is limited.

- ❖ A smokeproof enclosure is intended to provide an effective barrier to the entry of smoke into an exit stairway, thereby offering an additional level of protection for occupants of high-rise and underground structures.

**SOLID.** A material that has a melting point and decomposes or sublimates at a temperature greater than 68°F (20°C).

- ❖ One of the three states of matter, solids must decompose (pyrolysis) before they can produce vapors that will support combustion. The surface area of a solid in relation to the heat source is a concern for fire fighters; the greater the surface being subjected to a heat source, the more rapid the pyrolysis.

**SOLID BIOFUEL.** Densified biomass made in the form of cubiform, polyhedral, polyhydric or cylindrical units, produced by compressing milled biomass.

- ❖ This definition coordinates with the definition of “Biomass” and the application of this term in Section 2809. Essentially these materials need to be treated the same as materials such as finished lumber. The materials are compressed biomass materials. Section 2809.4 exempts the solid biofuel inside of buildings from the fencing requirements in the same way traditional lumber is exempted. Without these terms it makes it difficult to know how to regulate such materials.

**SOLID BIOMASS FEEDSTOCK.** The basic materials of which solid biofuel is composed, manufactured or made.

- ❖ This explains the types of materials that make up solid biofuel. This clarifies how the requirements of Section 2809 are to be applied. In addition, these materials need to be treated in accordance with Section 2808 prior to becoming a “solid biofuel.” These materials are processed in agro-industrial facilities (see the definition for “Agro-industrial”).

**SOLID SHELVING.** Shelving that is solid, slatted or of other construction located in racks and which obstructs sprinkler discharge down into the racks.

- ❖ Solid shelving generally consists of nominal wood (lumber), plywood, particleboard or metal shelves that span between the supports of the storage system to support the commodities. Solid shelving creates a condition where the rack storage system is effectively divided into areas by the shelving. The shelving can

potentially act as a protective barrier for a fire and from fire service hose streams by preventing the penetration of water into the fire area. As a result, the sprinkler system design will require an in-rack sprinkler system, in addition to the ceiling sprinkler system for water distribution, to penetrate the shelving barriers.

**SOLVENT DISTILLATION UNIT.** An appliance that receives contaminated flammable or *combustible liquids* and which distills the contents to remove contaminants and recover the solvents.

- ❖ A solvent distillation unit recycles flammable and combustible liquids by the condensation and collection of the vapors that are produced as the mixture is heated. The solvent distillation unit processes waste solvents in a separate, stand-alone batch, on-line batch or continuous systems. The distillation units heat the waste solvent to its boiling point. This causes the solvent to evaporate and the solvent vapors are then condensed in a separate container. The basic components of a distillation unit are the process chamber or boiler, the encapsulated heaters, a water-cooled chamber and associated piping and instrumentation. Temperature sensors monitor the temperature and help maintain the required distillation temperature. Disposable vessel liners can be used for simple collection and disposal of still bottoms. Vacuum pumps that can distill high-boiling solvents at lower temperatures are also available. Solvent distillation units having a distillation chamber capacity of 60 gallons (227 L) or less are listed under UL 2208. Solvent distillation units having a distillation chamber capacity greater than 60 gallons (227 L) must comply with Section 5705.4.2.

**SOLVENT OR LIQUID CLASSIFICATIONS.** A method for classifying solvents or liquids according to the following classes:

**Class I solvents.** Liquids having a *flash point* below 100°F (38°C).

**Class II solvents.** Liquids having a *flash point* at or above 100°F (38°C) and below 140°F (60°C).

**Class IIIA solvents.** Liquids having a *flash point* at or above 140°F (60°C) and below 200°F (93°C).

**Class IIIB solvents.** Liquids having a *flash point* at or above 200°F (93°C).

**Class IV solvents.** Liquids classified as nonflammable.

- ❖ These dry cleaning solvent classifications parallel the flammable and combustible liquid classifications defined in Chapter 57, with a notable exception that, while flammable liquids (Class I) are divided into three subclasses (Class IA, IB and IC) based on flash point and boiling point, Class I solvents are not. Solvent classifications, on the other hand, include a classification (Class IV) for those solvents considered to be nonflammable, whereas the flammable and combustible liquid classifications have no comparable category.

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**SPECIAL AMUSEMENT BUILDING.** A building that is temporary, permanent or mobile that contains a device or system that conveys passengers or provides a walkway along, around or over a course in any direction as a form of amusement arranged so that the egress path is not readily apparent due to visual or audio distractions or an intentionally confounded egress path, or is not readily available because of the mode of conveyance through the building or structure.

❖ In general, a special amusement building is a building or portion thereof in which people gather (thus, an assembly occupancy) and in which egress is either not readily apparent due to distractions, is intentionally confounded (i.e., a maze) or is not readily available or where the occupants are moved through the building by way of a people mover system or are specifically directed through a walkway. Because of the nature of their use, these buildings contain special effects and other features that make it more difficult for occupants to determine when an emergency exists and where exits are located. The definition includes all such facilities, including portable and temporary structures. The hazard associated with such buildings is not related to the permanence or length of use; therefore, seasonal uses (such as “haunted houses” at Halloween) and portable uses (carnival attractions) are included if they meet the criteria in the definition. See also Section 411 of the IBC which regulates special amusement buildings.

**SPECIAL INDUSTRIAL EXPLOSIVE DEVICE.** An explosive power pack containing an *explosive* charge in the form of a cartridge or construction device. The term includes but is not limited to explosive rivets, explosive bolts, *explosive* charges for driving pins or studs, cartridges for *explosive*-actuated power tools and charges of *explosives* used in automotive air bag inflators, jet tapping of open hearth furnaces and jet perforation of oil well casings.

❖ Special industrial explosive devices are explosive-actuated power devices and propellant-actuated power devices. “Explosive-actuated device” means a tool or special mechanized device that is actuated by explosives. Examples of explosive-actuated power devices are jet tappers and jet perforators. “Propellant-actuated device” means a tool or special mechanized device or gas generator system that is actuated by a smokeless propellant or that releases and directs work through a smokeless propellant charge (also see commentary, Section 5601.1, Exception 6).

**SPRAY BOOTH.** A mechanically ventilated appliance of varying dimensions and construction provided to enclose or accommodate a spraying operation and to confine and limit the escape of spray vapor and residue and to exhaust it safely.

❖ Spray booths vary in construction, size and design. The definition is clear in that it can be a fully enclosed structure or it can be designed to contain the flammable or combustible vapors. An example of a fully enclosed structure is a spray booth where products are carried/carted into the booth for spraying operation and carted out once the operation is complete.

This definition, however, also allows for what is typically described as “open-face booths,” where the spray booth is enclosed on three sides and ventilated on the open side to confine the vapors to the spray booth area (see Commentary Figure 202-S4). An example of this is wood furniture finishing, where products such as wood tables are sprayed with stains and coating.

**SPRAY ROOM.** A room designed to accommodate spraying operations, constructed in accordance with the *International Building Code* and separated from the remainder of the building by a minimum 1-hour *fire barrier*.

❖ When spray booths cannot accommodate the spraying processes, because of size or for economic reasons, an entire room is dedicated to the process. In many cases, the oversprayed flammable/combustible liquids are allowed to remain on the floor until cleaned. These rooms have specific ventilation requirements to prevent the accumulation of vapors at the floor. See the commentary to Section 2404.3.1 for further discussion of spray rooms.

**SPRAYING SPACE.** An area in which dangerous quantities of flammable vapors or combustible residues, dusts or deposits are present due to the operation of spraying processes. The *fire code official* is authorized to define the limits of the spraying space in any specific case.

❖ Spraying spaces generally occur in one or a combination of three forms. The least desirable form is open floor area spraying, where the spraying area consists of an entire floor of a building without isolating the spraying operation. A better form is the spray room that isolates the spray operation by construction to less than an entire floor of the facility. The optimum form is a specially designed spray booth that isolates the operational hazards of spraying to an appropriately regulated space. Regardless of the form, all require special safeguards to address hazards, including adequate ventilation, fire suppression and management of overspray.

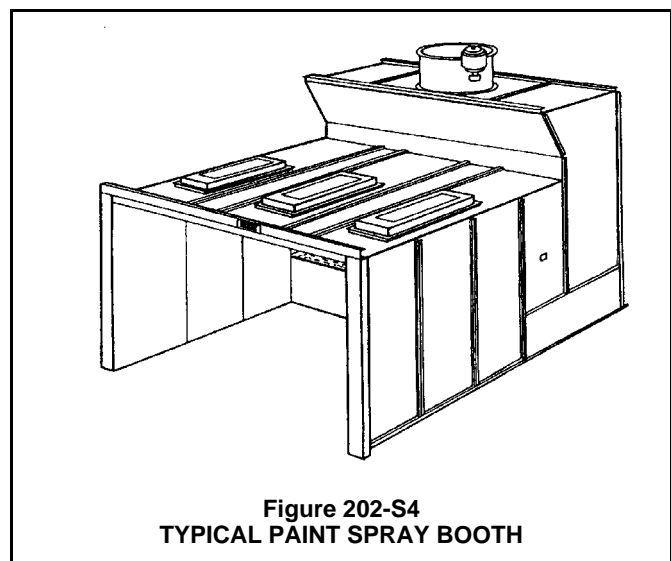


Figure 202-S4  
TYPICAL PAINT SPRAY BOOTH

**[BE] STAIR.** A change in elevation, consisting of one or more risers.

- ❖ All steps, even a single step, are defined as a stair. This makes the stair requirements applicable to all steps unless specifically exempt in the code.

**[BE] STAIRWAY.** One or more *flights of stairs*, either exterior or interior, with the necessary landings and platforms connecting them, to form a continuous and uninterrupted passage from one level to another.

- ❖ It is important to note that this definition characterizes a stairway as connecting one level to another. The term “level” is not to be confused with “story.” Steps that connect two levels, one of which is not considered a “story” of the structure, would be considered a stairway. For example, a set of steps between the basement level in an areaway and the outside ground level would be considered a stairway. A series of steps between the floor of a story and a mezzanine within that story would also be considered a stairway (see definitions for “Flight,” “Stairway, exterior,” “Stairway, interior” and “Interior exit stairway,” and Sections 1011, 1019, 1023 and 1027).

**STAIRWAY, EXIT ACCESS.** See “Exit access stairway.”

**STAIRWAY, EXTERIOR EXIT.** See “Exterior exit stairway.”

**STAIRWAY, INTERIOR EXIT.** See “Interior Exit Stairway.”

**STAIRWAY, SCISSOR.** See “Scissor stairway.”

**[BE] STAIRWAY, SPIRAL.** A *stairway* having a closed circular form in its plan view with uniform section-shaped treads attached to and radiating from a minimum-diameter supporting column.

- ❖ Spiral stairways are permitted as part of a means of egress in limited circumstances given in Section 1011.10. Spiral staircases could be used for supplemental/convenience stairways in other locations. Spiral stairways are commonly used where a small number of occupants use the stairway and the floor space for the stair is very limited. Spiral stairways are typically supported by a center pole. Requirements are found with stairways in Section 1011.10.

**STANDBY POWER SYSTEM.** A source of automatic electric power of a required capacity and duration to operate required building, hazardous materials or ventilation systems in the event of a failure of the primary power. Standby power systems are required for electrical loads where interruption of the primary power could create hazards or hamper rescue or fire-fighting operations.

- ❖ This definition is intended to provide clarity for the fire code official as to exactly what systems are considered to be standby power systems and is consistent with definitions in NFPA 110 and NFPA 111. However, since the list of systems in the definition is not exhaustive, reference must be made to Section 604 of the code which provides the “where required” provisions. When the normal power supply to any of the

indicated systems, or other systems designated by the code, fails, the standby power system is to provide a specified degree and duration systems and equipment that are essential for life safety such as elevators and platform lifts, emergency responder radio coverage and smoke control systems. See the commentary to Section 604 for more detailed discussion on the difference between standby and emergency power.

**STANDPIPE SYSTEM, CLASSES OF.** Standpipe system classes are as follows:

- ❖ A standpipe system is typically an arrangement of vertical piping located in exit stairways that allows fire-fighting personnel to connect hand-carried hoses at each level to manually extinguish fires. Section 905 and NFPA 14 recognize three different classes of standpipe systems. For a further discussion of standpipe classes and types, see the commentary to Section 905.3.1.

**Class I system.** A system providing 2½-inch (64 mm) hose connections to supply water for use by fire departments and those trained in handling heavy fire streams.

- ❖ A Class I standpipe system is intended for use by trained fire service personnel as a readily available water source for manual fire-fighting operations. A Class I standpipe system is equipped with only 2½-inch (64 mm) hose connections to allow the fire service to attach the appropriate hose and nozzles. A Class I standpipe system is not equipped with hose stations, which include a cabinet, hose and nozzle.

**Class II system.** A system providing 1½-inch (38 mm) hose stations to supply water for use primarily by the building occupants or by the fire department during initial response.

- ❖ A Class II standpipe system is intended for use by building occupants or by the fire department for manual suppression. The hose stations defined in NFPA 14 as part of the Class II standpipe system include a hose rack, hose nozzle, hose and hose connection. The intent of providing the hose is for use by properly trained personnel. Occupant-use hose stations should only be provided where they can be used by people who have been properly trained in the use of the hose and nozzle.

**Class III system.** A system providing 1½-inch (38 mm) hose stations to supply water for use by building occupants and 2½-inch (64 mm) hose connections to supply a larger volume of water for use by fire departments and those trained in handling heavy fire streams.

- ❖ A Class III standpipe system is intended for use by building occupants as well as trained fire service personnel. The 1½-inch (38 mm) hose station is for use by the building occupants or fire department for manual fire suppression and the 2½-inch (64 mm) hose connection is intended for use primarily by fire service personnel or those who have received training in the use of the larger hoses. Class III systems allow the

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fire department to select the types of hose necessary based on the fire hazard present. If the fire is effectively controlled by an automatic sprinkler system, the smaller hose size may be all that is necessary for fire department mop up operations.

**STANDPIPE, TYPES OF.** Standpipe types are as follows:

- ❖ Section 905 recognizes five types of standpipe systems. The use of each type of system depends on specific occupancy conditions and the presence of an automatic sprinkler system. For a further discussion of standpipe classes and types, see the commentary to Section 905.3.1.

**Automatic dry.** A dry standpipe system, normally filled with pressurized air, that is arranged through the use of a device, such as a dry pipe valve, to admit water into the system piping automatically upon the opening of a hose valve. The water supply for an automatic dry standpipe system shall be capable of supplying the system demand.

- ❖ A typical automatic dry standpipe system has an automatic water supply retained by a dry pipe valve. The dry pipe valve clapper is kept in place by air placed in the standpipe system under pressure. Once a standpipe hose valve is opened, the air is released from the system, allowing water to fill the system through the dry pipe valve. This system is traditionally used in areas where the temperature falls below 40°F (4°C); where a wet system could freeze and possibly burst the pipe or simply not be available when needed.

**Automatic wet.** A wet standpipe system that has a water supply that is capable of supplying the system demand automatically.

- ❖ An automatic wet standpipe system is used in locations where the entire system would remain above 40°F (4°C). Because the system is pressurized with water, an immediate release of water occurs when a hose connection valve is opened. This is the most generally preferred type of standpipe but it is not necessarily the required type unless so stipulated.

**Manual dry.** A dry standpipe system that does not have a permanent water supply attached to the system. Manual dry standpipe systems require water from a fire department pumper to be pumped into the system through the fire department connection in order to supply the system demand.

- ❖ A manual dry standpipe system is filled with water only when the fire service is present. Typically, the fire service connects the discharge from a water source, such as a pumper truck, to the fire department connection of a manual dry standpipe system. When the fire service has suppressed the fire and is preparing to leave, the system is drained of the remaining water. Manual dry standpipe systems are commonly installed in open parking structures.

**Manual wet.** A wet standpipe system connected to a water supply for the purpose of maintaining water within the

system but which does not have a water supply capable of delivering the system demand attached to the system. Manual wet standpipe systems require water from a fire department pumper (or the like) to be pumped into the system in order to supply the system demand.

- ❖ A manual wet standpipe system is connected to an automatic water supply, but the supply is not capable of providing the system demand. The manual wet system could be one that is connected with the sprinkler system such that it is capable of supplying the demand for the sprinkler system but not for the standpipe. The standpipe system demand is met when the fire service provides additional water through the fire department connection from the discharge of a water source, such as a pumper truck.

**Semiautomatic dry.** A dry standpipe system that is arranged through the use of a device, such as a deluge valve, to admit water into the system piping upon activation of a remote control device located at a hose connection. A remote control activation device shall be provided at each hose connection. The water supply for a semiautomatic dry standpipe system shall be capable of supplying the system demand.

- ❖ This type of dry standpipe is a special design that uses a solenoid-activated valve to retain the automatic water supply. Once the standpipe hose valve is opened, a signal is sent to the deluge valve retaining the automatic water supply to allow water to fill the system. This kind of system is used in areas where the temperature falls below 40°F (4°C), where a wet system would otherwise freeze. As such, there is no semiautomatic wet system type.

**STATIC PILES.** Piles in which processed wood product or solid biomass feedstock is mounded and is not being turned or moved.

- ❖ Static piles are long-term bulk storage piles that must be monitored for internal heat buildup. This term includes processed wood products but also addresses solid biomass feedstock. See the definition for "Solid biomass feedstock."

**STEEL.** Hot- or cold-rolled as defined by the *International Building Code*.

- ❖ This is a basic definition that clarifies that steel is either cold- or hot-rolled as defined by the IBC; however, the IBC does not specifically define cold- or hot-rolled steel but describes how it must be used.

**STORAGE, HAZARDOUS MATERIALS.** The keeping, retention or leaving of hazardous materials in closed containers, tanks, cylinders, or similar vessels; or vessels supplying operations through closed connections to the vessel.

- ❖ Storage of hazardous materials in a structure is governed either by the occupancy group that it is accessory to or by the hazard group that it is associated with. The determination of the occupancy class is based on the MAQs and the exceptions found in the IBC and the code.

**[BG] STORY.** That portion of a building included between the upper surface of a floor and the upper surface of the floor or roof next above (see “Basement,” “Building height,” “Grade plane” and “Mezzanine”). A story is measured as the vertical distance from top to top of two successive tiers of beams or finished floor surfaces and, for the topmost story, from the top of the floor finish to the top of the ceiling joists or, where there is not a ceiling, to the top of the roof rafters.

❖ All levels in a building that conform to this description are stories, including basements. A mezzanine is considered part of the story in which it is located. See Chapter 5 of the IBC for code requirements regarding limitations on the number of stories in a building as a function of the type of construction.

**[BG] STORY ABOVE GRADE PLANE.** Any story having its finished floor surface entirely above grade plane, or in which the finished surface of the floor next above is:

1. More than 6 feet (1829 mm) above grade plane; or
2. More than 12 feet (3658 mm) above the finished ground level at any point.

❖ The determination of the allowed height of a building under Section 504 of the IBC is based on the number of stories above grade plane. (See definitions of “Basement,” “Building height” and “Grade plane.”) The code establishes by this definition which stories of a building are those above grade plane. Clearly it includes those stories that are fully above grade plane. It also includes stories that may be partially below finished ground level, but the finished floor level is more than 6 feet (1829 mm) above grade plane. It also includes those floor levels that, due to an irregular terrain, have a finished floor level more than 12 feet (3658 mm) above finished ground level at any point surrounding the building. Any building level not qualifying as a story above grade plane is, by definition, a basement.

**SUPERVISING STATION.** A facility that receives signals and at which personnel are in attendance at all times to respond to these signals.

❖ The supervising station is the location where all fire protection-system-related signals are sent and where trained personnel are present to respond to an emergency. The supervising station may be an approved central station, a remote supervising station, a proprietary supervising station or other constantly attended location approved by the fire code official. Each type of supervising station must comply with the applicable specific provisions described in NFPA 72.

**SUPERVISORY SERVICE.** The service required to monitor performance of guard tours and the operative condition of fixed suppression systems or other systems for the protection of life and property.

❖ The supervisory service is responsible for maintaining the integrity of the fire protection system by notifying the supervising station of a change in protection system status.

Guard tours are recognized as a nonrequired (voluntary) system. If a guard tour is provided, the signals from that system can be transmitted through the supervisory service to the supervision station. Guard tours are not a required part of a fire alarm system.

**SUPERVISORY SIGNAL.** A signal indicating the need of action in connection with the supervision of guard tours, the fire suppression systems or equipment, or the maintenance features of related systems.

❖ Activation of a supervisory signal-initiating device transmits a signal indicating that a change in the status of the fire protection system has occurred and that action must be taken. These signals are the basis for the actions taken by the attendant at the supervising station. These signals do not indicate an emergency condition but indicate that a portion of the system is not functioning in the manner in which it should and that if the condition is not corrected it could impair the ability of the fire protection system to perform properly. A supervisory signal is also a part of the nonrequired guard tour system.

**SUPERVISORY SIGNAL-INITIATING DEVICE.** An initiating device such as a valve supervisory switch, water level indicator, or low-air pressure switch on a dry-pipe sprinkler system whose change of state signals an off-normal condition and its restoration to normal of a fire protection or life safety system; or a need for action in connection with guard tours, fire suppression systems or equipment, or maintenance features of related systems.

❖ The supervisory signal-initiating device detects a change in protection system status. Examples of a supervisory signal-initiating device include a flow switch to detect movement of water through the system and a tamper switch to detect when someone shuts off a water control valve.

**SYSTEM.** An assembly of equipment consisting of a tank, container or containers, appurtenances, pumps, compressors and connecting piping.

❖ As with tanks or containers, a system can be either open or closed. The difference between a closed system and an open system is whether the hazardous material involved in a process is exposed to the atmosphere. Materials in closed or open systems are assumed to be “in use” as opposed to “in storage.” Gases are always assumed to be in closed systems, since they would be immediately dispersed in an open system if exposed to the atmosphere without some means of containment.

**TANK.** A vessel containing more than 60 gallons (227 L).

❖ This definition establishes the distinction between containers and tanks for purposes of code application, with a container being defined as a vessel of 60 gallons (227 L) or less capacity (see commentary to the definition of “Container”).

**TANK, ATMOSPHERIC.** A storage tank designed to operate at pressures from atmospheric through 1.0 pound per

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square inch gauge (760 mm Hg through 812 mm Hg) measured at the top of the tank.

- ❖ This type of tank is not designed for an internal pressure that exceeds atmospheric pressure. Most require some type of emergency venting system to assist in the relief of pressure in a fire.

**TANK, PORTABLE.** A packaging of more than 60-gallon (227 L) capacity and designed primarily to be loaded into or on or temporarily attached to a transport vehicle or ship and equipped with skids, mountings or accessories to facilitate handling of the tank by mechanical means. It does not include any cylinder having less than a 1,000-pound (454 kg) water capacity, cargo tank, tank car tank or trailers carrying cylinders of more than 1,000-pound (454 kg) water capacity.

- ❖ A portable tank must be movable without having to detach permanently mounted electrical controls for the pumping or dispensing systems.

**TANK, PRIMARY.** A *listed* atmospheric tank used to store liquid. See “Primary containment.”

- ❖ The primary tank is the principal storage vessel for flammable and combustible liquids. The tank may use a secondary containment system or be installed in a dike area to control leaks and spills.

**TANK, PROTECTED ABOVE GROUND.** A tank *listed* in accordance with UL 2085 consisting of a primary tank provided with protection from physical damage and fire-resistive protection from a high-intensity liquid pool fire exposure. The tank may provide protection elements as a unit or may be an assembly of components, or a combination thereof.

- ❖ A protected above-ground tank is a shop-fabricated above-ground storage tank that has been subjected to a fire test that replicates an exposure to a 2-hour flammable liquid pool fire. Such tanks are constructed with integral secondary containment and are evaluated for vehicle impact and bullet resistance. All openings on a protected above-ground tank are located at the top of the storage tank which further limits the potential for liquid leaks—openings below the liquid level in these tanks are prohibited by the code. These tanks are listed as meeting the requirements of UL 2085, *Standard for Protected Above-ground Tanks for Flammable and Combustible Liquids*. Section 5704.2.9.7 has a number of requirements for protected above-ground tanks, including overfill protection that limits the volume of fuel oil to 95 percent of the tank’s capacity, an informational sign that explains how the tank is to be filled and that the tank volume must be verified before the tank is filled, and a minimum 5-gallon (19 L) spill container at the tank fill connection to capture any fuel trapped in the fuel delivery hose. If the liquid piping extends below the top of the tank, Section 5704.2.9.7.9 requires the installation of an antisiphon valve. An antisiphon valve is designed to prevent the siphoning of liquid from the tank in the event a pipe or fitting fails and leaks liquid.

**TANK, STATIONARY.** Packaging designed primarily for stationary installations not intended for loading, unloading or attachment to a transport vehicle as part of its normal operation in the process of use. It does not include cylinders having less than a 1,000-pound (454 kg) water capacity.

- ❖ This type of tank is placed in a permanent location and typically has electrically mounted controls attached to a permanent power source.

**TANK VEHICLE.** A vehicle other than a railroad tank car or boat, with a cargo tank mounted thereon or built as an integral part thereof, used for the transportation of flammable or *combustible liquids*, LP-gas or hazardous chemicals. Tank vehicles include self-propelled vehicles and full trailers and semitrailers, with or without motive power, and carrying part or all of the load.

- ❖ Tank vehicles used for storage and transportation of hazardous chemicals over public roadways are governed by the DOTn.

**TEMPORARY STAGE CANOPY.** A temporary ground-supported membrane-covered frame structure used to cover stage areas and support equipment in the production of outdoor entertainment events.

- ❖ There were four high-profile temporary stage canopy collapses during the 2011 summer concert season: August 7 at Brady District Block Party, Tulsa Oklahoma; July 17 at the Cisco Ottawa Blues Festival in Ottawa, Canada; August 13 at the Indiana State Fairgrounds, which resulted in seven dead and 50 injured; and August 18 at the Pukkelpop Festival in Kiewit, Belgium. In the summer of 2012, a life was lost at a Radiohead concert in Toronto. All resulted in tremendous property damage and two in multiple fatalities. The obvious concern is for the safety of the performers and audiences, stage-hands, lighting technicians, security personnel and every other individual in proximity to a temporary stage.

Temporary stage canopies are very specialized and complex. The nature of the structures must accommodate a wide variety of changing components such as audio equipment, video walls and scenery. The entertainment industry is continually evolving with new ways to improve shows, creating larger and more complex spectacles.

Due to the unique design of temporary stage canopies, very specific requirements for these structures are necessary.

**[BG] TENT.** A structure, enclosure or shelter, with or without sidewalls or drops, constructed of fabric or pliable material supported by any manner except by air or the contents that it protects.

- ❖ Tents can be temporary or permanent structures. When permanent, they are regulated by Section 3104. When erected as temporary enclosures, they are regulated by Sections 3103 and 3104 (see also Chapter 31 of the IBC). Commentary Figure 202-T1 illustrates a tent.

**THEFT RESISTANT.** Construction designed to deter illegal entry into facilities for the storage of *explosive materials*.

- ❖ Theft-resistant designs are intended to provide security against illegal or unauthorized entry into magazines containing explosives. Security measures specified in this and subsequent sections require special tools, keys or excessive force to compromise the security measure.

**TIMBER AND LUMBER PRODUCTION FACILITIES.**

Facilities where raw wood products are processed into finished wood products.

- ❖ Wood is still our most used structural material. With the ever increasing demand for wood products, growth of the forest products industry continues. Some woodworking facilities are a “one-man” shop while others employ as many as several thousand people.

**TIRES, BULK STORAGE OF.** Storage of tires where the area available for storage exceeds 20,000 cubic feet (566 m<sup>3</sup>).

- ❖ This definition describes a storage space that is larger than what would be found in most typical mercantile and storage occupancies. Because of its size and the volume of combustible material it would house, it poses an extraordinary hazard for fire protection.

The volume is based on the legacy code definition which was based on 10,000 passenger vehicle tires weighing an average of 25 pounds (11 kg) each rather than the volume of the stored tires. Assuming a 24-inch by 24-inch space (610 mm by 610 mm) for an average passenger vehicle tire and a 6-inch (152 mm) thickness, the result is 20,000 cubic feet (566 m<sup>3</sup>):

$$10,000 \text{ tires} \times 2 \text{ ft} \times 2 \text{ ft} \times 0.5 \text{ ft} = 20,000 \text{ ft}^3$$

The 20,000 cubic feet (566 m<sup>3</sup>) represents the actual volume of stored materials based on an equivalent height and area for passenger vehicle tires as shown in the calculation above and does not

include circulation area or other portions of the building. Rather, it focuses on how much of the material is present. Although the definition uses the term “area” rather than “volume,” it is the volume that becomes the threshold consideration. Still, the area where the tires are stored implies the footprint used for storage. It is not the intent to apply this to areas outside of those used for bulk tire storage.

Buildings used for the bulk storage of tires are classified as Group S-1 occupancies in accordance with Section 311.2 of the IBC. All Group S-1 occupancies, regardless of square footage, must be equipped with an NFPA 13 automatic sprinkler system if used for the bulk storage of tires as required by Section 903.2.9.2. Chapter 34 of the code also requires that bulk tire storage buildings be further designed to comply with NFPA 13, and Chapter 32 of the code includes additional requirements for high-piled rubber tire storage as a high-hazard commodity (see commentary, Chapters 32 and 34).

**TOOL.** A device, storage container, workstation or process machine used in a fabrication area.

- ❖ A tool is basically any device or piece of equipment, including a workstation, in a fabrication area where hazardous materials are used, stored or handled.

**TORCH-APPLIED ROOF SYSTEM.** Bituminous roofing systems using membranes that are adhered by heating with a torch and melting asphalt back coating instead of mopping hot asphalt for adhesion.

- ❖ This is a very specific operation that relates to hot work that uses a torch to adhere the materials. It is not considered welding, but still falls within the definition of “Hot work” (see Commentary Figure 6104.3.1).

**[A] TOWNHOUSE.** A single-family *dwelling unit* constructed in a group of three or more attached units in which each unit extends from the foundation to roof and with open space on not less than two sides.

- ❖ This specific configuration of construction is called different things in different parts of the country, such



Figure 202-T1  
EXAMPLE OF TENT STRUCTURE

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as a rowhouse. A townhouse structure that meets the following four criteria is not regulated by the code but is regulated by the IRC. Those criteria are:

1. Each unit extends from foundation to roof with no vertical overlap of any parts of adjoining units.
2. Each unit must have open space on at least two sides (either two opposite or two adjoining sides).
3. Each unit must have a separate means of egress.
4. The building must not exceed three stories above grade plane.

If all of these criteria are met, then according to the exception to Section 101.2 of the IBC, the structure is within scope of the IRC. (It should also be noted that townhouses within the IRC must be separated by a wall or walls meeting specific criteria.) If a structure does not meet these four criteria, it will need to be regulated under the code and will either be classified as a Group R-2 or Group R-3 structure, depending on how the units are separated. A building containing three or more dwelling units is regulated as a Group R-2 occupancy. To be considered a Group R-3, the structure must have one or two dwelling units, or be subdivided by fire walls between every unit or every two units (see the definitions for "Area, building," "Dwelling" and "Dwelling unit"). Finally, the definition of "Townhouse" is not dependent on the presence of individual lots. A townhouse structure could be built with any number of attached units on the same lot, or it could be developed such that a property line lies at each common wall separating two units (see definition for "Lot").

**TOXIC.** A chemical falling within any of the following categories:

1. A chemical that has a median lethal dose ( $LD_{50}$ ) of more than 50 milligrams per kilogram, but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
2. A chemical that has a median lethal dose ( $LD_{50}$ ) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
3. A chemical that has a median lethal concentration ( $LC_{50}$ ) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than 2 milligrams per liter but not more than 20 milligrams per liter of mist, fume or dust, when administered by continuous inhalation for 1 hour (or

less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

❖ See the commentary to the definition of "Highly toxic."

**TRAFFIC CALMING DEVICES.** Traffic calming devices are design elements of fire apparatus access roads such as street alignment, installation of barriers, and other physical measures intended to reduce traffic and cut-through volumes, and slow vehicle speeds.

❖ The definition for traffic calming is based on the definition provided by the Institute of Transportation Engineers. Many communities are facing increased traffic volumes. Both new and existing streets are experiencing higher vehicular volumes and speeds as drivers attempt to find "short cuts" to ease their commutes. Designers, planning departments and traffic engineering departments are increasingly turning to traffic calming measures to preserve the quality and enjoyment of life for their citizens.

In many communities a concern of home owners is the use of residential streets as an alternative route to minor and major thoroughfares. They are concerned about pedestrian safety, reducing vehicle speeds and the traffic volume on residential streets. On the other hand, property owners also want the lowest response time that is practical in the event of an emergency that requires a response by the fire or police department. In fact, response time is the primary measurement for quality of service used by the public. The installation of traffic calming devices competes with these two goals.

A number of studies have been conducted to evaluate the impact of traffic calming devices on the response time of fire and emergency medical services (EMS) apparatus. These studies found that traffic calming devices have no real impact on law enforcement vehicles because of their size however, depending on the method of traffic calming used (e.g., "roundabouts," "speed bumps," "speed pillows," narrowing of streets, winding roads rather than straight roads, etc.) and the vehicle type, response times for fire and emergency services generally are increased by these devices by 2 to 10 seconds. Studies have also found that the vehicle frames of fire and EMS apparatus can be damaged and emergency services personnel have been injured while responding over certain traffic calming devices. See the commentary to Section 503.4.1 for further discussion of traffic calming devices. See also Commentary Figures 202-T2 and 202-T3 for illustrations of several typical traffic calming devices.

**[BG] TRANSIENT.** Occupancy of a dwelling unit or sleeping unit for not more than 30 days.

❖ The intent of this definition is to establish a time parameter to differentiate between transient and non-transient as listed under Groups R-1 and R-2. Real estate law dictates that a lease must be created after

30 days and time periods greater than 30 days are typically how extended-stay hotels and motels rent to people.

Such a time period enables the occupant to become familiar with the surroundings and, therefore, become more accustomed to any hazards of the built environment than an overnight guest or a guest who stays for just a few days would be. Since nontransient occupancies do not have the same level of protection in the code as transient occupancies, it is important to

determine what makes an occupancy transient so as to provide consistency in enforcement.

**[BG] TRANSIENT AIRCRAFT.** Aircraft based at another location and that is at the transient location for not more than 90 days.

- ❖ In place of the undefined term “private aircraft” previously used in the code, a defined term, “transient aircraft,” was added in the 2009 edition. Transient aircraft are those that are merely visiting an airport as compared to those which are based at that location.



**Figure 202-T2**  
**SPEED PILLOW TRAFFIC CALMING DEVICE**



**Figure 202-T3**  
**ROUNDBOUT TRAFFIC CALMING DEVICE**

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The definition is used in conjunction with Section 914.8.3 to establish the level of fire suppression needed in various aircraft hangars. Fixed base operators, especially at larger airports, will have distinct hangars that are used for repair and maintenance of aircraft. The hangars used by transient aircraft are primarily a storage place for aircraft based at another location. This better identifies the intent of this type of aircraft hangar. Most frequently, the owner that wants to develop an aircraft hangar that fits the Group II category, will do no "major maintenance" and will only "store" airplanes in their hangar (see the commentary, Section 914.8.3).

**TRANSVERSE FLUE SPACE.** See "Flue space—Transverse."

**TRASH.** See "Rubbish."

**TROUBLE SIGNAL.** A signal initiated by the fire alarm system or device indicative of a fault in a monitored circuit or component.

❖ This type of signal indicates that there has been an abnormal change in the normal status of the fire detection system or devices and that a response is required to determine the nature of the fault condition. The trouble signal is only associated with electronic portions of a fire protection system. Physical conditions such as a closed valve are monitored electronically and would report as a supervisory signal rather than a trouble signal. A valve supervisory switch or "tamper switch," for example, would perform such a function.

**TUBE TRAILER.** A semitrailer on which a number of tubular gas cylinders have been mounted. A manifold is typically provided that connects the cylinder valves enabling gas to be discharged from one or more tubes or cylinders through a piping and control system.

❖ Tube trailers are a common method of supplying compressed gases to a variety of industrial processes, and it is not uncommon to have more than one tube trailer on a site. Depending on the cylinder's length and maximum allowable working pressure (MAWP), a trailer may have as few as six or as many as 18 to 24 cylinders varying in length from 20 feet (6096 mm) for small tube trailers to 38 feet (11 582 mm) on jumbo tube trailers. The vessels are generally designed for MAWP between 2,800 to approximately 3,800 pounds per square inch (psi) (19 305 to 26 200 kPa), depending on the storage pressure. At such pressures, each cylinder can hold anywhere from 5,000 to 20,000 standard cubic feet (scf) (142 to 566 m<sup>3</sup>), depending on the gas being stored. Tube trailers are subject to periodic inspections in accordance with U.S. Department of Transportation (DOTn) regulations and each new or substantially modified tube is required to successfully pass a substantial hydrostatic pressure test.

The transport of compressed gases by these road trailers, which are regulated by the DOTn as a bulk

compressed gas source, is an established distribution method used widely in the industrial gas industry for the transport over short distances of relatively small volumes of inert, flammable, oxidizer, corrosive or toxic compressed gases and gas mixtures, including hydrogen, methane, oxygen, nitrogen, argon, helium, many fluorocarbons, hydrogen sulfide and hydrogen



**Figure 202-T4  
TUBE TRAILER**

chloride.

At one end of the trailer is a manifold to which each cylinder valve is connected so that one or more tubes can discharge gas into a piping and control system. The tube trailer is connected via the manifold to the building or process using the compressed gas [see Commentary Figure 202-T4 and commentary, Section 5303.7.11)].

**TWENTY-FOUR HOUR BASIS.** See "24-hour basis" before the "A" entries.

**UNAUTHORIZED DISCHARGE.** A release or emission of materials in a manner which does not conform to the provisions of this code or applicable public health and safety regulations.

❖ Remember that hazardous chemicals pose a threat to life and property only when release is not authorized, controlled or properly protected.

**UNSTABLE (REACTIVE) MATERIAL.** A material, other than an *explosive*, which in the pure state or as commercially produced, will vigorously polymerize, decompose, condense or become self-reactive and undergo other violent chemical changes, including explosion, when exposed to heat, friction or shock, or in the absence of an inhibitor, or in the presence of contaminants, or in contact with *incompatible materials*. Unstable (reactive) materials are subdivided as follows:

**Class 4.** Materials that in themselves are readily capable of *detonation* or explosive decomposition or explosive reaction at *normal temperatures and pressures*. This class includes materials that are sensitive to mechanical or localized thermal shock at *normal temperatures and pressures*.

**Class 3.** Materials that in themselves are capable of *detonation* or of explosive decomposition or explosive reaction

but which require a strong initiating source or which must be heated under confinement before initiation. This class includes materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures.

**Class 2.** Materials that in themselves are normally unstable and readily undergo violent chemical change but do not detonate. This class includes materials that can undergo chemical change with rapid release of energy at *normal temperatures and pressures*, and that can undergo violent chemical change at elevated temperatures and pressures.

**Class 1.** Materials that in themselves are normally stable but which can become unstable at elevated temperatures and pressure.

- ❖ The definition of an “Unstable (reactive) material” is based on NFPA 704. The different classes of unstable (reactive) material reflect the degree of susceptibility of the materials to release energy. Unstable (reactive) materials polymerize, decompose or become self-reactive when exposed to heat, air, moisture, pressure or shock. Separation from incompatible materials is essential to minimizing the hazards. Examples of unstable (reactive) materials include acetaldehyde, ammonium nitrate, ethylene oxide, hydrogen cyanide, nitromethane, perchloric acid, sodium perchlorate, vinyl acetate and acetic acid.

**UNWANTED FIRE.** A fire not used for cooking, heating or recreational purposes or one not incidental to the normal operations of the property.

- ❖ For the purposes of applying the code, a clarification is provided to note that certain fires present in buildings would be acceptable; for example, the normal operation of a water heater, a gas stove or a fireplace. The definition does not address whether a fire is intentional or unintentional (arson versus a welding accident, for example).

**USE (MATERIAL).** Placing a material into action, including solids, liquids and gases.

- ❖ This term refers to when a chemical or material is used in a process that forms another substance, whether it is hazardous or not, and when the chemical is used independently.

**VAPOR PRESSURE.** The pressure exerted by a volatile fluid as determined in accordance with ASTM D 323.

- ❖ Vapor pressure is a characteristic property of liquids and varies with their temperature. As the temperature of the liquid increases, more and more of the liquid enters the vapor stage. This increased pressure can cause an emergency vent to release, or, if the conditions are serious enough, can result in a BLEVE.

**[M] VENTILATION.** The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space.

- ❖ Ventilation is the process of moving air to or from building spaces. Ventilation requirements are used in the code to establish minimum levels of air movement within a building for the purposes of providing a healthful interior environment. Ventilation would include both natural (openable exterior windows and doors for wind movement) and mechanical (forced air with mechanical equipment) methods.

**VESSEL.** A motorized watercraft, other than a seaplane on the water, used or capable of being used as a means of transportation. Nontransportation vessels, such as houseboats and boathouses, are included in this definition.

- ❖ Vessels, in this definition, are motorized watercraft, but by dictionary definition, a vessel is “...a watercraft or structure with its equipment, whether self-propelled or not, that is used or capable of being used as a means of transportation in navigation or commerce on water...” The definition could include small rowboats and sailboats. No minimum or maximum length is specified. Houseboats and boathouses that would be occupied as dwelling or sleeping units are also included in the definition.

**VISIBLE ALARM NOTIFICATION APPLIANCE.** A notification appliance that alerts by the sense of sight.

- ❖ Visible alarm notification appliances are located anywhere an occupant notification system is required, in occupancies where occupants may be hearing impaired and in sleeping accommodations of Group I-1 and R-1 occupancies. These alarm notification devices must be located and oriented so that they will display alarm signals throughout the required space. Visible alarms, when provided, are typically installed in the public and common areas of buildings (see the commentary, Section 907.5.2.3).

**WATER MIST SYSTEM, AUTOMATIC.** See “Automatic water mist system.”

**WATER-REACTIVE MATERIAL.** A material that explodes; violently reacts; produces flammable, toxic or other hazardous gases; or evolves enough heat to cause autoignition or ignition of combustibles upon exposure to water or moisture. Water-reactive materials are subdivided as follows:

**Class 3.** Materials that react explosively with water without requiring heat or confinement.

**Class 2.** Materials that react violently with water or have the ability to boil water. Materials that produce flammable, toxic or other hazardous gases, or evolve enough heat to cause autoignition or ignition of combustibles upon exposure to water or moisture.

**Class 1.** Materials that react with water with some release of energy, but not violently.

- ❖ Class 2 and 3 water-reactive materials can liberate significant quantities of heat and hazardous gases when reacting with water. Combustible water-reactive materials are capable of self-ignition. Even noncom-

## DEFINITIONS

bustible water-reactive materials pose a hazard because of the heat released during their reaction with water, which may be sufficient to ignite surrounding combustible materials. The description of each of the subdivisions is consistent with the approach used for the determination of water hazards in NFPA 704.

**WET-CHEMICAL EXTINGUISHING AGENT.** A solution of water and potassium-carbonate-based chemical, potassium-acetate-based chemical or a combination thereof, forming an extinguishing agent.

❖ This extinguishing agent is a suitable alternative to the use of a dry chemical, especially when protecting commercial kitchen range hoods. There is less cleanup time after system discharge. Wet chemical solutions are considered to be relatively harmless and normally have no lasting effect on the skin or respiratory system. These solutions may produce temporary irritation, which is usually mild and disappears when contact is eliminated. These systems must be pre-engineered and labeled. NFPA 17A applies to the design, installation, operation, testing and maintenance of wet-chemical extinguishing systems.

**WET FUELING.** See “Mobile fueling.”

**WET HOSING.** See “Mobile fueling.”

**WHARF.** A structure or bulkhead constructed of wood, stone, concrete or similar material built at the shore of a harbor, lake or river for vessels to lie alongside of, and to anchor piers or floats.

❖ A wharf is constructed along the shore and does not project significantly into the body of water as a pier would. Piers or floats may be attached to and project out from a wharf. Wharves may also have structures on them that support the use of the wharf.

**WILDFIRE RISK AREA.** Land that is covered with grass, grain, brush or forest, whether privately or publicly owned, which is so situated or is of such inaccessible location that a fire originating upon it would present an abnormally difficult job of suppression or would result in great or unusual damage through fire or such areas designated by the *fire code official*.

❖ This defined term provides clarification to Sections 105.6.24, Item 4, 105.6.32, 308.1.6 and 308.1.6.1 where the undefined term “hazardous fire area” had been used in previous editions of the code, leaving the fire code official with little or no guidance as to the code's intent. The source for this definition was a definition for the term “hazardous fire area” in the legacy *Uniform Fire Code*. However, in order to avoid conflict and confusion with the already-defined term “fire area,” the new term and the indicated section texts were changed to “wildfire risk area.”

**[BE] WINDER.** A tread with nonparallel edges.

❖ Winders are used as components of stairways that change direction, just as “fliers” (rectangular treads) are components in straight stairways. A winder performs the same function as a tread, but its shape

allows the additional function of a gradual turning of the stairway direction. The tread depth of a winder at the walkline and the minimum tread depth at the narrow end control the turn made by each winder. Winders are not landings. Winder treads are limited to curved or spiral stairways with all groups but are all stairways within dwelling units (see Section 1011.5.3).

**WIRELESS PROTECTION SYSTEM.** A system or a part of a system that can transmit and receive signals without the aid of wire.

❖ These systems use radio frequency transmitting devices that comply with the special requirements for supervision of low-power wireless systems in NFPA 72. Wireless devices have the advantage of flexibility in positioning. Consequently, portable wireless notification devices are frequently used in existing facilities where visual devices are not present throughout.

**WORKSTATION.** A defined space or an independent principal piece of equipment using HPM within a fabrication area where a specific function, laboratory procedure or research activity occurs. *Approved* or *listed* hazardous materials storage cabinets, flammable liquid storage cabinets or gas cabinets serving a workstation are included as part of the workstation. A workstation is allowed to contain ventilation equipment, fire protection devices, detection devices, electrical devices and other processing and scientific equipment.

❖ In HPM facilities, workstations further subdivide a fabrication area and provide relatively self-contained, specialized areas where HPM processes are conducted. Workstation controls limit the quantity of materials and impose limitations on the design of these processes to include, but not be limited to, protection by local exhaust; sprinklers; automatic and emergency shutoffs; construction materials and HPM compatibility. Excess materials are prohibited and must be contained in storage rooms designed to accommodate such hazards.

**[BG] YARD.** An open space, other than a *court*, unobstructed from the ground to the sky, except where specifically provided by the *International Building Code*, on the lot on which a building is situated.

❖ This definition is used, similar to the definition of “Court,” to establish the applicability of code requirements when yards are utilized for natural light or natural ventilation purposes (see Section 1206.1 of the IBC). Whereas a court is bounded on three or more sides with the building or structure, a yard is bounded on two or less sides by the building or structure. See also the definition of “Egress court.”

**ZONE.** A defined area within the protected premises. A zone can define an area from which a signal can be received, an area to which a signal can be sent or an area in which a form of control can be executed.

❖ Zoning a system is important to emergency personnel in locating a fire. When an alarm is designated to a specific zone, it allows the fire service to immediately respond to the area where the fire is in progress

instead of searching the entire building for the origin of an alarm.

**ZONE, NOTIFICATION.** An area within a building or facility covered by notification appliances which are activated simultaneously.

❖ This definition is provided to clarify the code by making a clear distinction between fire alarm system initiation device zones required by Section 907.6.4 and the zones that may be designed into occupant notification device systems in a building. The term is used primarily in the exceptions for sprinkler systems found in the manual fire alarm system requirements in Section 907.2 and its subsections. Note that the code does not require audible and visible occupant notification device systems to be zoned; if such zones are provided, it is a matter of the system design engineers judgment. The voice paging component in high-rise building emergency voice/alarm communication systems are, however, required to be zoned in accordance with Section 907.5.2.2.

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The following resource materials were used in the preparation of the commentary for this chapter of the code:

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## Part II—General Safety Provisions

# Chapter 3: General Requirements

### General Comments

Fire is always a concern, whether a building is under construction, is occupied for normal use or is undergoing renovation, restoration, expansion or demolition. But careful planning combined with common sense can make buildings and premises much safer, regardless of the occupancy or other activities at the site.

The primary focus of the requirements in this chapter is making sure the three elements necessary for a fire—ignition source, fuel and oxygen—do not come in contact with one another. NFPA 550 describes in great detail the features of fire safety systems and includes a logic tree called “The Fire Safety Concepts Tree” to graphically show all the possible means of achieving user-defined fire safety objectives. A portion of that tree is reproduced here as Commentary Figure 3 to show how to avoid fire ignition. Activities on this diagram that follow a plus sign (+), also known as an “or” gate, may be undertaken independently of each other to arrive at the desired goal. Alternatives following a dot (·), also known as an “and”

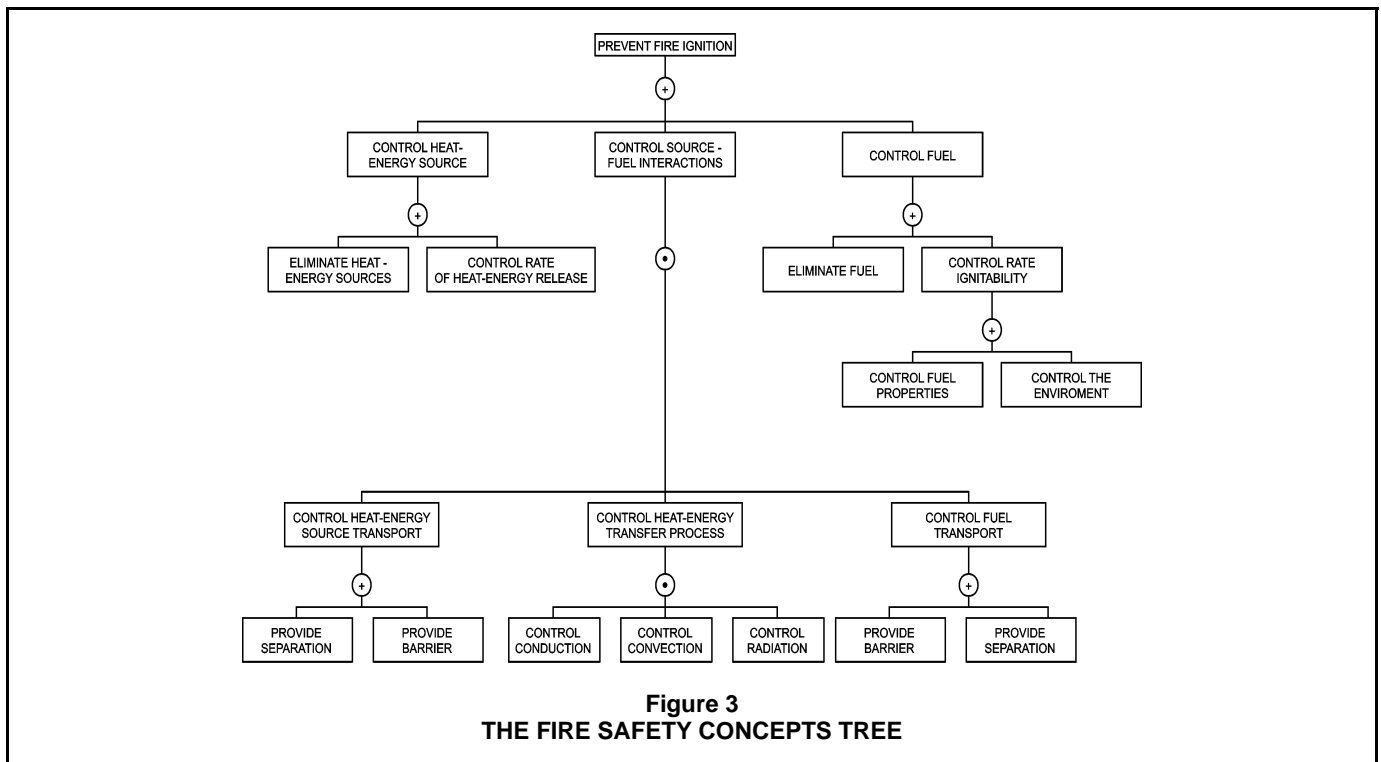
gate, must be combined to achieve the desired result.

Commentary Figure 3 shows that eliminating any one of the three elements required for a fire to occur will prevent a fire from happening. If there is no ignition source, a fuel load of any size should not catch fire. If there is no fuel load, there is nothing for an ignition source to ignite. If there is little or no air available to sustain combustion, any fire ignited in a fuel load will quickly die.

The requirements and precautions outlined in this chapter, when applied using good judgment and the common sense mentioned above, will help to foster safety for everyone.

### Purpose

The requirements and precautions contained in this chapter are intended to improve premises safety for everyone, including construction workers, tenants, operations and maintenance personnel and emergency response personnel.



## GENERAL REQUIREMENTS

### SECTION 301 GENERAL

**301.1 Scope.** The provisions of this chapter shall govern the occupancy and maintenance of all structures and premises for precautions against fire and the spread of fire and general requirements of fire safety.

- ❖ The requirements of Chapter 3 prescribe fire safety precautions for conditions that are likely to cause or contribute to the spread of fire in any building or structure or on any premises, regardless of occupancy.

**301.2 Permits.** Permits shall be required as set forth in Section 105.6 for the activities or uses regulated by Sections 306, 307, 308 and 315.

- ❖ Issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Applicants for permits should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit.

### SECTION 302 DEFINITIONS

**302.1 Definitions.** The following terms are defined in Chapter 2:

**BONFIRE.**

**HI-BOY.**

**HIGH-VOLTAGE TRANSMISSION LINE.**

**OPEN BURNING.**

**PORTABLE OUTDOOR FIREPLACE.**

**POWERED INDUSTRIAL TRUCK.**

**RECREATIONAL FIRE.**

**SKY LANTERN.**

- ❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

### SECTION 303 ASPHALT KETTLES

**303.1 Transporting.** Asphalt (tar) kettles shall not be transported over any highway, road or street when the heat source for the kettle is operating.

**Exception:** Asphalt (tar) kettles in the process of patching road surfaces.

- ❖ The hazards of hauling a fired kettle of molten asphalt over public ways are obvious. Most asphalt kettles for roofing, paving and similar uses are currently liquefied petroleum gas (LP-gas) fired. Contractors often wish to keep asphalt in a liquid state to save time between jobs and when work is interrupted. Once asphalt is transformed from a solid to a liquid by heating, it retains much of its heat for some time, and although it becomes increasingly viscous as it cools, it remains fluid for a considerable time. Maintaining a fire under a kettle during transport is usually unnecessary and, therefore, prohibited, since little additional heat is required to return the asphalt to a usable consistency. An accident, flat tire or anything else that could cause the kettle to overturn, spilling the molten asphalt in the presence of an open flame, could lead to a serious fire. Even hitting potholes or other bumps in the road could cause the molten asphalt to splash out of the kettle, causing injury to people nearby or damage to property.

The exception for asphalt being used for road repair is necessary for efficient operations for work crews sealing pavement joints and performing similar roadway repairs.

**303.2 Location.** Asphalt (tar) kettles shall not be located within 20 feet (6096 mm) of any combustible material, combustible building surface or any building opening and within a controlled area identified by the use of traffic cones, barriers or other *approved* means. Asphalt (tar) kettles and pots shall not be utilized inside or on the roof of a building or structure. Roofing kettles and operating asphalt (tar) kettles shall not block *means of egress*, gates, roadways or entrances.

- ❖ Asphalt kettles sometimes catch fire. Having one located inside a building would present a serious smoke problem, as well as the fire hazards of asphalt spills flowing to lower floors or the release of LP-gas inside the building. Having one located next to quantities of combustible materials would also represent a fire hazard, as well as the possibility that splashes and splatters could damage construction materials beyond use. Keeping egress pathways and other travel lanes free of obstructions provides a needed

immediate exit from an area where an asphalt kettle-related incident might occur and enhances access to such areas for the fire department.

**303.3 Location of fuel containers.** Fuel containers shall be located not less than 10 feet (3048 mm) from the burner.

**Exception:** Containers properly insulated from heat or flame are allowed to be within 2 feet (610 mm) of the burner.

- ❖ This section reduces the likelihood that any gas or vapors escaping from fuel containers would be ignited by the open flame of the kettle burner and that the heat of the burner would cause overheating of the fuel containers.

The exception acknowledges the greater safety of insulated containers.

**303.4 Attendant.** An operating kettle shall be attended by not less than one employee knowledgeable of the operations and hazards. The employee shall be within 100 feet (30 480 mm) of the kettle and have the kettle within sight. Ladders or similar obstacles shall not form a part of the route between the attendant and the kettle.

- ❖ Having a trained attendant watch the kettle helps to create a safe operation. The attendant is usually responsible for making sure the asphalt is at the proper temperature, the level of liquid in the kettle is maintained at the required level and the fuel supply for the kettle burner is adequate. The attendant should watch for any change in the kettle that would signal the potential for a safety hazard, and adjust the burner output or other factors to keep the kettle in safe operating condition. The attendant is also often responsible for keeping the area surrounding the kettle free of combustible materials and other construction debris that could become a safety hazard.

**303.5 Fire extinguishers.** There shall be a portable fire extinguisher complying with Section 906 and with a minimum 40-B:C rating within 25 feet (7620 mm) of each asphalt (tar) kettle during the period such kettle is being utilized. Additionally, there shall be one portable fire extinguisher with a minimum 3-A:40-B:C rating on the roof being covered.

- ❖ This section defines the type and size of extinguisher that must be available for use, both on the ground near the kettle and on the roof level to which the asphalt is being applied. In the event of a kettle fire, water should not be used as an extinguishing agent because it could cause the molten asphalt to froth and possibly overflow the kettle or spatter over anything or anyone in the surrounding area. See also the commentary to Section 3317.3 for roofing operations during construction.

**303.6 Lids.** Asphalt (tar) kettles shall be equipped with tight-fitting lids.

- ❖ A tight-fitting lid on a hot kettle limits the air supply available to feed a kettle fire. Any fire that might start in a closed kettle will quickly burn itself out because of the limited amount of air available for combustion. The lid also helps prevent splashes and splatters that could cause personal injury.

**303.7 Hi-boys.** Hi-boys shall be constructed of noncombustible materials. Hi-boys shall be limited to a capacity of 55 gallons (208 L). Fuel sources or heating elements shall not be allowed as part of a hi-boy.

- ❖ Hi-boys are used on the roof of a building to transport hot asphalt from a point of supply near the edge of the roof to the site of the roofing application. Due to the hazards of molten asphalt discussed in Section 303.1, hi-boys are limited in size to control the maximum amount of potential spills on the roof, which could ignite and pose a high-challenge fire-suppression operation for the fire department. A limited size also enhances the movability and stability of the hi-boy, thus reducing the potential for a tip over. As a further safeguard against a fire incident, hi-boys are prohibited from being fired or equipped with a fuel source for firing. Hi-boys must also be constructed of noncombustible materials to enhance their durability and prevent the container from contributing fuel to a fire. Hi-boys should be well-maintained, including the frame; steering mechanism; tires or wheels; faucets and fill connections (see commentary, Section 202 for the definition of “Hi-boy”).

**303.8 Roofing kettles.** Roofing kettles shall be constructed of noncombustible materials.

- ❖ The requirement for noncombustible materials represents sound safety practice as well as good business practice. Portions of kettles constructed of combustible materials can be easily destroyed and could lead to larger fires. Replacement of destroyed kettles would be expensive. Paying for other fire damage would be even more costly.

Also note that roofing mops soaked in asphalt or pitch must never be left inside a building, near heating equipment or near combustible materials. These mops are subject to spontaneous heating no matter what material they are made of.

**303.9 Fuel containers under air pressure.** Fuel containers that operate under air pressure shall not exceed 20 gallons (76 L) in capacity and shall be *approved*.

- ❖ Limiting the size of pressurized fuel containers limits the probability of a container becoming a major fuel

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source in case of a kettle fire. Requiring the use of approved containers gives the fire code official more control over the type and suitability of the vessel to be used under pressure.

### SECTION 304 COMBUSTIBLE WASTE MATERIAL

**304.1 Waste accumulation prohibited.** Combustible waste material creating a fire hazard shall not be allowed to accumulate in buildings or structures or upon premises.

❖ Accumulated waste, trash, construction debris and other natural materials, such as grass clippings, leaves and shrubbery cuttings, can become a serious fire hazard. The three subsections that follow this general statement address the most common situations.

**304.1.1 Waste material.** Accumulations of wastepaper, wood, hay, straw, weeds, litter or combustible or flammable waste or rubbish of any type shall not be permitted to remain on a roof or in any *court*, yard, vacant lot, alley, parking lot, open space, or beneath a grandstand, *bleacher*, pier, wharf, manufactured home, recreational vehicle or other similar structure.

❖ This section considers the kind of waste material that is most likely to accumulate during construction, renovation, additions or demolition and is often referred to as “the housekeeping section.” It prohibits disorderly, unkempt storage or accumulation of trash, waste rags, wastepaper, scrub brush and weeds, litter and other combustible materials. Litter and trash represent a serious fire hazard because of their ease of ignition and rapid heat release once ignited. The importance of maintaining property and buildings in good order seems obvious, but sloppy housekeeping still occurs and can be the cause of serious fires. In one of the most serious fires in recent years, improper storage of linseed-oil-soaked rags used to refinish paneling in a high-rise office building caused a fire that destroyed eight floors of the building and killed three fire fighters.

**304.1.2 Vegetation.** Weeds, grass, vines or other growth that is capable of being ignited and endangering property, shall be cut down and removed by the *owner* or occupant of the premises. Vegetation clearance requirements in urban-wildland interface areas shall be in accordance with the *International Wildland-Urban Interface Code*.

❖ Accumulations of natural waste, such as grass clippings, weed growth and shrubbery cuttings, are not only unsightly, but also represent a serious fire hazard. All too often these accumulations occur at or near fence lines that are adjacent to streets or alleys. This makes accidental ignition by a cigarette butt tossed from a passing vehicle a good possibility. Common sense tells us that removal of this kind of waste is beneficial. The rules of nearly all jurisdictions make waste control and removal the responsibility of the building or property owner, his or her agent, the

tenant or the contractor if work is being done on the site. Uncontrolled vegetation growth poses substantial risk to areas designated as wildland-urban interface areas. Accordingly, such areas must comply with the provisions of the *International Wildland-Urban Interface Code*<sup>®</sup> (IWUIC<sup>®</sup>).

**304.1.3 Space underneath seats.** Spaces underneath grandstand and bleacher seats shall be kept free from combustible and flammable materials. Except where enclosed in not less than 1-hour fire-resistance-rated construction in accordance with the *International Building Code*, spaces underneath grandstand and bleacher seats shall not be occupied or utilized for purposes other than *means of egress*.

❖ Numerous fires in grandstands and stadiums have shown over the years that the accumulation of flammable or combustible materials under grandstand seating areas can lead to fire disasters. Except as noted in the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>), areas under grandstand seating must be kept free of flammable materials, including accumulations of waste or trash. One of the best ways to prevent a fire is to make certain there is no fuel to feed one.

The IBC does allow space under the stands to be used for purposes other than means of egress if that space is separated from the seating area by construction having at least a 1-hour fire-resistance rating. The separation is intended to allow time for occupants in the seating to vacate if a fire should occur. The fire code official would usually have to approve plans for use of space under the stands for concession stands, sales areas or storage areas.

**304.2 Storage.** Storage of combustible rubbish shall not produce conditions that will create a nuisance or a hazard to the public health, safety or welfare.

❖ Storage of combustible rubbish either indoors or outdoors must be approved by the fire code official. Combustibles should be accumulated in noncombustible containers, such as metal trash cans with tight lids, steel barrels or steel dumpster bins, which should be removed from the site regularly. The use of plastic waste containers should be discouraged due to the extremely high fuel content of such materials, which can sometimes be several times the fuel content of the waste material they contain. Such containers could, under fire conditions, cause rapid fire spread and overtax sprinkler systems, where installed. This section mentions public health as well as safety and welfare, indicating concern over retention of decomposing organic waste as well as flammable and combustible materials.

**304.3 Containers.** Combustible rubbish, and waste material kept within or near a structure shall be stored in accordance with Sections 304.3.1 through 304.3.4.

❖ Proper containers must be used to improve the safety of indoor or outdoor storage (in close proximity to buildings) of trash and isolate readily combustible materials. This section introduces the more detailed requirements in Sections 304.3.1 through 304.3.4.

**304.3.1 Spontaneous ignition.** Materials susceptible to spontaneous ignition, such as oily rags, shall be stored in a *listed* disposal container. Contents of such containers shall be removed and disposed of daily.

❖ Disposal containers, often called “waste cans” or “oily rag cans,” used for storage of materials that might auto-ignite as a result of the spontaneous combustion process must be tested and listed for that use by a recognized testing laboratory or agency and must bear a label showing that they have been tested, along with the name of the testing agency. Such containers are most commonly round and generally available in sizes ranging from 5 to 40 gallons (19 to 151 L). They are equipped with a manual or foot treadle-operated lid that opens to a maximum angle of 60 degrees (1.05 rad) and closes by gravity. These containers are designed to prevent continuing combustion of the contents if ignition occurs. Container design includes features that keep the can body containing waste from coming into contact with combustible surfaces of walls or floors (see commentary, Section 202, for the definition of “Listed”). Daily disposal of container contents reduces the amount of time that oily materials will lie dormant, generating internal heat that can lead to ignition. UL 32 provides further information on the construction, testing and listing of these containers.

**304.3.2 Capacity exceeding 5.33 cubic feet.** Containers with a capacity exceeding 5.33 cubic feet (40 gallons) (0.15 m<sup>3</sup>) shall be provided with lids. Containers and lids shall be constructed of noncombustible materials or of combustible materials with a peak rate of heat release not exceeding 300 kW/m<sup>2</sup> where tested in accordance with ASTM E1354 at an incident heat flux of 50 kW/m<sup>2</sup> in the horizontal orientation.

**Exception:** Wastebaskets complying with Section 808.

❖ Requiring larger containers to meet stricter conditions is common sense. The larger the volume of waste each container holds, the larger the fire hazard. Isolating the containers from one another with lids helps reduce the possibility that a fire in one container will spread to nearby containers. The lid also helps to smother a fire within the container by limiting the oxygen available to feed it. Additionally, closed containers protect flammable and combustible materials from potential external ignition sources.

Combustible materials, used in such containers, must meet the performance criteria stated when tested in accordance with ASTM E1354. Most non-metallic waste containers are manufactured from polyethylene, which has a fuel value of 20,050 Btu per pound (46 636 kJ/kg). In comparison, the fuel value of newsprint paper is 9,000 Btu per pound (20 934 kJ/kg). To contain combustible waste in another combustible material that has twice the fuel potential value makes little sense. This section will prohibit the use of larger, nonfire-retardant polyethylene trash

containers within a structure. Several manufacturers have had the formulation for years to make a fire-retardant polyethylene.

The exception to this general provision points to more specific requirements for waste containers in Group I-3 facilities contained in Section 808.1.

**304.3.3 Capacity exceeding 1.5 cubic yards.** Dumpsters and containers with an individual capacity of 1.5 cubic yards [40.5 cubic feet (1.15 m<sup>3</sup>)] or more shall not be stored in buildings or placed within 5 feet (1524 mm) of combustible walls, openings or combustible roof eave lines.

**Exceptions:**

1. Dumpsters or containers in areas protected by an *approved automatic sprinkler system* installed throughout in accordance with Section 903.3.1.1, 903.3.1.2 or 903.3.1.3.
2. Storage in a structure shall not be prohibited where the structure is of Type I or IIA construction, located not less than 10 feet (3048 mm) from other buildings and used exclusively for dumpster or container storage.

❖ Although waste containers of this size are nearly always constructed of welded steel because of the weight of the waste load, the very fact that the waste load is large makes the containers a large fire hazard. Keeping these large containers in the open and away from combustible construction is the obvious way to keep the fire hazard low.

Exception 1 permits storage of these large containers indoors if the area is protected by an approved sprinkler system. It would be up to the fire code official to determine the maximum quantities that could be stored under these conditions.

Exception 2 applies only to buildings that are of fire-resistance-rated construction and are used exclusively for container storage. Such facilities might be found in scrap yards or at recycling centers, but rarely, if ever, in other occupancies.

**304.3.4 Capacity of 1 cubic yard or more.** Dumpsters with an individual capacity of 1.0 cubic yard [200 gallons (0.76 m<sup>3</sup>)] or more shall not be stored in buildings or placed within 5 feet (1524 mm) of combustible walls, openings or combustible roof eave lines unless the dumpsters are constructed of noncombustible materials or of combustible materials with a peak rate of heat release not exceeding 300 kW/m<sup>2</sup> where tested in accordance with ASTM E1354 at an incident heat flux of 50 kW/m<sup>2</sup> in the horizontal orientation.

**Exceptions:**

1. Dumpsters in areas protected by an *approved automatic sprinkler system* installed throughout in accordance with Section 903.3.1.1, 903.3.1.2 or 903.3.1.3.
2. Storage in a structure shall not be prohibited where the structure is of Type I or IIA construction, located

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not less than 10 feet (3048 mm) from other buildings and used exclusively for dumpster or container storage.

- ❖ Medium-density polyethylene dumpsters up to 9 cubic yards [27 ft<sup>3</sup> (0.76 m<sup>3</sup>)] in capacity and that have a fuel content of 20,020 Btu per pound (46 567 kJ/kg) [by comparison, municipal solid waste averages 4,500 Btu/lb (10 467 kJ/kg)] are now being distributed and used. Medium-density polyethylene is essentially equal to the fuel value for gasoline and becomes a burning liquid that spreads and flows when involved in a fire. As such, placing them 5 feet (1524 mm) away from a nearby structure will be of little value unless their flammability hazard is mitigated. This section does that by limiting container heat release rate and heat flux using the test parameters of ASTM E1354. The peak rate of heat release criterion is consistent with the one in Sections 304.3.2 and 808.1.

Exception 1 permits storage of these containers indoors if the area is protected by an approved sprinkler system. It would be up to the fire code official to determine the maximum quantities that could be stored under these conditions.

Exception 2 applies only to buildings that are of fire-resistance-rated construction and are used exclusively for waste container storage. Such facilities might be found in scrap yards or at recycling centers, but rarely, if ever, in other occupancies.

### SECTION 305 IGNITION SOURCES

**305.1 Clearance from ignition sources.** Clearance between ignition sources, such as luminaires, heaters, flame-producing devices and combustible materials, shall be maintained in an *approved* manner.

- ❖ Establishing safe clearances will usually mean following the requirements of the IBC or other codes adopted by the jurisdiction as well as having the approval of the fire code official.

**305.2 Hot ashes and spontaneous ignition sources.** Hot ashes, cinders, smoldering coals or greasy or oily materials subject to spontaneous ignition shall not be deposited in a combustible receptacle, within 10 feet (3048 mm) of other combustible material including combustible walls and partitions or within 2 feet (610 mm) of openings to buildings.

**Exception:** The minimum required separation distance to other combustible materials shall be 2 feet (610 mm) where the material is deposited in a covered, noncombustible receptacle placed on a noncombustible floor, ground surface or stand.

- ❖ This section covers two different, but equally serious, ignition source problems. First, hot ashes, embers and cinders from fireplaces, stoves or other fireboxes must never be placed in a combustible container. This point seems almost too obvious to be mentioned, but every year fires are started when someone carelessly scoops ashes containing glowing

embers into paper bags or cardboard cartons. It is also not uncommon to see construction scrap being burned in steel drums on construction sites in cold weather. Care must be taken when emptying ashes from those containers to make sure no hot coals get dumped on paper waste or other combustible materials.

The second problem, greasy or oily materials subject to spontaneous combustion, is addressed by requiring such materials to be placed in listed containers (see commentary, Section 304.3.1).

In both cases, safe distances must be maintained from combustible construction and building openings for added protection.

The exception recognizes the added protection of tight-fitting covers on noncombustible trash containers as well as the reduced fire hazard when the containers are placed on a noncombustible surface.

**305.3 Open-flame warning devices.** Open-flame warning devices shall not be used along an excavation, road, or any place where the dislodgment of such device might permit the device to roll, fall or slide on to any area or land containing combustible material.

- ❖ Open-flame warning devices other than fusees used to mark road accidents or other short-term emergencies are rarely used today. The old-fashioned kerosene pots used to mark construction hazards in dark areas have been largely replaced by “sawhorse” barriers with battery-powered flashing lights. But, even though use may be limited, the warning in this section is nonetheless real. One fusee not firmly fixed in the ground or on another stable surface can fall into a roadside ditch filled with dry weeds and cause a roadside fire that could spread into dry woodland or cropland, causing enormous fire damage. Likewise, a burned-out hand-held fusee that is carelessly tossed aside while still hot could ignite dry refuse.

**305.4 Deliberate or negligent burning.** It shall be unlawful to deliberately or through negligence set fire to or cause the burning of combustible material in such a manner as to endanger the safety of persons or property.

- ❖ The deliberate setting of fires, whether in a structure or in a waste container located where it could endanger a structure or its occupants, is normally considered arson, which is a felony that is punishable by a lengthy prison sentence. Fortunately, arson is not that common. More likely, a fire would be caused by carelessness or by someone not considering the consequences of his or her actions.

Regardless of the circumstances, fires must be avoided. Following the requirements in the code as well as those in the IBC will help to maintain a safe, fire-free site. On construction or demolition sites, secure fencing around the site and its waste containers is good protection. Following good housekeeping practices, including routine disposal of combustible materials, is also an excellent first line of protection against fire. An ignition source cannot cause damage

to property or endanger life unless there is a fuel load to be ignited.

**305.5 Unwanted fire ignitions.** Acts or processes that have caused repeated ignition of unwanted fires shall be modified to prevent future ignition.

- ❖ Many industrial processes have the potential to produce frequent nuisance fires that generate unwanted alarms necessitating emergency responses that risk the health and safety of fire fighters and citizens. This section empowers the fire code official to alter such processes to mitigate nuisance fires.

### SECTION 306

#### MOTION PICTURE PROJECTION ROOMS AND FILM

**306.1 Motion picture projection rooms.** Electric arc, xenon or other light source projection equipment that develops hazardous gases, dust or radiation and the projection of ribbon-type cellulose nitrate film, regardless of the light source used in projection, shall be operated within a motion picture projection room complying with Section 409 of the *International Building Code*.

- ❖ The requirements in this section are specific to spaces housing equipment used to project cellulose acetate film, also called safety film, which is in common use today. This film has about the same fire hazard characteristics as paper of the same thickness and form. The equipment used to project the film, however, may also present fire or health hazards that can be minimized by proper construction of the room. Section 409 of the IBC covers these construction requirements in detail.

The older type of motion picture film was made of cellulose nitrate, which is also called pyroxylin, which presents a significantly greater fire hazard and, therefore, calls for stricter construction requirements, including sprinklers. These requirements are contained in Sections 6504 and 903.2.5.3. The greater hazard of cellulose nitrate film, which today is found mainly in museum collections and other archives or film preservation facilities, comes from the characteristic of the material to begin degrading at temperatures below its ignition temperature, causing a chemical reaction that can lead to spontaneous combustion. The combustion products of cellulose nitrate are both flammable and extremely toxic because they include oxides of nitrogen. Cellulose nitrate film burns at a rate that is as much as 15 times the rate of common combustibles.

**306.2 Cellulose nitrate film storage.** Storage of cellulose nitrate film shall be in accordance with NFPA 40.

- ❖ NFPA 40 contains minimum requirements for a reasonable level of protection for the storage and handling of cellulose nitrate film. The standard does not address the manufacture of the film because it has not been made in the United States since 1951.

### SECTION 307 OPEN BURNING, RECREATIONAL FIRES AND PORTABLE OUTDOOR FIREPLACES

**307.1 General.** A person shall not kindle or maintain or authorize to be kindled or maintained any *open burning* unless conducted and *approved* in accordance with Sections 307.1.1 through 307.5.

- ❖ To control the hazards associated with it, open burning may not be authorized or undertaken without the approvals specified in Section 307. See the commentary to Section 202 for the definition of “Open burning” for a discussion of the types of burning intended to be regulated by this section.

**307.1.1 Prohibited open burning.** Open burning shall be prohibited when atmospheric conditions or local circumstances make such fires hazardous.

**Exception:** Prescribed burning for the purpose of reducing the impact of wildland fire when authorized by the *fire code official*.

- ❖ This section is intended to protect the public from irresponsible burning when it endangers the safety, health or welfare of persons near the burn site. The terms “offensive” and “objectionable” in the previous code edition were undefined and unreasonably subjective, making the prohibition of open burning due to smoke emissions unenforceable. Also, there is not a referenced standard that provides a method for measuring or otherwise determining when smoke emissions are “offensive or objectionable.” In the absence of such guidance, the legal requirements for consistency of enforcement were unattainable.

Fundamentally and historically, the code has regulated fire hazards and not poor air quality caused by smoke from fires. Experience strongly suggests that the previous wording encouraged citizens to request intervention by the fire code official to resolve neighborhood disputes regarding smoke emissions from many forms of outdoor fires that citizens correctly or incorrectly believed to be “open burning” (e.g., recreational fires, bonfires, charcoal burners, etc.); such situations should be civil matters rather than unlawful acts subject to the penalties prescribed in Section 109.

The revised wording empowers the fire code official to prohibit open burning when such fires would, in fact, be hazardous because of measurable environmental factors, such as weather (e.g., wind, temperature, relative humidity) or fuel characteristics (e.g., fuel moisture content).

The exception allows for prescribed burning that is conducted in an effort to minimize the fuel load in wildland and interface areas. Such prescribed burning is a common practice and is done with great planning and forethought and includes safeguards for proper fire control. Annually, several million wildland acres are subjected to prescribed burning in the U.S. to eliminate hazardous fuels, alter vegetation to pro-

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mote the growth of fuels that produce less heat and burn slower, improve the habitat for wildlife and vegetation, control nuisance pests, and improve access for replanting and other recreational activities. The ability for a fire agency to utilize prescribed burning operations in a season when the fire can be more easily controlled reduces the personnel and resources needed to control a wildland fire when it occurs, and increases the likelihood that fewer structures and lives will be lost to wildland fire.

**307.2 Permit required.** A permit shall be obtained from the *fire code official* in accordance with Section 105.6 prior to kindling a fire for recognized silvicultural or range or wildlife management practices, prevention or control of disease or pests, or a bonfire. Application for such approval shall only be presented by and permits issued to the *owner* of the land upon which the fire is to be kindled.

❖ This section defines a rather narrow range of purposes for which permits will be issued. Section 105.6.30 covers open-burning permits in general. This section restricts permissible fires to those used for silviculture (the cultivation of forests and shade trees); range or wildlife management; pest control; and bonfires as defined in the code. This section further restricts the permitting process to owners of the land on which the fire is to be kindled (see commentary, Section 301.2).

**307.2.1 Authorization.** Where required by state or local law or regulations, *open burning* shall only be permitted with prior approval from the state or local air and water quality management authority, provided that all conditions specified in the authorization are followed.

❖ This section requires permit applicants to comply with state and local regulations covering air and water quality as well as safety regulations established by the jurisdiction having authority.

**307.3 Extinguishment authority.** Where open burning creates or adds to a hazardous situation, or a required permit for open burning has not been obtained, the *fire code official* is authorized to order the extinguishment of the open burning operation.

❖ When the fire code official finds that open burning creates a hazardous condition such as the potential for igniting exposures or is unsafe because of atmospheric conditions, this section establishes the authority of the fire code official to order that the open burning fire be extinguished. Note that the fire department is not included in the extinguishment scenario but, rather, the section relies on the provisions of Section 109.3.2, which establishes who must comply with the extinguishment order, i.e., "...the owner, operator, occupant or other person responsible for the condition or violation...." This enhances public safety by not requiring the commitment of a piece of fire apparatus to extinguish an open-burning fire that is not an emergency (see commentary, Section 109.3.2).

**307.4 Location.** The location for *open burning* shall be not less than 50 feet (15 240 mm) from any structure, and provisions shall be made to prevent the fire from spreading to within 50 feet (15 240 mm) of any structure.

### Exceptions:

1. Fires in *approved* containers that are not less than 15 feet (4572 mm) from a structure.
2. The minimum required distance from a structure shall be 25 feet (7620 mm) where the pile size is 3 feet (914 mm) or less in diameter and 2 feet (610 mm) or less in height.

❖ The 50-foot (15 240 mm) restriction applies to large fires in large open areas, such as those defined in Section 307.2. Exception 1 refers to fires that generally would be considerably smaller or would be controlled by the container in which they burn, presenting a reduced exposure risk to nearby buildings. Exception 2 allows a reduction in clearance from buildings based on the lesser hazard of fires that are limited in size.

**307.4.1 Bonfires.** A bonfire shall not be conducted within 50 feet (15 240 mm) of a structure or combustible material unless the fire is contained in a barbecue pit. Conditions that could cause a fire to spread within 50 feet (15 240 mm) of a structure shall be eliminated prior to ignition.

❖ Bonfires usually are large and associated with some kind of planned event (for example, a school pep rally, holiday celebration or camp celebration). This section restricts the location of these large fires to open areas in which sparks and burning embers would be unlikely to endanger structures and smoke would not be a significant hazard to public health. Allowing a bonfire in a barbecue pit automatically restricts the size of the fire to the fuel load that can be contained within the noncombustible fire pit.

**307.4.2 Recreational fires.** *Recreational fires* shall not be conducted within 25 feet (7620 mm) of a structure or combustible material. Conditions that could cause a fire to spread within 25 feet (7620 mm) of a structure shall be eliminated prior to ignition.

❖ Recreational fires are usually fairly small, but can still represent a significant fire hazard if the area in which they are kindled is not kept free of combustible trash and debris. Basic fire safety practices followed by campers make good guidelines. No fire should ever be kindled in a location where it would endanger structures or would be likely to ignite combustible materials close by.

**307.4.3 Portable outdoor fireplaces.** Portable outdoor fireplaces shall be used in accordance with the manufacturer's instructions and shall not be operated within 15 feet (3048 mm) of a structure or combustible material.

**Exception:** Portable outdoor fireplaces used at one- and two-family *dwellings*.

❖ Portable outdoor fireplaces (also known as patio fireplaces) designed to burn solid fuel are available at

retailers ranging from local grocery stores to big box retailers. Their widespread availability and use created considerable confusion for citizens and the fire service regarding if or how they were regulated by the code since Sections 307 and 308 were essentially silent on the use of this specific type of device. Fires in portable outdoor fireplaces could not be considered a “recreational fire” because critical to that definition is the concept that the fire is not contained in an incinerator, outdoor fireplace, barbecue grill or barbecue pit. It could then have been suggested that a portable outdoor fireplace is merely a type of “outdoor fireplace,” but the code did not contain any references pertaining to where an outdoor fireplace could be located or operated. Since the use and hazards associated with operating such fireplaces are more consistent with the type of activities regulated in Section 307 than other types of open flames addressed in Section 308, specific regulations are now provided in Section 307.

This section makes it clear that the use of portable outdoor fireplaces is specifically regulated by the code. It prohibits the use of these devices within 15 feet (3048 mm) of any structure and is consistent with Section 307.4, Exception 1. Also, consistent with regulations for other appliances, this section relies upon compliance with the manufacturer’s instructions for additional safeguards.

The exception exempts one- and two-family dwellings from the requirements of this section. In those occupancies, the level of familiarity and control exercised by the building occupants is recognized as offsetting the hazards of using these devices. There are practical difficulties involved in enforcing such regulations in one- and two-family dwellings as well.

**307.5 Attendance.** *Open burning, bonfires, recreational fires* and use of portable outdoor fireplaces shall be constantly attended until the fire is extinguished. A minimum of one portable fire extinguisher complying with Section 906 with a minimum 4-A rating or other *approved* on-site fire-extinguishing equipment, such as dirt, sand, water barrel, garden hose or water truck, shall be available for immediate utilization.

❖ This section reiterates basic common sense, but tends to be ignored quite often. Having one or more individuals responsible for keeping watch on a fire, even one of small size, is the first line of fire prevention. All too often news articles tell of wooden decks burning because hot embers from a charcoal grill fell unobserved onto the unprotected wooden surface, or of a huge brush or forest fire being caused by careless individuals who did not watch their campfires.

For practical purposes as well as for fire safety, some means of extinguishing a kindled fire should be kept close at hand. For small fires, a shovelful of dirt may be sufficient. For large fires, such as bonfires, large volumes of water may be necessary; however, no matter how much extinguishing equipment is available, it may prove useless unless someone is tending the fire and can sound an alarm.

## SECTION 308 OPEN FLAMES

**308.1 General.** Open flame, fire and burning on all premises shall be in accordance with Sections 308.1.1 through 308.4.1 and with other applicable sections of this code.

❖ This section establishes the scope of the requirements of Section 308 as being applicable to both indoor and outdoor situations involving open flames.

**308.1.1 Where prohibited.** A person shall not take or utilize an open flame or light in a structure, vessel, boat or other place where highly flammable, combustible or explosive material is utilized or stored. Lighting appliances shall be well-secured in a glass globe and wire mesh cage or a similar *approved* device.

❖ This section intends to maintain separation between ignitable combustible materials and ignition sources that involve an open flame in any vessel, structure or occupancy.

**308.1.2 Throwing or placing sources of ignition.** A person shall not throw or place, or cause to be thrown or placed, a lighted match, cigar, cigarette, matches, or other flaming or glowing substance or object on any surface or article where it can cause an unwanted fire.

❖ This section recognizes the hazard caused by carelessness in disposing of smoking materials and other flaming or glowing objects. Smoking in bed or in situations where the smoker could forget about lighted smoking materials has caused large numbers of fires and fatalities over the years. Lack of attention to fireplaces and ash pits has caused great property loss as well. As one example, a three-story fraternity house at Iowa State University in Ames, Iowa, was completely destroyed by the fire that resulted from a burning log tumbling from an overflowing ash pit onto a combustible floor surface.

Lighted cigarettes discarded through the windows of moving vehicles each year cause grass, brush and forest fires that consume huge acreage in open country as well as dwellings and other structures.

**308.1.3 Torches for removing paint.** A person utilizing a torch or other flame-producing device for removing paint from a structure shall provide not less than one portable fire extinguisher complying with Section 906 and with a minimum 4-A rating, two portable fire extinguishers, each with a minimum 2-A rating, or a water hose connected to the water supply on the premises where such burning is done. The person doing the burning shall remain on the premises 1 hour after the torch or flame-producing device is utilized.

❖ Any time an open flame is used to soften old paint in preparation for removal, there is a risk of fire that must be covered by having approved fire extinguishers or a water source readily available. The requirement for a 1-hour fire watch after discontinuing the use of the open flame covers the possibility that paint fragments could still be hot enough to ignite flammable or combustible materials that might be lying around. It also considers the possibility that the flame used to remove

## GENERAL REQUIREMENTS

paint from a combustible base material could heat that material to its ignition temperature and leave an almost undetectable smolder that might burst into flames later. Safe and effective means for removing paint at lower temperatures, such as warm-air heat devices capable of generating high-temperature convection air, are readily available for sale or rent and far less likely to result in an ignition of combustible materials.

**308.1.4 Open-flame cooking devices.** Charcoal burners and other open-flame cooking devices shall not be operated on combustible balconies or within 10 feet (3048 mm) of combustible construction.

### Exceptions:

1. One- and two-family *dwelling*s.
  2. Where buildings, balconies and decks are protected by an *automatic sprinkler system*.
  3. LP-gas cooking devices having LP-gas container with a water capacity not greater than 2<sup>1</sup>/<sub>2</sub> pounds [nominal 1 pound (0.454 kg) LP-gas capacity].
- ❖ This section contains a strict prohibition on the use of charcoal-burning grills and other open-flame cooking devices in the locations described. Its intent is to mitigate the potential for hot embers to fall from the firebox of the cooking device and ignite a combustible surface, such as a wooden balcony or deck. The 10-foot (3048 mm) separation also reduces the likelihood that fire-starting or cooking flare-ups will come in contact with combustible wall construction that is easily ignited.

Since this section appears to regulate only the operation of the cooking devices, it is often asked if the devices can even be located or stored in the locations described. In the case of LP-gas fired grills using containers larger than those described in Exception 3, the answer is generally no, based on Section 6.20.11.2 of NFPA 58, which does not allow larger containers to be transported through an occupied building. See Sections 6101.1 and 6104.1 of the code for references to NFPA 58.

In the case of locating non-LP-gas-fired cooking devices, the location would have to be approved by the fire code official. Note that the prohibition in this section would also apply to gas grills connected to the building's fuel gas piping system since they are still open flame cooking devices. See also Section 603.4.2.1.1.

Exception 1 exempts one- and two-family dwellings from the requirements of this section and would allow the use of LP-gas barbeque grills of any size on balconies of such buildings. In those occupancies, the level of familiarity and control exercised by the building occupants is recognized as offsetting the hazards of using open-flame cooking devices. There are practical difficulties involved in enforcing such regulations in one- and two-family dwellings as well. Exception 2 recognizes the added protection pro-

vided by sprinklers. Exception 3 allows small LP-gas burning devices such as the tabletop grills or units that might be used in cooking within residential occupancies.

**308.1.5 Location near combustibles.** Open flames such as from candles, lanterns, kerosene heaters and gas-fired heaters shall not be located on or near decorative material or similar combustible materials.

❖ Each year in nearly every county and community in the country at least one house fire occurs that is caused by a gas-fired space heater igniting nearby combustibles. Accidents involving candles and lanterns used in both outdoor and indoor settings are not at all uncommon. In nearly all of these incidents, the exercise of common sense and the practice of keeping ignition sources and fuel packages well separated could have prevented property damage or loss of life.

**308.1.6 Open-flame devices.** Torches and other devices, machines or processes liable to start or cause fire shall not be operated or used in or upon wildfire risk areas, except by a permit in accordance with Section 105.6 secured from the *fire code official*.

**Exception:** Use within inhabited premises or designated campsites that are not less than 30 feet (9144 mm) from grass-, grain-, brush- or forest-covered areas.

❖ This section establishes the fire code official's authority to control through the permitting process the use of open flames in areas susceptible to fires. The term "wildfire risk area" is defined in Chapter 2 of the code and is applied to land covered with grass, grain, brush, forest or similar vegetation that, if ignited, could pose a severe fire danger to surrounding areas. The exception recognizes open ground that is free of combustible materials as an acceptable barrier to fire spread [see the *International Wildland-Urban Interface Code*<sup>®</sup> (IWUIC<sup>®</sup>) for further information].

**308.1.6.1 Signals and markers.** Flame-employing devices, such as lanterns or kerosene road flares, shall not be operated or used as a signal or marker in or upon wildfire risk areas.

**Exception:** The proper use of fusees at the scenes of emergencies or as required by standard railroad operating procedures.

❖ This section prohibits the use of flame-producing devices as signal or marker devices except for the use of fusees to mark the scene of an emergency or where routinely employed in railroad procedures, such as when a train is stopped across a roadway not protected by permanent signal lights.

**308.1.6.2 Portable fueled open-flame devices.** Portable open-flame devices fueled by flammable or combustible gases or liquids shall be enclosed or installed in such a manner as to prevent the flame from contacting combustible material.

### Exceptions:

1. LP-gas-fueled devices used for sweating pipe joints or removing paint in accordance with Chapter 61.

2. Cutting and welding operations in accordance with Chapter 35.
3. Torches or flame-producing devices in accordance with Section 308.4.
4. Candles and open-flame decorative devices in accordance with Section 308.3.

❖ This section prohibits the use of portable devices in situations where they might be placed on unstable platforms or where they could be knocked over by human contact. The exceptions list the types of open-flame or heat-producing operations not regulated by this section but regulated elsewhere in the code.

**308.1.6.3 Sky lanterns.** A person shall not release or cause to be released an untethered sky lantern.

❖ Sky lanterns, variously known as Kongming lanterns, Chinese lanterns, fire balloons or fire parachutes, are typically made of paper and contain an open flame used to heat the air inside the device to make it airborne, similar to but on a much smaller scale than a hot air balloon. Once airborne, if these devices are untethered and their movement is thus unrestricted, they are subject to winds and other atmospheric conditions such that the location of the final landfall is completely unknown and uncontrolled by the user. Obviously, uncontrolled open flame devices descending out of the sky have a significant potential to start wildfires and structure fires.

**308.1.7 Religious ceremonies.** When, in the opinion of the *fire code official*, adequate safeguards have been taken, participants in religious ceremonies are allowed to carry hand-held candles. Hand-held candles shall not be passed from one person to another while lighted.

❖ This section has a very narrow application. As stated, only religious ceremonies are covered and the judgment of the fire code official is required for final approval. Prohibiting the passing of lighted candles from person to person is intended to minimize the opportunities for the candles to be dropped where they could become an ignition source for flammable or combustible materials or come into contact with clothing or hair. Spiritual significance may be attached to the use of candles in places of worship; therefore, the local fire code official should work closely with religious groups when enforcing this section.

**308.1.7.1 Aisles and exits.** Candles shall be prohibited in areas where occupants stand, or in an *aisle* or *exit*.

❖ This prohibition is intended to prevent accidents caused by lighted candles being knocked from their holders onto combustible furniture, carpeting or decorative materials. Candles are commonly found at seasonal religious observances where attendance often exceeds the norm. In case of an emergency, people must be able to move through the aisles toward the

exits without risking the ignition of clothing, hair or decorations.

**308.1.8 Flaming food and beverage preparation.** The preparation of flaming foods or beverages in places of assembly and drinking or dining establishments shall be in accordance with Sections 308.1.8.1 through 308.1.8.5.

❖ The regulations in this section of the code are necessary to give the fire code official guidance in allowing the preparation of flaming food and beverages to be conducted in restaurants in a safe manner. These types of foods, sometimes referred to as “flambé foods,” are prepared by adding a small amount of flammable or combustible liquid in the form of alcoholic beverages to the food and igniting it. Many restaurants prepare popular selected dishes, such as cherries jubilee, brandied peaches and flaming bananas, in this manner, usually tableside within close proximity of the customers. The proximity plus the intentional ignition of flammable liquids in a Group A occupancy make regulation of this process appropriate. Note that the regulations in this section are not intended to address a fuel source, such as Sterno, used to keep food warm.

**308.1.8.1 Dispensing.** Flammable or *combustible liquids* used in the preparation of flaming foods or beverages shall be dispensed from one of the following:

1. A 1-ounce (29.6 ml) container.
2. A container not exceeding 1-quart (946.5 ml) capacity with a controlled pouring device that will limit the flow to a 1-ounce (29.6 ml) serving.

❖ These dispensing provisions limit the amount of flammable or combustible liquid being transported around the restaurant for use in flaming food or beverage preparation in order to minimize the fuel potential in a fire incident involving such operations. Item 1 could be referring to a typical shot glass. Item 2 could be referring to a “jigger-pourer,” which is a device that fits into the neck of a bottle and is intended to limit the per-pour quantity to 1 ounce.

**308.1.8.2 Containers not in use.** Containers shall be secured to prevent spillage when not in use.

❖ Securing the containers used in flaming food or beverage preparation while not in use reduces the likelihood of an accidental spill.

**308.1.8.3 Serving of flaming food.** The serving of flaming foods or beverages shall be done in a safe manner and shall not create high flames. The pouring, ladling or spooning of liquids is restricted to a maximum height of 8 inches (203 mm) above the receiving receptacle.

❖ Limiting the height from which flammable or combustible liquids are poured reduces the likelihood of a spill or overpour that might miss the target dish and be ignited by a table candle, smoking materials or another ignition source.

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**308.1.8.4 Location.** Flaming foods or beverages shall be prepared only in the immediate vicinity of the table being serviced. They shall not be transported or carried while burning.

❖ This section prohibits movement or transport of “flambé foods” while they are burning in order to reduce the potential for incidents wherein the tray or dish might be dropped or tipped causing a spill of burning liquid, which, while limited in size, could lead to a panic reaction by restaurant patrons or, if spilled on a patron, could cause serious burn injuries.

**308.1.8.5 Fire protection.** The person preparing the flaming foods or beverages shall have a wet cloth towel immediately available for use in smothering the flames in the event of an emergency.

❖ Flaming-food preparation is a cooking hazard much the same as stovetop preparation. An efficient method for extinguishing a stovetop fire in a frying pan or similar utensil is to put the cover on the utensil to exclude oxygen. In flambé preparation, the food is prepared in a relatively small pan or even in the dish in which it will be served and in which the flames can be easily smothered by a wet towel. Note that this precautionary measure is in addition to the portable fire extinguishers to be provided in accordance with Section 906.

**308.2 Permits required.** Permits shall be obtained from the *fire code official* in accordance with Section 105.6 prior to engaging in the following activities involving open flame, fire and burning:

1. Use of a torch or flame-producing device to remove paint from a structure.
2. Use of open flame, fire or burning in connection with Group A or E occupancies.
3. Use or operation of torches and other devices, machines or processes liable to start or cause fire in or upon wild-fire risk areas.

❖ This section establishes the authority of the fire code official to control the hazards of using open flames through the permitting process. The restrictions here do not prohibit the use of open-flame devices in the listed activities, but they do allow the fire code official to inspect plans and ongoing activities to make certain they are safe for the occupancy in which they are held. Permit applicants should be required to demonstrate that their regulated activities comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit and Sections 105.6.33 and 105.6.34 for a discussion of specific operational permits for the indicated regulated activities. The permit process also serves to notify the fire department of the increased hazard at particular locations.

**308.3 Group A occupancies.** Open-flame devices shall not be used in a Group A occupancy.

### Exceptions:

1. Open-flame devices are allowed to be used in the following situations, provided *approved* precautions are taken to prevent ignition of a combustible material or injury to occupants:
  - 1.1. Where necessary for ceremonial or religious purposes in accordance with Section 308.1.7.
  - 1.2. On stages and platforms as a necessary part of a performance in accordance with Section 308.3.2.
  - 1.3. Where candles on tables are securely supported on substantial noncombustible bases and the candle flames are protected.
2. Heat-producing equipment complying with Chapter 6 and the *International Mechanical Code*.
3. Gas lights are allowed to be used provided adequate precautions satisfactory to the *fire code official* are taken to prevent ignition of combustible materials.

❖ The use of open-flame devices in Group A occupancies where large numbers of people gather for entertainment, instruction, food or drink consumption, deliberation, awaiting transportation or social or religious functions increases the likelihood of the occupants coming into contact with these devices and is, therefore, prohibited. Safe alternatives to open-flame devices should be used where practical, especially in restaurants and other assembly occupancies where the focus is on atmosphere rather than symbolism or religious significance.

Exception 1 refers to Sections 308.1.7 and 308.3.2 for use in religious and theatrical settings as well as permitting use on tabletops when properly secured and protected.

Exception 2 refers to building service heat-producing equipment that meets other code requirements.

Exception 3 covers gas lights installed with proper flame safeguards and with the approval of the fire code official. This kind of lighting is often a permanent installation that would be covered by additional code requirements.

**308.3.1 Open-flame decorative devices.** Open-flame decorative devices shall comply with all of the following restrictions:

1. Class I and Class II liquids and LP-gas shall not be used.
2. Liquid- or solid-fueled lighting devices containing more than 8 ounces (237 ml) of fuel must self-extinguish and not leak fuel at a rate of more than 0.25 teaspoon per minute (1.26 ml per minute) if tipped over.
3. The device or holder shall be constructed to prevent the spillage of liquid fuel or wax at the rate of more

than 0.25 teaspoon per minute (1.26 ml per minute) when the device or holder is not in an upright position.

4. The device or holder shall be designed so that it will return to the upright position after being tilted to an angle of 45 degrees (0.79 rad) from vertical.

**Exception:** Devices that self-extinguish if tipped over and do not spill fuel or wax at the rate of more than 0.25 teaspoon per minute (1.26 ml per minute) if tipped over.

5. The flame shall be enclosed except where openings on the side are not more than 0.375-inch (9.5 mm) diameter or where openings are on the top and the distance to the top is such that a piece of tissue paper placed on the top will not ignite in 10 seconds.
6. Chimneys shall be made of noncombustible materials and securely attached to the open-flame device.

**Exception:** A chimney is not required to be attached to any open-flame device that will self-extinguish if the device is tipped over.

7. Fuel canisters shall be safely sealed for storage.
8. Storage and handling of *combustible liquids* shall be in accordance with Chapter 57.
9. Shades, where used, shall be made of noncombustible materials and securely attached to the open-flame device holder or chimney.
10. Candelabras with flame-lighted candles shall be securely fastened in place to prevent overturning, and shall be located away from occupants using the area and away from possible contact with drapes, curtains or other combustibles.

- ❖ This class of open-flame devices includes items such as wall-mounted candles or torch sconces; bug-repellant candles in glass jars or metal cans; tabletop candles and oil lamps; free-standing torch holders and candelabras. The criteria for the use of this kind of device are all intended to enhance safety.

**308.3.2 Theatrical performances.** Where *approved*, open-flame devices used in conjunction with theatrical performances are allowed to be used when adequate safety precautions have been taken in accordance with NFPA 160.

- ❖ Theatrical performances typically occur on stages and involve large quantities of combustible materials. Hazards associated with stages can include: combustible scenery and lighting suspended overhead; scenic elements, contents and acoustical treatment on the back and sides of the stage; workshops, scene docks and dressing rooms located around the stage perimeter, and storage areas and property rooms located underneath the stage. Because of the inherent dangers associated with the introduction of open flames into such a fuel-rich environment, the use of open-flame devices in theatrical performances requires review, evaluation and the approval of the fire code official on a case-by-case basis and must be safeguarded in accordance with the provisions of

NFPA 160. For further discussion of the special hazard nature of stages, see the commentary for Section 410 of the IBC.

**308.4 Group R occupancies.** Open flame, fire and burning in Group R occupancies shall comply with the requirements of Sections 308.1 through 308.1.6.3 and Section 308.4.1.

- ❖ This section establishes the applicability of the indicated requirements of Section 308 to open flame activities in Group R occupancies.

**308.4.1 Group R-2 dormitories.** Candles, incense and similar open-flame-producing items shall not be allowed in sleeping units in Group R-2 dormitory occupancies.

- ❖ This section provides the fire code official with the needed authority to control the introduction of potential ignition sources into Group R-2 dormitory occupancies and help to stop dorm fires before lives are endangered and potentially lost. Fire represents a significant risk to life and property in dormitory occupancies, particularly at residential schools, colleges and universities. The large number of young people living in close proximity to one another creates the potential for a relatively small fire to have serious and possibly fatal consequences.

Candle and incense use presents a significant life safety risk in the close confines of a typical residence hall. According to NFPA fire loss data, there is an average of 1,425 fires each year in dormitories, causing \$6.3 million in direct property damage. The data show that candle fires alone cause a staggering \$2.3 million in direct property damage each year in these occupancies, which makes them the most costly type of fire in a residence hall. Prohibiting the use of candles, incense and similar open flame items reduces the potential ignition sources for a fire, providing for a safer living environment.

## SECTION 309

### POWERED INDUSTRIAL TRUCKS AND EQUIPMENT

**309.1 General.** Powered industrial trucks and similar equipment including, but not limited to, floor scrubbers and floor buffers, shall be operated and maintained in accordance with Section 309.2 through 309.6.

- ❖ This section establishes the fire safety requirements for control of the hazards associated with powered industrial trucks and industrial equipment. Because these trucks or equipment may have either battery-powered electric motors or internal combustion engines using liquid or gaseous fuel, Sections 309.2 through 309.6 cover the fire safety aspects of both.

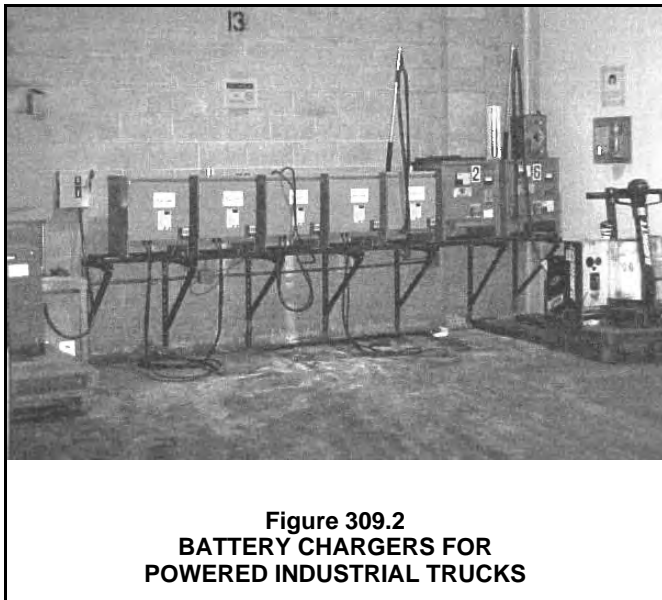
**309.2 Battery chargers.** Battery chargers shall be of an *approved* type. Combustible storage shall be kept not less than 3 feet (915 mm) from battery chargers. Battery charging shall not be conducted in areas accessible to the public.

- ❖ Battery chargers offer several safety challenges if they are not properly housed and operated. A battery that is connected to the charger with the poles

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reversed can explode when charging power is turned on, which could result in corrosive liquid being sprayed over the charger room and anyone who happens to be in it. Aside from the possibility of serious bodily injury from flying debris or corrosive spray, eye damage from the spray is a critical consideration. There is also the possibility of energized charging leads shorting, arcing or fusing and causing sparks to become an ignition source for combustibles if they are not kept out of the area.

When a charger is properly connected and energized, the charging process causes generation of hydrogen and oxygen gases as well as acid or alkali fumes. These gases must be vented to prevent them from reaching ignitable or detonable levels (see commentary, Section 309.3). A typical battery charger arrangement is illustrated in Commentary Figure 309.2. Note that these battery chargers are outside of the scope of Section 608 and thus not subject to its provisions.



**Figure 309.2**  
**BATTERY CHARGERS FOR**  
**POWERED INDUSTRIAL TRUCKS**

**309.3 Ventilation.** Ventilation shall be provided in an *approved* manner in battery-charging areas to prevent a dangerous accumulation of flammable gases.

❖ Charging lead-acid or nickel iron batteries is a process of electrolysis in which oxides created by operation of the battery are reduced to metal and redeposited on the electrode plates. The process results in the rejuvenation of the electrolyte in the battery and the emission of both oxygen and hydrogen gases as well as corrosive fumes. If these gases are allowed to accumulate in an enclosed space, they could eventually reach an ignitable or detonable level. Section 608.6 and the applicable provisions of the *International Mechanical Code*® (IMC)® describe one method of ventilation used to carry off and dilute the concentrations of hazardous gases. See the commentaries to Section 608.6 and its subsections.

**309.4 Fire extinguishers.** Battery-charging areas shall be provided with a fire extinguisher complying with Section 906 having a minimum 4-A:20-B:C rating within 20 feet (6096 mm) of the battery charger.

❖ Because of the electrical hazards associated with the battery-charging operation; the fuel load presented by the plastic battery cases and other area contents; and the potential for the presence of gases in the room, an appropriately sized portable fire extinguisher must be located within the battery-charging area. The extinguisher must be accessible with minimum travel.

**309.5 Refueling.** Powered industrial trucks using liquid fuel, LP-gas or hydrogen shall be refueled outside of buildings or in areas specifically *approved* for that purpose. Fixed fuel-dispensing equipment and associated fueling operations shall be in accordance with Chapter 23. Other fuel-dispensing equipment and operations, including cylinder exchange for LP-gas-fueled vehicles, shall be in accordance with Chapter 57 for flammable and *combustible liquids* or Chapter 61 for LP-gas.

❖ Because of the hazards associated with liquid fuel spills and gaseous fuel discharges, this section requires that powered industrial trucks be refueled outside where the vapors or gas can be readily dissipated. This section also allows the alternative of fueling inside of buildings where safeguards mitigate the hazards of the operation and the location is specifically approved for the use by the fire code official. Where fueling with liquid or gaseous fuel is done from fixed equipment, compliance with Chapter 23 of the code is required for both the fueling equipment and its operation because of the proven safeguards for such operations that are included in that chapter. Similarly, fueling equipment and operations for flammable or combustible liquids or LP-gas utilizing non-fixed equipment must be conducted in accordance with the applicable provisions of the appropriate material-specific chapter.

**309.6 Repairs.** Repairs to fuel systems, electrical systems and repairs utilizing open flame or welding shall be done in *approved* locations outside of buildings or in areas specifically *approved* for that purpose.

❖ Repairs that could create ignition sources or a fuel load for an ignition source must be done in indoor or outdoor locations that are designed specifically for vehicle repairs and that have been approved by the fire code official.

## SECTION 310 SMOKING

**310.1 General.** The smoking or carrying of a lighted pipe, cigar, cigarette or any other type of smoking paraphernalia or material is prohibited in the areas indicated in Sections 310.2 through 310.8.

❖ This section states that smoking is prohibited in those areas designated in Sections 310.2 and 310.8. Before entering an area posted with “No Smoking”

signs, anyone carrying a lighted smoking product or device must extinguish the smoking material and properly dispose of the ashes and other residue. Suitable ashtrays should be available at the entry to “No Smoking” areas for disposal of the prohibited smoking materials.

**310.2 Prohibited areas.** Smoking shall be prohibited where conditions are such as to make smoking a hazard, and in spaces where flammable or combustible materials are stored or handled.

❖ Smoking can be prohibited wherever it would be a hazard in the judgment of the fire code official.

**310.3 “No Smoking” signs.** The *fire code official* is authorized to order the posting of “No Smoking” signs in a conspicuous location in each structure or location in which smoking is prohibited. The content, lettering, size, color and location of required “No Smoking” signs shall be *approved*.

**Exception:** In Group I-2 occupancies where smoking is prohibited, “No Smoking” signs are not required in interior locations of the facility where signs are displayed at all major entrances into the facility.

❖ The fire code official is not only authorized to designate where signs are to be posted, but is also responsible for establishing the specification for all aspects of those signs. A typical sign design is shown in Commentary Figure 310.3.

The exception provides correlation with NFPA 101 on this topic. Since the majority of healthcare facilities already prohibit smoking, where signs are posted at the main entrances, it is redundant and unnecessary to also require the signs to be posted throughout a facility that does not permit smoking, has a staff

trained to monitor and policies in place to quickly stop or prevent the action (see Commentary Figure 310.3.)

**310.4 Removal of signs prohibited.** A posted “No Smoking” sign shall not be obscured, removed, defaced, mutilated or destroyed.

❖ Posted signs must remain in the locations designated by the fire code official and be readable at all times. Many, if not all, jurisdictions establish penalties for removing, obscuring, defacing or mutilating official signs.

**310.5 Compliance with “No Smoking” signs.** Smoking shall not be permitted nor shall a person smoke, throw or deposit any lighted or smoldering substance in any place where “No Smoking” signs are posted.

❖ Penalties are usually imposed for violating “no smoking” prohibitions. Smoking must be confined to approved areas, and discarded smoking materials must be deposited only in approved ashtrays or receptacles. Violation of this provision customarily constitutes a misdemeanor. Prosecution of misdemeanor offenses should be coordinated with the jurisdiction’s legal counsel. Offense and penalty clauses, such as those included in Section 109, are required in order to prosecute infractions (see commentary, Section 109.3).

**310.6 Ash trays.** Where smoking is permitted, suitable non-combustible ash trays or match receivers shall be provided on each table and at other appropriate locations.

❖ Where smoking is permitted, smokers must have available a noncombustible ashtray or other receptacle where smoking materials can be safely deposited. These receptacles must be located on each table and other locations throughout the smoking area so that the smoker does not have to look for a place to discard used materials.

**310.7 Burning objects.** Lighted matches, cigarettes, cigars or other burning object shall not be discarded in such a manner that could cause ignition of other combustible material.

❖ Lighted matches, burning tobacco products and all other burning objects must be deposited in ashtrays or other approved noncombustible containers to separate these ignition sources from any potential fuel loads.

**310.8 Hazardous environmental conditions.** Where the *fire code official* determines that hazardous environmental conditions necessitate controlled use of smoking materials, the ignition or use of such materials in mountainous, brush-covered or forest-covered areas or other designated areas is prohibited except in *approved* designated smoking areas.

❖ This section gives the fire code official the authority to establish “no smoking” areas whenever and wherever environmental conditions are considered hazardous. This can include prohibiting burning dry grasses and leaves when lack of rain has rendered the environment dangerously dry or burning of specific materials when the smoke plume from the fire would endanger



**Figure 310.3  
NO SMOKING SIGN**

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the health or welfare of a population. The possibilities for determination of hazardous conditions are too numerous to itemize. The judgment of the fire code official, with the advice of other officials being sought as needed, is the determining factor. The fire code official can also exercise the discretion of designating areas in which smoking is permitted.

### SECTION 311 VACANT PREMISES

**311.1 General.** Temporarily unoccupied buildings, structures, premises or portions thereof, including tenant spaces, shall be safeguarded and maintained in accordance with Sections 311.1.1 through 311.6.

❖ Vacant buildings or portions of buildings that are open at doors or windows pose fire safety and criminal trespass hazards to a community and are correctly declared to be unsafe buildings in Section 110.1.1. Such premises are often called an “attractive nuisance” to neighborhood children who may enter them to play or to other persons who may enter seeking shelter from the elements or to engage in potential criminal activities.

**311.1.1 Abandoned premises.** Buildings, structures and premises for which an *owner* cannot be identified or located by dispatch of a certificate of mailing to the last known or registered address, which persistently or repeatedly become unprotected or unsecured, which have been occupied by unauthorized persons or for illegal purposes, or which present a danger of structural collapse or fire spread to adjacent properties shall be considered abandoned, declared unsafe and abated by demolition or rehabilitation in accordance with the *International Property Maintenance Code* and the *International Building Code*.

❖ This section establishes the authority to dispose of by demolition or rehabilitation properties that pose a variety of public safety hazards when the owners of the property cannot be located by customary legal means. Because demolition and rehabilitation are regulated by the IBC, *International Property Maintenance Code*® (IPMC®) and applicable state laws, any action taken must be a carefully coordinated effort by all affected code officials in close relationship with the jurisdiction’s legal counsel.

**311.1.2 Tenant spaces.** Storage and lease plans required by this code shall be revised and updated to reflect temporary or partial vacancies.

❖ The intent of this section is to keep storage and lease plans up to date so that the fire service will always have a complete picture of the kinds of hazards they might face in case of a fire, including vacant, unattended spaces.

**311.2 Safeguarding vacant premises.** Temporarily unoccupied buildings, structures, premises or portions thereof shall

be secured and protected in accordance with Sections 311.2.1 through 311.2.3.

❖ This section lists a number of problems that commonly occur when buildings or portions of buildings remain vacant for long periods of time. It covers concerns for security, fire protection and fire separation in vacant spaces.

**311.2.1 Security.** Exterior and interior openings accessible to other tenants or unauthorized persons shall be boarded, locked, blocked or otherwise protected to prevent entry by unauthorized individuals. The *fire code official* is authorized to placard, post signs, erect barrier tape or take similar measures as necessary to secure public safety.

❖ Unauthorized or illegal activities in vacant buildings can lead to the presence of unanticipated fire loads susceptible to ready ignition and rapid fire spread, thus increasing the hazard to adjoining properties or spaces and fire department personnel (see commentary, Section 110.1.1). This section requires securing the openings of vacant buildings or spaces against unauthorized entry by any of the methods listed or by other equally effective means approved by the fire code official and provides that appropriate signage or other readily visible warnings to the public may be posted. For a suggested standard for boarding windows and doors, see IPMC Appendix A.

**311.2.2 Fire protection.** Fire alarm, sprinkler and stand-pipe systems shall be maintained in an operable condition at all times.

#### Exceptions:

1. Where the premises have been cleared of all combustible materials and debris and, in the opinion of the *fire code official*, the type of construction, *fire separation distance* and security of the premises do not create a fire hazard.
2. Where *approved* by the fire chief, buildings that will not be heated and where *fire protection systems* will be exposed to freezing temperatures, fire alarm and sprinkler systems are permitted to be placed out of service and standpipes are permitted to be maintained as dry systems (without an automatic water supply), provided the building has no contents or storage, and windows, doors and other openings are secured to prohibit entry by unauthorized persons.

❖ The basic requirement of this section is clearly stated. The on-site fire protection systems must be maintained whether the property is occupied or vacant. The systems would be subject to the same inspections in either case.

Exception 1 gives the fire code official the authority to determine whether vacant premises pose a significant hazard and lists criteria he or she can use in making that determination.

Exception 2 recognizes that systems located in unheated premises in cold climates could be ren-

dered inoperable by freezing and authorizes permission to disable those systems when the security of the premises and fire separation arrangements meet the code requirements stated in Sections 311.2.1 and 311.2.3. Since an inoperative fire protection system has a direct effect on the tactical approaches and operations of the fire department, this exception is only applicable where the fire chief of the jurisdiction has approved the securing of the system.

**311.2.3 Fire separation.** Fire-resistance-rated partitions, *fire barriers* and *fire walls* separating vacant tenant spaces from the remainder of the building shall be maintained. Openings, joints and penetrations in fire-resistance-rated assemblies shall be protected in accordance with Chapter 7.

❖ Fire-resistance-rated construction separating vacant spaces from the remainder of the building must be maintained to the satisfaction of the fire code official. The requirements for openings, joints and penetrations are covered in Chapter 7.

**311.3 Removal of combustibles.** Persons owning, or in charge or control of, a vacant building or portion thereof, shall remove therefrom all accumulations of combustible materials, flammable or combustible waste or rubbish and shall securely lock or otherwise secure doors, windows and other openings to prevent entry by unauthorized persons. The premises shall be maintained clear of waste or hazardous materials.

**Exceptions:**

1. Buildings or portions of buildings undergoing additions, *alterations*, repairs or change of occupancy in accordance with the *International Building Code*, where waste is controlled and removed as required by Section 304.
2. Seasonally occupied buildings.

❖ Property owners, their agents and persons leasing vacant spaces are responsible for preventing accumulations of flammable or combustible materials as well as for securing the vacant space against entry by unauthorized persons.

Exception 1 covers building situations in which larger amounts of flammable or combustible waste would reasonably be generated and cites code references to cover requirements in those situations.

Exception 2 allows reasonable accumulations of flammable or combustible materials in spaces that are occupied seasonally. For example, this exception would allow unattended off-season storage of stock for sale.

**311.4 Removal of hazardous materials.** Persons owning or having charge or control of a vacant building containing hazardous materials regulated by Chapter 50 shall comply with the facility closure requirements of Section 5001.6.

❖ This section gives the fire code official the authority to require property owners, their agents and their tenants to submit a facility closure plan, and make sure combustible and hazardous materials are removed

from the premises. The requirements for the facility closure plan are given in Section 5001.6 (see Section 407.7).

**311.5 Placards.** Any vacant or abandoned buildings or structures determined to be unsafe pursuant to Section 110 of this code relating to structural or interior hazards shall be marked as required by Sections 311.5.1 through 311.5.5.

❖ Vacant or abandoned buildings are often of questionable structural integrity and have a very high probability of intentionally set fires. When fires occur in these buildings, they present a host of unusual hazards to fire fighters. Since the buildings are uninhabited, fires may develop for significant periods of time before they are detected and reported.

In December 1999, six professional fire fighters died after they became lost in a six-floor, maze-like, cold-storage and warehouse building while searching for two reportedly trapped people and fire extension. In the wake of this tragedy, the National Institute for Occupational Safety and Health (NIOSH) conducted a Fatality Assessment and Control Evaluation (FACE) as part of its Fire Fighter Fatality Investigation and Prevention Program and issued its findings in report FACE-99-F47 in September, 2000. NIOSH investigators concluded that, to reduce the risk of similar occurrences, fire departments should, among other recommendations, implement a program to “identify dangerous vacant buildings by affixing warning placards to entrance doorways or other openings where fire fighters may enter.”

In order to improve fire-fighter safety when responding to incidents in buildings that have structural safety issues and have been declared to be unsafe due to being vacant or abandoned, this section establishes an information placarding system that will assist incident commanders in making personnel and equipment deployment decisions.

**311.5.1 Placard location.** Placards shall be applied on the front of the structure and be visible from the street. Additional placards shall be applied to the side of each entrance to the structure and on penthouses.

❖ Prominent positioning of warning placards where they can be readily seen by first-in fire companies or other emergency responders will assist in the initial incident size-up and resource assignments.

**311.5.2 Placard size and color.** Placards shall be 24 inches by 24 inches (610 mm by 610 mm) minimum in size with a red background, white reflective stripes and a white reflective border. The stripes and border shall have a 2-inch (51 mm) minimum stroke.

❖ In order to be truly effective in conveying the critical information about a building’s structural stability, placards must be fabricated so as to be in bold contrast to their mounting surface. The required reflectivity will enhance placard visibility under low ambient light conditions where flashlights, spotlights or emergency vehicle warning lights may be the only light-emitting source.

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**311.5.3 Placard date.** Placards shall bear the date of their application to the building and the date of the most recent inspection.

❖ Including the date of placard posting and the most recent inspection information on the placard will assist the incident commander in verifying the validity and currency of the building's status.

**311.5.4 Placard symbols.** The design of the placards shall use the following symbols:

1.  This symbol shall mean that the structure had normal structural conditions at the time of marking.
2.  This symbol shall mean that structural or interior hazards exist and interior fire-fighting or rescue operations should be conducted with extreme caution.
3.  This symbol shall mean that structural or interior hazards exist to a degree that consideration should be given to limit fire fighting to exterior operations only, with entry only occurring for known life hazards.
4. Vacant marker hazard identification symbols: The following symbols shall be used to designate known hazards on the vacant building marker. They shall be placed directly above the symbol.
  - 4.1. R/O—Roof open
  - 4.2. S/M—Stairs, steps and landing missing
  - 4.3. F/E—Avoid fire escapes
  - 4.4. H/F—Holes in floor

❖ The placard symbols required by this section are intended to provide clear information regarding the level of structural hazard facing personnel in the conduct of rescue and fire-fighting operations as of the inspection date on the placard. Upon considering the degree of hazards, incident commanders can restrict operations to strictly defensive or cautiously offensive.

**311.5.5 Informational use.** The use of these symbols shall be informational only and shall not in any way limit the discretion of the on-scene incident commander.

❖ This section simply states that the placards are but an operational tool and the scene incident commander is the final authority in applying the information provided by the placards to the situation at hand.

**311.6 Unoccupied tenant spaces in mall buildings.** Unoccupied tenant spaces in covered and open mall buildings shall be:

1. Kept free from the storage of any materials.
2. Separated from the remainder of the building by partitions of not less than 0.5-inch-thick (12.7 mm) gypsum board or an *approved* equivalent to the underside of the ceiling of the adjoining tenant spaces.
3. Without doors or other access openings other than one door that shall be kept key locked in the closed position except during that time when opened for inspection.
4. Kept free from combustible waste and be broomswept clean.

❖ This section (formerly Section 408.11.3) is primarily concerned with the hazards posed by tenant spaces that are not in use or that are not under the supervision of employees. These spaces are more likely to be targets of vandalism and possibly incendiary activity. Generally, a fire can grow unnoticed in such spaces as a result of the lack of supervision or activity in the space. To reduce these risks, this section contains several requirements that focus on reducing the fire ignition, growth and spread potential by limiting combustibles in the space, securing the space through the use of locks and installing fire separations constructed of 1/2-inch-thick (12.7 mm) gypsum or similar materials. Note that mall buildings are required to be sprinklered throughout and that the systems in the tenant spaces must be independent of the mall area.

## SECTION 312 VEHICLE IMPACT PROTECTION

**312.1 General.** Vehicle impact protection required by this code shall be provided by posts that comply with Section 312.2 or by other *approved* physical barriers that comply with Section 312.3.

❖ This section applies to those locations where a moving vehicle could strike a piece of equipment that contains fuel or is fuel fired. These applications include motor fuel-dispensing facilities, above-ground storage tanks and repair garages as well as other locations in which gas- or oil-fired equipment or appliances could be installed where they would be in harm's way. Additional requirements for equipment protection are contained in Chapter 3 of the IMC and Section 305 of the *International Fuel Gas Code*® (IFGC®). Acceptable impact protection is dependent upon location and physical arrangement of the equipment requiring protection and is not limited to guard posts only. As indicated in Section 312.3, protection could consist of walls, barricades, guardrails or elevated locations that provide the requisite level of protection and are approved by the fire code official.

**312.2 Posts.** Guard posts shall comply with all of the following requirements:

1. Constructed of steel not less than 4 inches (102 mm) in diameter and concrete filled.
2. Spaced not more than 4 feet (1219 mm) between posts on center.
3. Set not less than 3 feet (914 mm) deep in a concrete footing of not less than a 15-inch (381 mm) diameter.

- 4. Set with the top of the posts not less than 3 feet (914 mm) above ground.
- 5. Located not less than 3 feet (914 mm) from the protected object.

❖ This section lists five requirements that guard posts must satisfy. Typical installations of posts in service stations and other locations are shown in Commentary Figures 312.2(1) and 312.2(2). These guard posts are designed to resist impact from vehicles moving at low speeds, as they would be when pulling up to a fuel pump at a motor fuel-dispensing facility or into a service area in an indoor service facility or repair garage.

**312.3 Other barriers.** Barriers, other than posts specified in Section 312.2, that are designed to resist, deflect or visually deter vehicular impact commensurate with an anticipated impact scenario shall be permitted where *approved*.

❖ This section provides a true performance option to Section 312.2. The text deliberately establishes a broad set of goals that must be achieved by the designer to fit a site-specific application, and the requirement places the onus on the designer to demonstrate selection of a satisfactory design scenario and a suitable solution to achieve approval of the fire code official. Although it could be argued that Section 312.3 could simply be deleted in favor of relying on Section 104.9 (alternate materials and methods), it made more sense to include the suggested

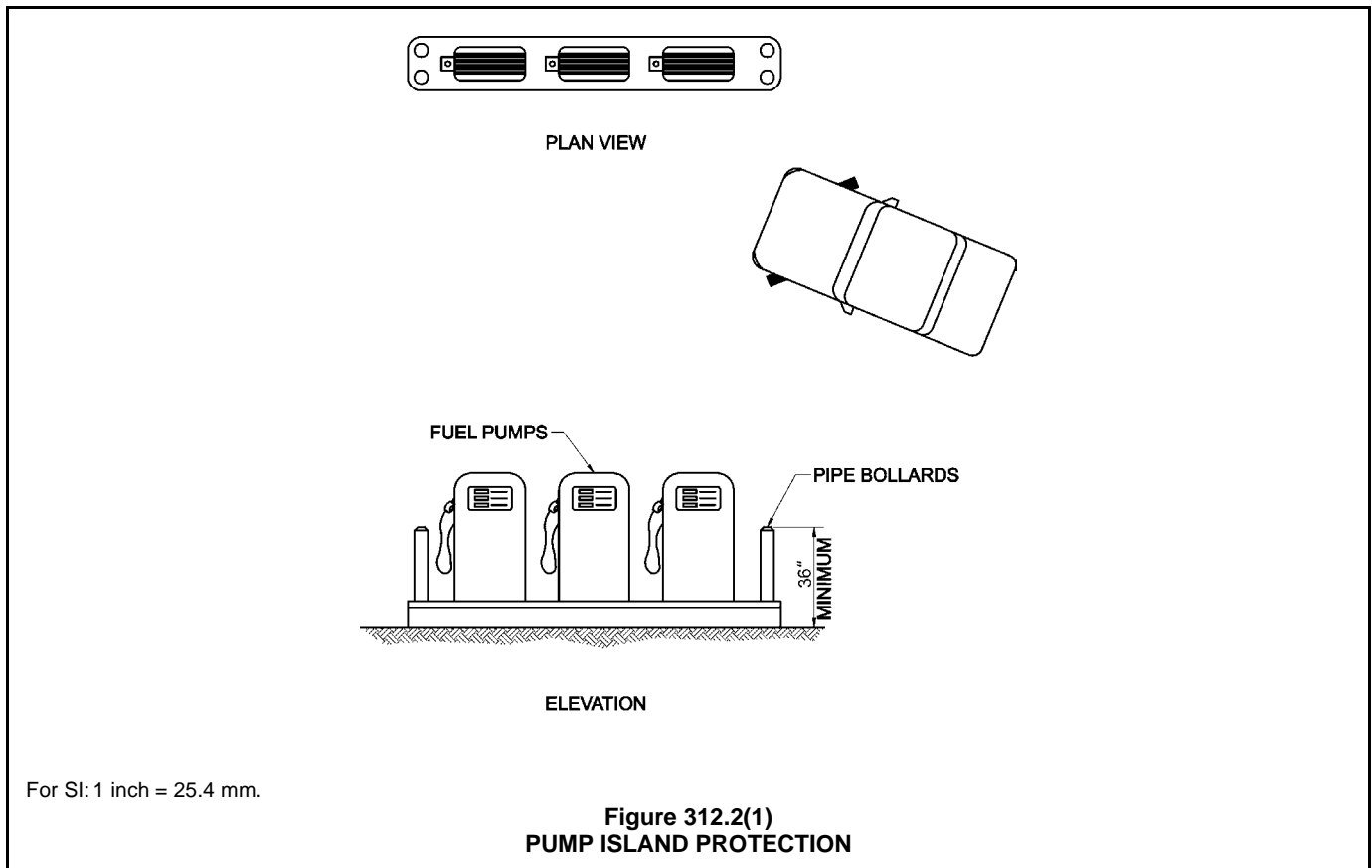
guidance in Section 312.3 of the code. Previously, the 12,000-pound resistance “force” prescribed by this section was actually a static load (i.e., a load with no associated impact velocity or acceleration) rather than an impact load. Without knowing an intended impact velocity, the kinetic energy resistance for a barrier cannot be accurately calculated. It is more appropriate for a performance requirement to accommodate determination of a suitable vehicle weight and impact speed to provide protection from moving vehicles as a design basis. Barriers other than posts could include walls, barricades or elevated locations for equipment (see Commentary Figure 312.3).

**SECTION 313  
FUELED EQUIPMENT**

**313.1 General.** Fueled equipment including, but not limited to, motorcycles, mopeds, lawn-care equipment, portable generators and portable cooking equipment, shall not be stored, operated or repaired within a building.

**Exceptions:**

- 1. Buildings or rooms constructed for such use in accordance with the *International Building Code*.
- 2. Where allowed by Section 314.
- 3. Storage of equipment utilized for maintenance purposes is allowed in *approved* locations where the aggregate fuel capacity of the stored equipment does

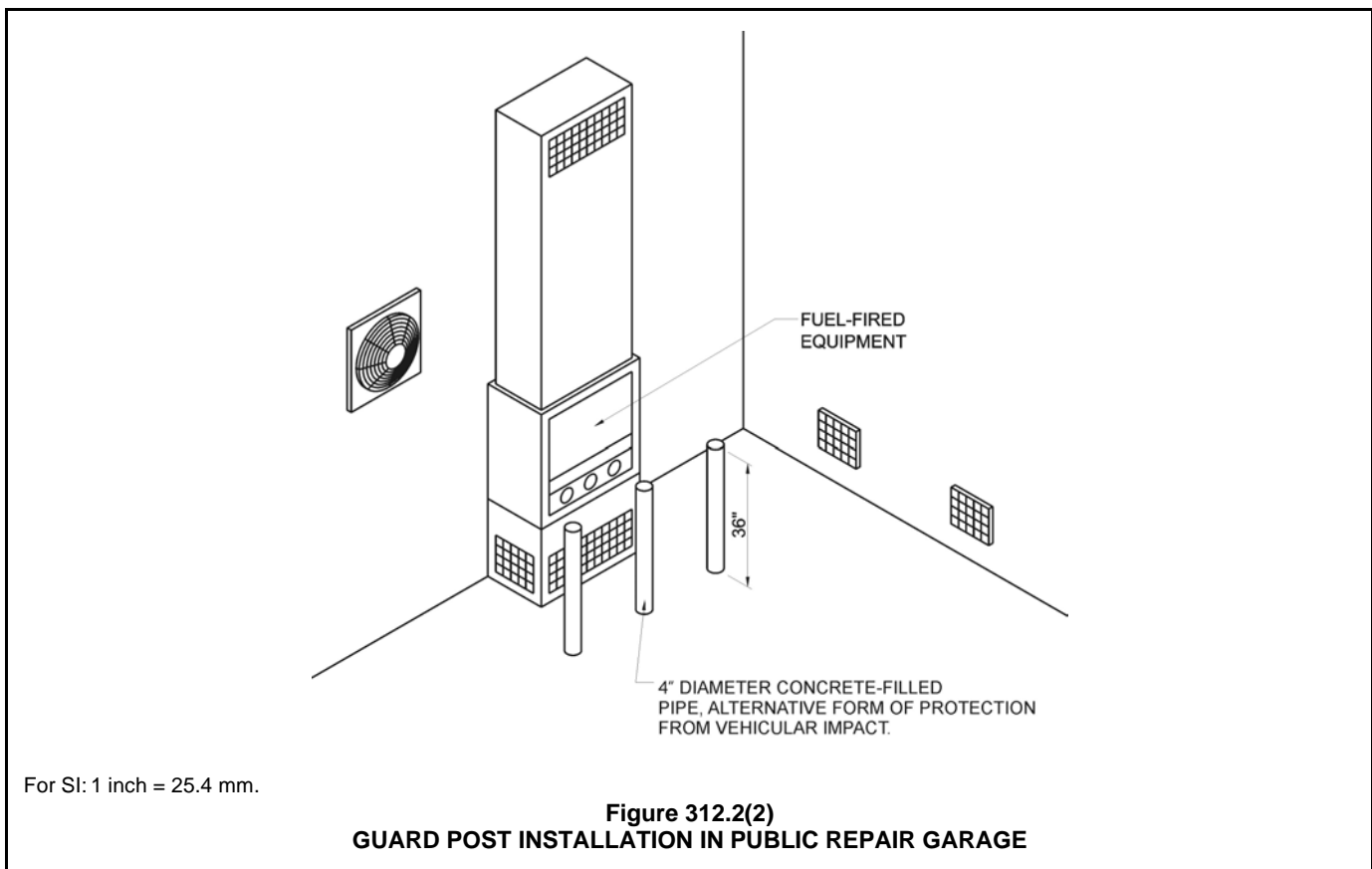
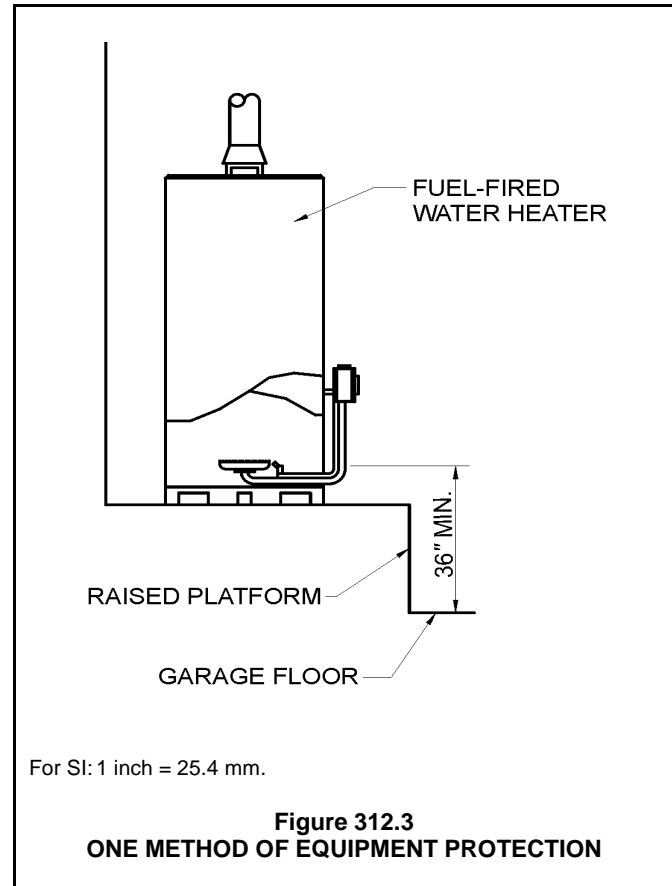


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not exceed 10 gallons (38 L) and the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.

- ❖ The restrictions in this section are similar to those in Section 314.4, but this section also regulates portable liquid- or gas-fueled cooking equipment, certain vehicles, the operation and repair of vehicles and equipment, and as storage (see commentary, Section 314.4). It has been documented that multiple fatalities occurred, related to natural disasters, as the result of the improper use and location of portable generators inside buildings. This section clarifies that portable generators are also not allowed to be used inside buildings except when utilized in accordance with one of the exceptions.

Exception 1 recognizes the increased safety afforded when these uses are isolated from other parts of the building with fire-resistance-rated construction in accordance with the IBC. Exception 2 defers to the other section of the code that also regulates fueled equipment covered by this section. Exception 3 recognizes the enhanced level of protection provided by an approved automatic sprinkler system by allowing fueled equipment to be stored inside in a location approved by the fire code official, up to an aggregate quantity of 10 gallons (38 L) of fuel. This exception provides consistency with Section 5704.3.4.4 of the code and, therefore, is applicable to flammable and combustible liquid fuels only; liquefied



gas fuels are not included. Note also that the fuel quantities allowed by this exception are not to be counted when determining maximum allowable quantities in accordance with Table 5003.1.1(1), as indicated in Note p to that table.

**313.1.1 Removal.** The *fire code official* is authorized to require removal of fueled equipment from locations where the presence of such equipment is determined by the *fire code official* to be hazardous.

❖ This section gives the fire code official the authority to conduct inspections to determine whether vehicle operation, repair and storage in buildings comply with the requirements of this section and, if they do not, the authority to order the removal of fueled equipment from the building as a means of eliminating the hazard.

**313.2 Group R occupancies.** Vehicles powered by flammable liquids, Class II *combustible liquids* or compressed flammable gases shall not be stored within the living space of Group R buildings.

❖ Prohibiting storage of fuel-burning vehicles recognizes the hazards associated with having significant quantities of flammable or combustible liquids or compressed gases in inhabited spaces. Most vehicles that use liquid fuels have tanks that are not pressurized and are not vapor tight. Even a small leak over time can build to dangerous levels in enclosed spaces. For these reasons, this section prohibits the storage of gas- or liquid-fueled vehicles and equipment within the dwelling units or sleeping units of Group R buildings including their associated balconies.

## SECTION 314 INDOOR DISPLAYS

**314.1 General.** Indoor displays constructed within any occupancy shall comply with Sections 314.2 through 314.4.

❖ Indoor displays of merchandise and the display of all manner of vehicles inside of buildings can create a number of hazards to building occupants, including blocked egress and rapid fire buildup. This section describes reasonable measures to reduce the hazards associated with indoor displays without prohibiting them.

**314.2 Fixtures and displays.** Fixtures and displays of goods for sale to the public shall be arranged so as to maintain free, immediate and unobstructed access to exits as required by Chapter 10.

❖ The reason for maintaining free and unobstructed access to exits in public shopping spaces is, of course, personal safety in times of emergency. Chapter 10 contains the requirements, criteria and guidelines for this purpose.

**314.3 Highly combustible goods.** The display of highly combustible goods, including but not limited to fireworks,

flammable or *combustible liquids*, liquefied flammable gases, oxidizing materials, pyroxylin plastics and agricultural goods, in main *exit access aisles, corridors*, covered and open malls, or within 5 feet (1524 mm) of entrances to *exits* and exterior exit doors is prohibited where a fire involving such goods would rapidly prevent or obstruct egress.

❖ As stated in Chapter 10, all elements of the means of egress of any occupancy open to the public must be kept clear of obstructions and other hazards that could prevent the occupants from exiting the premises quickly in an emergency. Displaying the hazardous materials itemized in this section where their involvement in a fire would block exit pathways is prohibited for this reason. The hazards associated with each of the materials mentioned in the section are discussed in the commentary to Chapters 50 through 67.

**314.4 Vehicles.** Liquid- or gas-fueled vehicles, boats or other motorcraft shall not be located indoors except as follows:

1. Batteries are disconnected.
2. Fuel in fuel tanks does not exceed one-quarter tank or 5 gallons (19 L) (whichever is least).
3. Fuel tanks and fill openings are closed and sealed to prevent tampering.
4. Vehicles, boats or other motorcraft equipment are not fueled or defueled within the building.

❖ It has become commonplace for covered malls and larger retail stores to have various types of gas- or liquid-fueled vehicles on inside display, such as for promotional events or fire apparatus displays during Fire Prevention Week (see Commentary Figure 314.4). Because the hazards of such displays in a public building are similar to those in residential buildings, Section 314.4 parallels Section 313.1, Exception 2 (see commentary, Section 313.1).



**Figure 314.4  
INDOOR CAR DISPLAY**

## SECTION 315 GENERAL STORAGE

**315.1 General.** Storage shall be in accordance with Sections 315.2 through 315.5.

❖ This section addresses general safety precautions for the storage of any volume of materials, including those regulated elsewhere in the code. Where a material in storage is specifically regulated by another section of the code, then that section would apply in addition to any applicable provisions in Section 315. For example, if the stored material were baled waste paper awaiting recycling, the material-specific provisions of Section 5205 would apply. However, Section 5205 does not specifically regulate the vertical clearance of the stored baled waste paper to the ceiling or sprinkler heads nor does it regulate clearance from heaters or heating devices. Accordingly, the provisions of Sections 315.3 and 315.3.1 would apply. Also note that if the storage meets the definition of high-piled combustible storage in Section 202, the applicable provisions of Chapter 32 would also apply. Control of combustible waste material is covered in Sections 304.2 and 304.3.

**315.2 Permit required.** A permit for miscellaneous combustible storage shall be required as set forth in Section 105.6.

❖ This section establishes the requirement that an operational permit for storage of certain combustible materials must be obtained from the fire code official. Permit fees, if any, must be paid prior to the issuance of the permit. See Section 105 for additional information on permits. Note that a permit is required only for storage of combustible materials. Even though Section 315.3 regulates storage of both combustible and noncombustible materials, a permit is required only for miscellaneous types of combustible materials and then only when the storage volume exceeds 2,500 cubic feet (70.79 m<sup>3</sup>), as specified in the permit requirements in Section 105.6.30. The storage of such combustible materials can easily fall into disarray, present a fire load out of proportion to the surroundings and be susceptible to ready ignition and rapid, uncontrolled combustion. Conversely, the orderly storage of mercantile stocks and goods, business records, etc., in piles, on shelving or in case-work cabinets, for example, while regulated by Section 315, is not considered to be a hazard requiring a permit.

**315.3 Storage in buildings.** Storage of materials in buildings shall be orderly and stacks shall be stable. Storage of combustible materials shall be separated from heaters or heating devices by distance or shielding so that ignition cannot occur.

❖ The first sentence of this section makes it clear that it applies to all storage and that the stacks of stored materials must be stable in order to prevent pile or stack collapse that could obstruct means of egress aisles and impede fire-fighter access. The second sentence applies only to storage of combustible materials and the need for them to be separated from

ignition sources. Throughout the code, the use of fire-resistance-rated construction and spatial separation distances to minimize fire hazards and fire spread is stated as a requirement for a variety of materials. It is not necessary to separate noncombustible materials from ignition sources because there is no combustible material hazard.

**315.3.1 Ceiling clearance.** Storage shall be maintained 2 feet (610 mm) or more below the ceiling in nonsprinklered areas of buildings or not less than 18 inches (457 mm) below sprinkler head deflectors in sprinklered areas of buildings.

❖ If the space is not equipped with sprinklers, the clearance between the stored materials and the ceiling must be 2 feet (610 mm) to allow manual hose streams to effectively reach the top of a burning pile as well as to project over and beyond adjacent piles to reach burning materials. Where sprinklers are installed, the 18-inch (457 mm) clearance permits timely activation of the sprinklers and allows unobstructed water distribution over the storage pile. Materials stored too close to sprinklers can not only prevent the heat of a fire from reaching the sprinkler fusible link but also inhibit water from reaching the seat of a fire once the sprinklers are activated.

In sprinklered areas of buildings, the question often arises as to whether storage on shelving can be installed on a wall not directly below sprinklers, with the storage extending above the level of a horizontal plane located 18 inches (457 mm) below the ceiling sprinkler deflector. Typically, storage on wall-mounted shelving functions the same as a wall with respect to its relationship to the automatic sprinklers installed at ceiling level and the relative obstruction it poses. As long as the storage is not directly below the sprinklers, the sprinkler clearance provisions of Section 315.2.1 would not apply. This is consistent with NFPA 13 annex notes on this topic.

Certain newer types of automatic sprinklers, because of their design or operating characteristics, may require greater clearance distances than the 18 inch (457 mm) minimum prescribed in this section. NFPA 13 and the sprinkler manufacturer's data should be consulted for specific information on the characteristics of the many different types of sprinklers that may be installed in a given building.

**315.3.2 Means of egress.** Combustible materials shall not be stored in exits or enclosures for stairways and ramps.

❖ As was stated in Section 314.3, all elements of the means of egress must be kept free of obstructions that could block an exit pathway and, thus, jeopardize occupants of the affected space. Chapter 10 offers more guidance on means of egress.

**315.3.3 Equipment rooms.** Combustible material shall not be stored in boiler rooms, mechanical rooms, electrical equipment rooms or in *fire command centers* as specified in Section 508.1.5.

❖ This section is intended is to keep ignition sources inherent in the use of certain indicated rooms (e.g.,

fuel-fired equipment, electrical panels) from coming into contact with combustible materials that might be stored in the rooms, whether the rooms are sprinklered or not. See also the commentary to Section 508.1.5 for storage prohibition in fire command centers and Section 605.3 for electrical equipment room clearance requirements and storage prohibition. Note that the IMC, Chapter 2, defines a “mechanical equipment/appliance room” as one in which nonfuel-fired mechanical equipment is located. Even though the ignition hazard is reduced in the absence of fuel-fired equipment in such rooms, they must be kept free of combustible storage to allow ready access for fire fighters and other authorized personnel to reach easily critical controls, such as power or equipment disconnects, in case of an emergency. Limited supplies of combustible materials related to mechanical room equipment (e.g., air distribution system filters) could be allowed but only in accordance with Section 315 of the code and with the specific approval of the fire code official. For additional discussion of requirements applicable to these and other specific occupancy rooms, see Section 509 of the IBC. Further discussion of the hazards of storage in boiler rooms can be found in Section 304 of the IMC.

**315.3.4 Attic, under-floor and concealed spaces.** Attic, under-floor and concealed spaces used for storage of combustible materials shall be protected on the storage side as required for 1-hour fire-resistance-rated construction. Openings shall be protected by assemblies that are self-closing and are of noncombustible construction or solid wood core not less than  $1\frac{3}{4}$  inches (44.5 mm) in thickness. Storage shall not be placed on exposed joists.

**Exceptions:**

1. Areas protected by *approved automatic sprinkler systems*.
2. Group R-3 and Group U occupancies.

❖ This section recognizes the reality that attics, crawl spaces and similar unoccupied, concealed spaces in buildings are attractive to building occupants for storage of all kinds of combustible materials. Storage in such unattended and out-of-the-way spaces creates a hazardous condition by introducing a higher fire load to spaces that were neither designed nor intended for such a high-intensity use and in which a fire could rapidly develop unobserved until it had gained a considerable hold on the building. Placing stored combustibles on exposed joists also could hasten collapse of the joists in a fire, which could lead to flaming debris being dropped into the building space below the joists and possible collapse of all or part of the building structure.

The code provides alternatives to using such spaces for storage and, if they are used for storage, how they can be constructed to isolate the higher fire loads created. Since the intent is to protect against a fire in the storage area from endangering the other occupied areas of the building, the required 1-hour

fire-resistance rating need only be achieved from the storage side. While any access openings in the 1-hour fire-resistant construction need not be rated, they must be self-closing and of either noncombustible construction or a minimum  $1\frac{3}{4}$ -inch (44 mm) thickness of solid wood core. Consistent with Section 102.4, any construction in connection with the concealed spaces regulated by this section must be in accordance with the IBC, especially Section 509.

Exception 1 recognizes the efficiency and reliability of automatic sprinklers as a trade-off for 1-hour fire-resistance-rated construction. This exception only requires the sprinkler system in the attic, under-floor or concealed space. Complete sprinkler protection throughout the building is not required in order to be in compliance with the exception.

Exception 2 exempts Group R-3 and U occupancies from the requirements of this section. In Group R-3, the level of familiarity and control exercised by the building occupants is recognized as offsetting the hazards of storage in concealed spaces. Because Group U occupancies are generally unoccupied, the hazards of miscellaneous storage are of little or no consequence to the few occupants that might be in such buildings. For further information on Group U occupancies, see Section 312 of the IBC and its commentary.

**315.4 Outside storage.** Outside storage of combustible materials shall not be located within 10 feet (3048 mm) of a lot line.

**Exceptions:**

1. The separation distance is allowed to be reduced to 3 feet (914 mm) for storage not exceeding 6 feet (1829 mm) in height.
2. The separation distance is allowed to be reduced where the *fire code official* determines that no hazard to the adjoining property exists.

❖ Outside storage of combustible materials, such as raw materials for production, idle pallets, dunnage and packaging, must be neat and compact. The requirement for a 10-foot (3048 mm) separation is consistent with storage area aisle width requirements throughout the code, often expressed as “one-half the pile height or 10 feet (3048 mm), whichever is greater.” The requirement of this section is consistent with that concept, as is Section 315.3.2, which limits pile height to 20 feet (6096 mm). The intent of this section is to provide fire suppression access on all sides of storage arrangements and reduce the likelihood of the spread of fire to adjacent properties in the event of a pile collapse. Pile collapses will generally not involve a full-height topple-over of a pile but rather only a partial collapse. Accordingly, Exception 1 allows a reduction in separation distance where the pile height is substantially less than the separation requirement.

Exception 2 allows the fire code official to grant separation reductions when the combustibles are

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judged to be no threat to adjoining property. Examples of such conditions could include storage where the combustible materials are enclosed in noncombustible containers, the presence of an impervious property line barrier or the provision of fixed fire protection equipment, such as deluge monitors, especially designed for rapid fire suppression and exposure protection.

**315.4.1 Storage beneath overhead projections from buildings.** Where buildings are protected by automatic sprinklers, the outdoor storage, display and handling of combustible materials under eaves, canopies or other projections or overhangs are prohibited except where automatic sprinklers are installed under such eaves, canopies or other projections or overhangs.

❖ The storage or display of combustible materials beneath unsprinklered canopies or other building projections attached to an otherwise fully sprinklered building could lead to a rapidly developing fire in the stored material, which could gain sufficient headway beyond the capability of the building sprinkler system to suppress it, should it spread into the building's interior. This section reinforces the requirements of NFPA 13 concerning the use of areas beneath building projections, such as eaves or canopies, for the storage or display of combustible materials where those locations are exempt from sprinkler protection as allowed in Section 8.15 of NFPA 13. NFPA 13 mandates that the scope of required sprinkler protection includes canopies or roofed-over areas attached to sprinklered buildings, unless these projections are constructed of noncombustible materials and the areas are not used for the storage, handling or display of combustible materials. Because NFPA 13 is a design standard and cannot be enforced as a maintenance document, this section essentially restates the NFPA 13 design requirement exception conditions in enforceable terms. Also note that, in the event that Appendix B of the code is adopted by a jurisdiction, areas used for the storage of combustible materials beneath a building's horizontally projecting elements must be included in the building area for purposes of determining the required fire flow.

**315.4.2 Height.** Storage in the open shall not exceed 20 feet (6096 mm) in height.

❖ Storage pile height limitations are a means of controlling the size of potential fires and reducing the tip-over potential as well as a way to facilitate the manual fire suppression process by keeping the top of the pile within reach of conventional fire-fighting and overhaul tools, such as the ground ladders carried by an engine company or the long pike poles carried by ladder companies. The 20-foot (6096 mm) storage pile height limitation also correlates with Section 315.3 and helps reduce the likelihood that a fire would jeopardize adjacent properties in the event of a pile collapse.

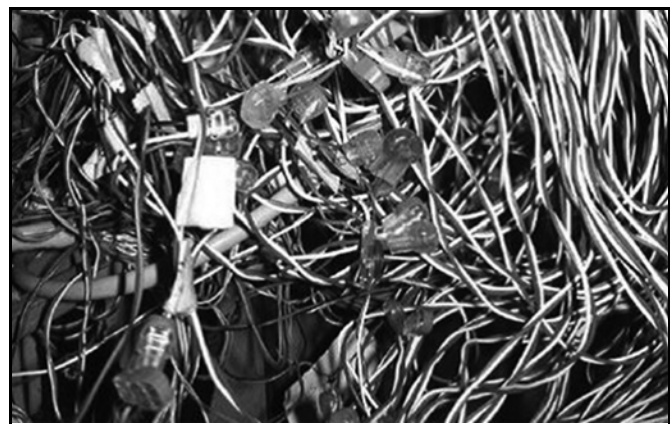
**315.5 Storage underneath high-voltage transmission lines.** Storage located underneath high-voltage transmission lines shall be in accordance with Section 316.6.2.

❖ High-voltage transmission lines are a special hazard requiring specific regulations to prevent them from being exposed to fire conditions that could cause them to fail or fall to the ground. This general section directs the code user to the section containing more specific requirements for this topic.

**315.6 Storage in plenums.** Storage shall not be permitted in plenums. Abandoned material in plenums shall be deemed to be storage and shall be removed. Where located in plenums, the accessible portion of abandoned cables that are not identified for future use with a tag shall be deemed storage and shall be removed.

❖ This section introduces a concept that has long been in NFPA 70 and NFPA 90A—that plenums (see Chapter 2 commentary to the definition of "Plenum") are intended specifically to be a part of the air distribution system. Plenums are also legitimately used for stringing communications and data cables as well as utility pipes, sprinkler pipes and similar items. However, such items often are not removed from the plenum when they become obsolete. For example, when an updated data system is installed in a facility (which can occur every 18 to 24 months), it is not unusual for old wires to be cut out of the system but left in place with a new wiring system added on top of them (see Commentary Figure 315.6).

The suspended ceiling tile systems that often enclose plenums are not intended to support any significant weight and can, therefore, easily be overwhelmed by the added weight of storage or abandoned materials such as cables (see commentary to IBC, Section 808.1.1.1). Recently, a plenum space fuel load study showed how the safety of fire fighters is compromised by the weight of these abandoned cables. It pointed out that plenum space fuel



**Figure 315.6**  
**ABANDONED DATA CABLE IN A PLENUM**

loads and wiring issues are serious concerns for fire fighters during interior fire-fighting operations and its key recommendation was that abandoned wiring be removed.

Although the primary reason to require the removal of abandoned materials in plenums is the elimination of unnecessary weight, fire safety considerations should also be taken into account, as should the practical consideration that the HVAC design airflow through the plenum could be adversely affected. Such a requirement was long believed not to be enforceable primarily because fire code inspectors would rarely spend their time looking into plenums in existing buildings. However, the danger presented by the fire load of storage or abandoned materials is well-documented. Thus, there should be no significant difficulty in having inspectors identify the existence of abandoned products—especially abandoned cables—classify them as storage and require their removal. Note that only the “accessible portions” of abandoned cables must be removed because there is no intent to cause potential damage to the building or facility by attempting to remove cables or circuits that are strung through walls, floors or other building elements. Where some cables are left in place because they are intended to be reused at a future date, they must be clearly identified as such by affixing a tag. See also Section 605.12.

**SECTION 316  
HAZARDS TO FIRE FIGHTERS**

**316.1 Trapdoors to be closed.** Trapdoors and scuttle covers, other than those that are within a *dwelling unit* or automatically operated, shall be kept closed at all times except when in use.

❖ Trapdoors and unguarded openings in floors and walkways must remain in the closed position or be designed to automatically close upon activation of the

fire alarm system. Openings in floors or walkways can injure emergency responders, especially if vision is obscured.

**316.2 Shaftway markings.** Vertical shafts shall be identified as required by this section.

❖ This section was developed to prevent fire fighters from falling through shafts when entering buildings off ladders placed on the exterior of the building.

**316.2.1 Exterior access to shaftways.** Outside openings accessible to the fire department and that open directly on a hoistway or shaftway communicating between two or more floors in a building shall be plainly marked with the word **SHAFTWAY** in red letters not less than 6 inches (152 mm) high on a white background. Such warning signs shall be placed so as to be readily discernible from the outside of the building.

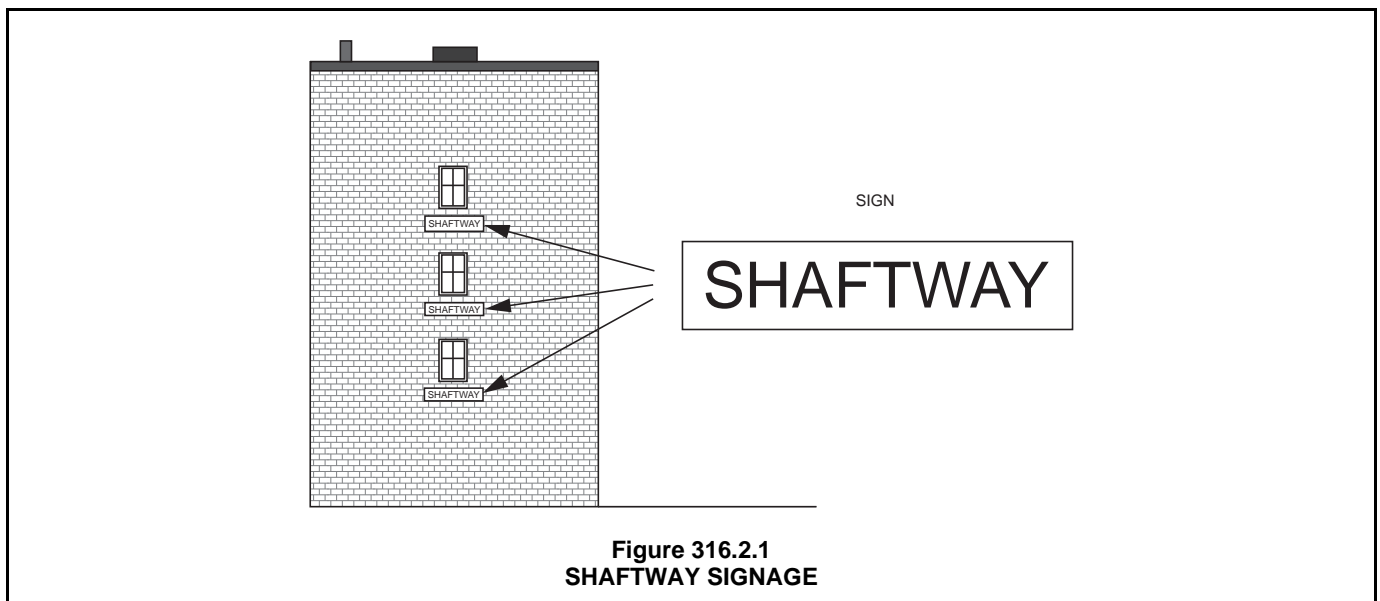
❖ Exterior wall openings that are accessible to fire fighters by way of ladders and aerial equipment and open directly into shafts or hoistways communicating between two or more floors must be clearly marked (see Commentary Figure 316.2.1).

**316.2.2 Interior access to shaftways.** Door or window openings to a hoistway or shaftway from the interior of the building shall be plainly marked with the word **SHAFTWAY** in red letters not less than 6 inches (152 mm) high on a white background. Such warning signs shall be placed so as to be readily discernible.

**Exception:** Marking shall not be required on shaftway openings that are readily discernible as openings onto a shaftway by the construction or arrangement.

❖ Openings into shaftways from the interior of the building pose a threat to fire fighters when visibility is poor. Interior shaft openings must be marked so that they are plainly visible from the interior of the building.

If fire fighters can readily identify an opening into a shaft by the way the opening is constructed, the shaft opening need not be marked, keeping in mind that



**Figure 316.2.1  
SHAFTWAY SIGNAGE**

## GENERAL REQUIREMENTS

the fire fighter may be feeling his or her way in heavy smoke or darkness.

**316.3 Pitfalls.** The intentional design or *alteration* of buildings to disable, injure, maim or kill intruders is prohibited. A person shall not install and use firearms, sharp or pointed objects, razor wire, *explosives*, flammable or *combustible liquid* containers, or dispensers containing highly toxic, toxic, irritant or other hazardous materials in a manner that could passively or actively disable, injure, maim or kill a fire fighter who forcibly enters a building for the purpose of controlling or extinguishing a fire, rescuing trapped occupants or rendering other emergency assistance.

❖ This paragraph prohibits the use of “booby-traps” in buildings, for whatever reason, if they could injure or disable the emergency responder during the performance of his or her duties.

**316.4 Obstructions on roofs.** Wires, cables, ropes, antennas, or other suspended obstructions installed on the roof of a building having a roof slope of less than 30 degrees (0.52 rad) shall not create an obstruction that is less than 7 feet (2133 mm) high above the surface of the roof.

### Exceptions:

1. Such obstruction shall be permitted where the wire, cable, rope, antenna or suspended obstruction is encased in a white, 2-inch (51 mm) minimum diameter plastic pipe or an approved equivalent.
  2. Such obstruction shall be permitted where there is a solid obstruction below such that accidentally walking into the wire, cable, rope, antenna or suspended obstruction is not possible.
- ❖ Part of the intent of the code in Section 101.2 is to control conditions that can affect the safety of fire fighters and emergency responders during operations. One of these conditions is obstructions on the roofs of buildings. This section does not prohibit the installation of these items, but it requires that they be identified or protected. The primary concern is poorly identified or unidentified obstructions on building roofs that can become an entanglement hazard or, in the case of equipment such as cellular or wireless communication antennas, a potential pathway for stray current if the electrical ground is somehow compromised and an emergency responder comes into contact with it. These provisions will also help to protect maintenance workers as they are working on a rooftop.

This section addresses obstructions on building roofs and was developed to establish criteria for identifying such obstructions. It is applicable only to roofs with a slope of 30 degrees (0.52 rad) or less. This section requires that a means of identification, a barrier, or some other form of obstruction be provided when a guy wire, cable, or rope is less than 7 feet (2133 mm) above the roof level. The 7-foot (2133 mm) value is based on the potential of a firefighter in a smoke-obscured environment striking the cable or wire, especially in the head, neck or upper torso area. A common fire service slang term for this is “being

clothes lined” and these events have resulted in serious injury from entanglement or falling from a roof, including permanent paralysis of fire fighters and other emergency responders.

Where the obstruction is located in the plane that is 7 feet (2133 mm) or less below the roof surface, Exception 1 allows the use of a protective collar such as a 2-inch (51 mm) diameter plastic pipe that is sleeved over the cable. Other options could include illuminating the cable, or providing reflective marking of the cable, wire or rope with a material similar to that used for marking of fire fighter clothing and gear. Any method that offers equivalency to the prescribed pipe sleeve can be approved by the fire code official upon demonstration of equivalency.

Exception 2 recognizes that solid obstructions such as screen walls or fencing can provide a physical barrier so that walking under the wire is not possible and can eliminate the need for protecting the emergency responders from roof obstructions that are less than 7 feet (2133 mm) above the roof level.

**316.5 Security device.** Any security device or system that emits any medium that could obscure a *means of egress* in any building, structure or premise shall be prohibited.

❖ Security devices that, when activated, emit a medium such as smoke or other aerosols into a building could obscure exits or confuse occupants, thus creating an inherently dangerous situation for the public and responding emergency personnel. In cases of activation of these devices, armed criminal perpetrators could be trapped inside buildings. Law enforcement personnel arriving on the scene could easily believe that a building is on fire and responding fire fighters could enter and be confronted by the perpetrator. Another danger is that false fire alarms could be transmitted automatically or by passers-by because of the appearance of smoke in the building. See also the commentary to Section 1031.2 regarding the reliability of exits.

**316.6 Structures and outdoor storage underneath high-voltage transmission lines.** Structures and outdoor storage underneath high-voltage transmission lines shall comply with Sections 316.6.1 and 316.6.2, respectively.

❖ This section introduces code provisions that address requirements for structure construction and material storage beneath high-voltage transmission lines (see definition in Section 202). The importance of such regulations and their impact on fire-fighter safety cannot be overstated. Among the various hazards fire fighters face in the course of duty are electrical hazards during fire suppression or rescue activities. Performing fire-ground operations near power lines may expose fire fighters to electric shock hazards through the following means, among others:

- Energized electrical lines or equipment obscured by dense smoke.
- Smoke and hot gases from a large fire creating a conductive path for electricity. When a fire is

burning under a high-voltage transmission line, electricity could arc from the conductor to the ground, endangering people and objects near the arc.

- Making accidental contact with power lines that are still energized.
- Overhead power lines falling on and energizing conductive equipment and materials located on the fire ground.
- Electrical currents flowing through the ground and extending several feet (ground gradient).
- Solid-stream water applications on or around energized or downed power lines or equipment.

The regulations in Sections 316.6.1 and 316.6.2 are intended to minimize the noted exposures by prohibiting buildings, structures and storage from being constructed or maintained beneath high-voltage transmission lines except under the strictest of conditions and only with the fire code official's approval.

**316.6.1 Structures.** Structures shall not be constructed within the utility easement beneath high-voltage transmission lines.

**Exception:** Restrooms and unoccupied telecommunication structures of noncombustible construction less than 15 feet (4572 mm) in height.

- ❖ Structure fires underneath high-voltage transmission lines could cause arcing and shock hazard. Fire-fighting operations can involve the use of elevated platforms or aerial ladder apparatus and other emergency equipment, personnel above ground and hose streams that may come in close proximity to high-voltage transmission lines. According to nationally recognized utility companies, manual de-energization of lines may take 20 minutes or longer to accomplish.

The exception recognizes that certain ancillary structures, such as restroom buildings and telecommunications structures, do not generally present a significant exposure threat to overhead power lines.

**316.6.2 Outdoor storage.** Outdoor storage within the utility easement underneath high-voltage transmission lines shall be limited to noncombustible material. Storage of hazardous materials including, but not limited to, flammable and *combustible liquids* is prohibited.

**Exception:** Combustible storage, including vehicles and fuel storage for backup power equipment serving public utility equipment, is allowed, provided that a plan indicating the storage configuration is submitted and *approved*.

- ❖ This section regulates the fire load that can be allowed to exist beneath overhead high-voltage transmission lines by restricting outdoor storage within the easement to only noncombustible materials. The exception recognizes that, in certain instances, combustible materials may need to be stored within the easement, such as for utility work on the power lines. Such materials storage must be strictly regulated

through a plans submittal and review process and approval by the fire code official. This section also makes it clear that under no circumstances are hazardous materials allowed to be stored beneath the power lines.

## SECTION 317 ROOFTOP GARDENS AND LANDSCAPED ROOFS

**317.1 General.** Rooftop gardens and landscaped roofs shall be installed and maintained in accordance with Sections 317.2 through 317.5 and Sections 1505 and 1507.16 of the *International Building Code*.

- ❖ Among the major elements of green building construction are energy conservation and preservation of natural resources such as water. Rooftop vegetation accomplishes both, in the form of gardens or using landscaping to cover part of a building roof. Roof gardens or landscaped roofs offer a number of savings to the building owner. For buildings constructed with a membrane-type roofing system, roof gardens or landscaping can increase the life of the roofing materials by almost 100 percent according to some studies. Depending on the design, roof area and local climate, research has found certain green roofs can reduce summer cooling loads by about 25 percent and in some cases have reduced heat gain by 95 percent. In addition to reduced energy costs, these reductions have the potential to reduce the size of HVAC equipment, which in turn lowers the capital costs for construction. These roofs and gardens can also reduce the sound pressure level inside of the building and are helpful in controlling storm water runoff.

Section 317 addresses rooftop gardens and landscaped roofs. The requirements in this section limit the area of roof gardens, require the use of roof assemblies designed for severe fire exposures, and provide for the installation of a standpipe connection. It also sets forth requirements for establishing a maintenance plan for the vegetation installed on roof gardens or landscaped roofs. This section does not define what constitutes a roof garden or landscaped roof; however, its intent is to deal with the structural and fire safety concerns regarding construction that creates a green space on a building roof rather than the placement of a small roof garden.

This section references the requirements in Chapter 15 of the IBC for roof gardens and landscaped roofs. Section 1507.16 of the IBC requires compliance with the requirements of the code, Chapter 15 of the IBC and specific structural requirements in Chapter 16 of the IBC for special purpose roofs and landscaped roofs. The IBC requires roof gardens and landscaped roofs to be calculated at a minimum 20 pound/square foot (0.958 kN/m<sup>2</sup>) uniform live load and that the weight of landscaping materials be considered as dead loads and computed assuming the rooftop soil is saturated.

In addition to the IBC structural requirements, roof

gardens and landscaped roofs can also require the installation of a Class A roof assembly. Section 317.1 of the code references the provisions in Section 1505 of the IBC, which sets forth the fire exposure ratings for roof assemblies. The IBC fire classification requirements for roof assemblies are based on the building's construction type, not on the classification of the building's occupancy. The minimum roof covering classification prescribed by the IBC is either a Class B or Class C roof assembly. The only time Class A roof assemblies are specified is when the jurisdiction has adopted Appendix D of the IBC and the building is located in a fire district or when required in the IWUIC. Section 1505.2 of the IBC requires Class A assemblies to be listed and identified as such by an approved testing agency, but because the IBC does not normally require the installation of Class A roof assemblies, the number of listed systems available to design professionals will be limited. Additional requirements on the design of green roofs are contained in the *International Green Construction Code*® (IgCC®). Another source of information on "green roofs" is contained in Property Loss Prevention Data Sheet 1-35, *Green Roof Systems*, published by FM Global.

**317.2 Rooftop garden or landscaped roof size.** Rooftop garden or landscaped roof areas shall not exceed 15,625 square feet (1450 m<sup>2</sup>) in size for any single area with a maximum dimension of 125 feet (39 m) in length or width. A minimum 6-foot-wide (1.8 m) clearance consisting of a Class A-rated roof system complying with ASTM E108 or UL 790 shall be provided between adjacent rooftop gardens or landscaped roof areas.

❖ On large roofs, the code does not permit complete coverage of the roof with vegetation. This section limits the area of roof gardens or landscaping to an area not exceeding 15,625 square feet (1,450 m<sup>2</sup>) and its maximum length or width dimension cannot exceed 125 feet (39 m). The 125-foot value is based on the typical amount of hose carried by fire departments for high-rise hose packs. If the area or dimension of a landscaped garden or roof exceeds the prescribed area or dimension limits, this section allows multiple landscaped areas when each is separated by a minimum 6-foot-wide (1.8 m) buffer space constructed as a Class A roof assembly. This buffer space will slow fire spread between multiple landscaped areas and will afford fire-fighter access to each separated segment and provide access to roof surface areas that may be used for fire department ventilation operations. Note that for buildings in which Section 905 requires the installation of a standpipe system, Section 905.3.8 will require the extension of a standpipe hose valve to the roof level serving the landscaped roof or roof garden.

**317.3 Rooftop structure and equipment clearance.** For all vegetated roofing systems abutting combustible vertical surfaces, a Class A-rated roof system complying with ASTM E108 or UL 790 shall be achieved for a minimum 6-foot-

wide (1829 mm) continuous border placed around rooftop structures and all rooftop equipment including, but not limited to, mechanical and machine rooms, penthouses, skylights, roof vents, solar panels, antenna supports and building service equipment.

❖ Where a building utilizes combustible construction for the construction of penthouses, mechanical equipment or rooftop elevator machine rooms, this section requires a minimum 6-foot-wide (1.8 m) border constructed around the combustible construction. The buffer space is also constructed to the IBC requirements for a Class A roof assembly (see the commentary to Section 317.1). The buffer space is not required if the roof garden or landscaped roof is separated by more than 6 feet (1.8 m) from the combustible construction or when noncombustible construction is used. This buffer space will slow fire spread between landscaped areas and combustible construction and will afford fire fighter access.

**317.4 Vegetation.** Vegetation shall be maintained in accordance with Sections 317.4.1 and 317.4.2.

❖ This section introduces requirements for the maintenance of rooftop garden or landscaped roof areas to reduce the fire risk that could otherwise arise for buildings and exposure buildings because of the possible lack of maintenance. Basically, an unmaintained roof garden that catches fire could be likened to a brush fire being conducted on top of a building rather than on the ground, creating an increased exposure hazard since roof covering rating requirements are based on flying embers, not falling ones.

**317.4.1 Irrigation.** Supplemental irrigation shall be provided to maintain levels of hydration necessary to keep green roof plants alive and to keep dry foliage to a minimum.

❖ Care of rooftop vegetation by simple watering provides a basic line of defense against accumulation of dry biomass that can present a significant fire load if ignited. The frequency of watering is not specified due to the diverse moisture needs of the wide variety of planted materials possible on any given roof. The person responsible for the landscaped roof must determine the level of watering needed for this purpose and that information should be included in the maintenance plan authorized by Section 317.4.3.

**317.4.2 Dead foliage.** Excess biomass, such as overgrown vegetation, leaves and other dead and decaying material, shall be removed at regular intervals not less than two times per year.

❖ In order to manage the significant fuel load accumulation and fire hazard associated with dead or unkempt rooftop vegetation, this section sets a basic level of maintenance and regular removal of dead biomass, similar to that found in Section 304.1.2 for the maintenance of vegetation in and around a building (see commentary, Section 304.1.2).

**317.4.3 Maintenance plan.** The *fire code official* is authorized to require a maintenance plan for vegetation placed on

roofs due to the size of a roof garden, materials used or where a fire hazard exists to the building or exposures due to the lack of maintenance.

- ❖ This section authorizes the fire code official to require a maintenance plan that may be used to guide maintenance personnel and inspectors in the care and upkeep of vegetation to reduce the hazard of having highly combustible dead plantings on the roof. This is beneficial to determine if the roof garden will be maintained or is just a bunch of vegetation placed on the roof as a “do-it-yourself” project. The maintenance plan is also beneficial to determine what happens to a building that goes vacant or when the building owner does not keep up with maintenance.

**317.5 Maintenance equipment.** Fueled equipment stored on roofs and used for the care and maintenance of vegetation on roofs shall be stored in accordance with Section 313.

- ❖ This section simply sends the code user to Section 313 for appropriate storage regulations for fueled equipment (see commentary, Section 313).

### SECTION 318 LAUNDRY CARTS

**318.1 Laundry carts with a capacity of 1 cubic yard or more.** Laundry carts with an individual capacity of 1 cubic yard [200 gallons (0.76 m<sup>3</sup>)] or more, used in laundries within Group B, E, F-1, I, M and R-1 occupancies, shall be constructed of noncombustible materials or materials having a peak rate of heat release not exceeding 300 kW/m<sup>2</sup> at a flux of 50 kW/m<sup>2</sup> where tested in a horizontal orientation in accordance with ASTM E1354.

#### Exceptions:

1. Laundry carts in areas protected by an *approved automatic sprinkler system* installed throughout in accordance with Section 903.3.1.1.
  2. Laundry carts in coin-operated laundries.
- ❖ The change from cooking with animal fat to vegetable oil has increased the number of spontaneous ignition fires. These fires occur frequently in laundry operations due to insufficient cool-down time in the laundry drying process and have been known to ignite in freshly folded linen, often contained in polyethylene laundry carts. Medium-density polyethylene laundry carts which have a fuel content of approximately 20,020 Btu per pound [27 ft<sup>3</sup> (0.76 m<sup>3</sup>)] are commonly used in industrial, commercial and institutional laundry operations. This material is essentially equal to the fuel value for gasoline and becomes a burning liquid that spreads and flows when involved in a fire. As such, the cart flammability hazard must be mitigated. This section does that by limiting combustible container heat release rate and heat flux using the test parameters of ASTM E1354. The peak rate of heat release criterion is consistent with the one in Sections 304.3.2, 304.3.4 and 808.1. The efficacy of using

these lesser-hazard carts has been demonstrated in several commercial and institutional fire incidents wherein the burning commercial dryer contents were emptied into an ASTM E1354 container and taken outside and overhauled without evacuation of the building, loss to the structure or damage to the container.

Exception 1 permits the use and storage of ordinary laundry carts in areas protected by an approved sprinkler system. It would be up to the fire code official to determine the maximum number that could be stored under these conditions.

Exception 2 recognizes that the small carts used in neighborhood coin laundries do not present the same hazard as those used in commercial-type operations because the clothes and other laundered items do not remain in the cart for a significant length of time.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

Code Changes Resource Collection—2015 *International Fire Code*. Washington, DC: International Code Council, 2014.

FACE-99-F47, Six Career Fire Fighters Killed in Cold-storage and Warehouse Building Fire—Massachusetts. Washington, DC: National Institute for Occupational Safety and Health, September 2000.

NFPA 550-12, Fire Safety Concepts Tree. Quincy, MA: National Fire Protection Association, 2012.

Property Loss Prevention Data Sheet 1-35, *Green Roof Systems*. Johnston, RI: FM Global, 2011.



# Chapter 4: Emergency Planning and Preparedness

## General Comments

This chapter is an expansion of the provisions found in the legacy fire codes used to develop the code. The overall approach has been to place all similar requirements into general sections. Unique occupancy and use-specific requirements are provided in Section 403.

This chapter first provides general scope and requirements for reporting emergencies and preventing interference with fire department activities in Section 401.

Section 403 provides detailed requirements based on occupancy. These requirements include seating plans for Group A occupancies. This section also establishes requirements for general public safety regarding fire watch personnel, crowd managers and planning requirements for public assemblages.

Section 404 provides detailed requirements for fire safety plans, fire evacuation plans and lockdowns.

The frequency and required documentation related to evacuation drills are addressed in Section 405. The minimum criteria for the training of occupants for emergency situations are found in Section 406. Section 407 provides requirements that apply to occupancies that contain hazardous materials. Some of the key elements are Hazardous Materials Inventory Statements (HMIS) and Hazardous Materials Management Plans (HMMP).

## Purpose

In addition to the requirements found throughout the building and fire codes, this chapter focuses on the actions of occupants. These additional requirements are warranted based on higher levels of care related to the concentration of people; physical and mental capabilities of the occupants; lack of familiarity with a building; or the complexity and size of the building. These requirements are intended to improve the effectiveness of other measures required by the code and the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>).

Basically, this chapter addresses human contributions to life safety in buildings when a fire or other emergency occurs. The requirements for continuous training and scheduled evacuation drills can be as important as the required periodic inspections and maintenance of built-in fire protection features. The level of preparation by the occupants also improves the emergency responders' abilities during an emergency.

The IBC focuses on built-in fire protection features, such as automatic sprinkler systems, fire-resistance-rated construction and properly designed egress systems. The human element is only indirectly addressed in the IBC, whereas this chapter fully addresses the human element. Traditionally, fire codes address the

human element more directly in their role in the long-term maintenance of buildings and systems.

Chapters 3 and 6 through 10 of the code and Chapters 7 through 10 of the IBC set forth provisions for how and when buildings are to be properly equipped and maintained to prevent damage and loss of life in the event of a fire. These requirements are based on two complementary fire safety strategies: managing the fire and managing the occupants. These strategies are discussed in more detail in the commentary for Chapter 1.

## Managing Fire

A fire can be either prevented or managed. This chapter of the code focuses on training and preparedness while also emphasizing prevention. In some cases, moving occupants to minimize their exposure to a hazard is difficult or impractical. In these situations, controlling or eliminating the hazard is preferable, especially while it is still manageable. In fact, this is the concept underlying all fire-suppression requirements. Successful fire control depends on building occupants recognizing the fire threat, deciding to respond, choosing how to respond and, in the case of choosing fire control, identifying, locating and using the correct method. All of these functions must promptly take place in that order. Failure to perform promptly may preclude alternative strategies; therefore, location and identification of fire extinguishers and occupant standpipe hose lines are provided so that incipient fire-fighting equipment is readily accessible to occupants. These appliances, however, are often difficult to operate, and regardless of experience, fighting fire is a difficult and dangerous task. This chapter prescribes training requirements that assist occupants who are expected to respond to incipient fires to be adequately prepared and trained.

## Managing Occupants

The management of occupants is primarily moving them away from the hazard. Verifying that enough exits have ample capacity, are immediately accessible, adequately arranged, appropriately identified and suitably protected are only the first steps toward achieving functional life safety. Occupants must know not only where exits are, but also when and how to use them. For instance, studies have shown that people have a "learned irrelevance" to emergency exits. Learned irrelevance is a psychological phenomenon that occurs when a person is exposed to a stimulus but usually does not need to respond to it. Because of this phenomenon, most occupants are likely to exit the way they have

entered, whether it is the correct way or not; therefore, beyond designing the building with an adequate number of exits, a method of encouraging the use of the best exits must be developed. Identifying dangerous conditions, deciding how to act and responding appropriately and promptly are essential. Various factors and situations can make evacuation not only difficult but potentially impractical. All of these factors involve the interaction between the building, its systems and features, occupants and the fire. The code concentrates on the last two factors while the IBC regulates the first two factors. Planning for life safety requires a response to these factors by defining the life safety strategies that must be implemented, as well as the means to achieve them. Life safety factors, such as buildings, fire and people, are important in managing exposed occupants.

This chapter concentrates on planning and practicing the desired actions of building occupants when a fire occurs. The remainder of the code focuses on the behaviors and procedures that must be practiced or observed to prevent or control a fire. The best way to create a safe building environment is through fire prevention. No system can ensure complete protection of building occupants.

Fires are not the only emergencies necessitating the implementation of life safety strategies; therefore, this chapter describes requirements for preparing and implementing life safety plans and programs in occupancies with special life safety problems. These include occupancies in which the number of occupants or the arrangement or complexity of the building may make evacuation or removal from hazardous conditions difficult or impractical.

A reality of the 21st century in the wake of terrorist attacks and school and business shootings is a need to establish so-called “lockdown” procedures in order to protect and defend building occupants. While the code does not mandate the implementation of lockdown plans and procedures, it does provide some minimum standards such plans must meet when they are prepared.

Not all occupants of each building are equally capable of performing tasks essential to their safety. A growing awareness, not only of people with physical disabilities, but also of what constitutes a disability, has focused life safety on everyone. Federal health care policies and funding criteria have spurred the deinstitutionalization of people who were formerly confined to nursing homes and other traditional health care institutions. This has created a new category of occupancies—board and care homes (institutional, residential care; I-1)—while the number of beds provided in nursing homes and hospitals continues to grow. Similarly, technological advances have promoted the creation of larger and more complex buildings, including high rises, open malls, domed stadiums, mixed-use complexes and convention centers. All of

these situations create special life safety problems that physical features alone cannot remedy. Additionally, these situations require that not only adequate physical accommodations be provided but also building occupants be trained to respond to emergencies in these facilities.

### **Life Safety**

Life safety strategies involve the development of an explicit statement of a desired life safety outcome. This statement, once designed to the capabilities of the building occupants and the physical arrangement of the exits, becomes a life safety strategy. Such approaches stress defining a specific strategy or strategies for protecting occupants. Protection may include moving them (assisting), causing them to move (directing), defending them in place or a combination of these measures. An effective strategy must consider the number and capabilities of building occupants; the type, location and arrangement of building exits; the fire; its effects on the people and building; and the number, training and capability of staff to direct or perform fire evacuation or incipient fire-fighting duties. Each strategy, combined with effective planning and practice, becomes the means for achieving the desired life safety outcome.

The life safety strategies for a health care facility, a high-rise office building and a multiplex theater could vary considerably based on the specific characteristics of the use. First, while the number of occupants will be significant in each case, the actual number occupying the building may be varied. Similarly, the occupant density and location of people in the building will vary, as well as the physical arrangement of the building, which in the first example that follows may be assumed as primarily horizontal and, in the second, as principally vertical. The most profound difference will be the capabilities of the occupants. In high rises and theaters, building occupants will be expected to perform life safety behaviors themselves, while patients in a health care facility may require substantial assistance or need to defend in place. High-rise and theater occupants will differ from each other in their levels of familiarity with the building design. Further, in a theater, lighting conditions may interfere with the occupants’ ability to discern the path of egress travel.

In the first two examples, health care and high rise, removing all occupants from the building in the event of fire is impractical. In a high-rise building, occupants located above a fire are in greater danger than occupants located below the fire, since combustion products naturally rise. In a health care occupancy, the risk to most occupants is compounded by their weakened or disabled condition prior to the fire. In both of these examples, a life safety strategy should first address the needs of those at greatest risk by removing them from harm. Secondly, the life safety strategy

should stress separating endangered occupants and their immediate neighbors from danger until the hazard can be controlled or confined. As seen in each example, life safety strategies should also incorporate both partial relocation and defend-in-place concepts. In the health care facility, however, occupants will be moved horizontally to achieve this objective, while in high-rise buildings, occupants will be expected to move downward or upward to separate themselves from danger. In the case of a multiplex theater, occupants will usually be directed to the nearest exit; however, its location may not be known to all or some of them. Further, because employees in assembly occupancies must be trained in the proper use of portable fire extinguishers, the life safety strategy should include instruction in using these appliances to minimize occupant exposure to fire effects. The resulting life safety strategies for these occupancies may resemble the following:

**Example 1 – Health Care Facility:** Upon notice of fire, direct or assist evacuation and relocate occupants from the area of fire origin to an adjacent smoke compartment through horizontal exits. Remove the most critically ill patients and those with special needs to an area providing the most appropriate level of care.

**Example 2 – High-rise Building:** Direct occupants in the area or floor of fire origin to the nearest exits. Occupants on the fire floor, the floor above and the floor below will relocate sequentially up or down at least two floors. Occupants located two floors above and two floors below the fire floor will be sequentially relocated following movement of fire floor occupants.

**Example 3 – Multiplex Theater:** Announce exit locations and evacuation instructions prior to each movie. Over voice/alarm systems, direct occupants to nearest exit. Employees in the immediate vicinity of an incipient fire may attempt to control or extinguish it using a portable fire extinguisher after activating the fire alarm system.

Once the appropriate strategy has been defined, a plan can be expanded with little additional effort to form the backbone of a comprehensive life safety protocol.

The following statements provide additional instructions for the aforementioned examples:

**Example 1 – Health Care Facility:** Monitor or reinforce fire barriers so that they provide adequate defense against fire until it is controlled and extinguished. Staff will report progress of the fire and relocation operation to the Private Branch Exchange (PBX) operator through the nurse call station in adjacent smoke compartments.

**Example 2 – High-rise Building:** Building fire manager will meet fire department personnel at the central control station located off the main lobby.

**Example 3 – Multiplex Theater:** Projectionist will stop films so that the alarm and evacuation instructions are heard and followed. Upon activation of the alarm, instructions are heard and followed while the on-duty manager telephones the fire department to confirm that the fire was reported. Ushers will follow occupants out of each auditorium as conditions permit, closing exit doors and preventing reentry. Upon completing assigned duties, all staff will report to the manager located in front of the lobby entrance.

These expanded statements certainly do not constitute a fully developed plan; however, with these elements of the life safety plan defined, details can be added to send the plan from preincident preparation through post-incident follow-up. A well-developed plan should include all or most of the following elements:

- Assignment of roles and responsibilities;
- Description of fire protection systems, including operating instructions, if appropriate;
- Building floor plans and sections;
- Seating diagrams and occupant load;
- Number, location and path of travel to exits;
- Emergency notification lists and procedures;
- Post-incident follow-up procedures, including salvage and insurance information; and
- Plan revision and evaluation procedures.

Once a plan is developed, reviewed and approved, it must be distributed, practiced and periodically revised.

## SECTION 401 GENERAL

**401.1 Scope.** Reporting of emergencies, coordination with emergency response forces, emergency plans and procedures for managing or responding to emergencies shall comply with the provisions of this section.

**Exception:** Firms that have *approved* on-premises fire-fighting organizations and that are in compliance with *approved* procedures for fire reporting.

❖ This section describes the overall scope of Chapter 4, which notes that all procedures relating to reporting

and managing fire and other emergencies be in accordance with this chapter. There is one exception recognizing organizations, such as large industrial sites, that have on-site fire brigades. The fire brigades and the associated reporting procedures must be approved by the fire code official.

**401.2 Approval.** Where required by this code, fire safety plans, emergency procedures and employee training programs shall be *approved* by the *fire code official*.

❖ To verify that emergency procedures, training and fire safety plans have taken all essential factors into

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account, the plans and procedures must be approved by the fire code official.

**401.3 Emergency responder notification.** Notification of emergency responders shall be in accordance with Sections 401.3.1 through 401.3.3.

❖ This section simply states that the notification of emergency forces must comply with Section 401.3 and all of its subsections.

**401.3.1 Fire events.** In the event an unwanted fire occurs on a property, the *owner* or occupant shall immediately report such condition to the fire department.

❖ This section requires prompt notification of the fire department in the event of a fire emergency. Employees or other occupants are prohibited from delaying in any way the notification of the fire department.

**401.3.2 Alarm activations.** Upon activation of a fire alarm signal, employees or staff shall immediately notify the fire department.

❖ This section specifically requires immediate notification of the fire department or other emergency response groups when an alarm signal is activated in order to bring emergency forces in the shortest amount of time.

**401.3.3 Delayed notification.** A person shall not, by verbal or written directive, require any delay in the reporting of a fire to the fire department.

❖ Emergency plans and procedures must not include a requirement that employees report an alarm to a supervisor or similar person before calling the fire department. There can be no substitute for immediate notification of emergency forces because a quick response is the key to efficient and effective rescue and fire fighting.

**401.4 Required plan implementation.** In the event an unwanted fire is detected in a building or a fire alarm activates, the emergency plan shall be implemented.

❖ Sections 401.3.1 through 401.3.3 mandate the prompt notification of emergency responders whenever a fire alarm is activated or an actual fire or suspected fire occurs. Since the emergency plan is designed to safely and effectively deal with those circumstances and safeguard the occupants, it must be implemented simultaneously with emergency responder notification as required by this section.

**401.5 Making false report.** A person shall not give, signal or transmit a false alarm.

❖ Chapter 2 of the code defines a false alarm as an intentional activation of an alarm or notification of a fire or other emergency when no emergency exists. This would not include a malfunctioning alarm system. False alarms have the potential for causing confusion or panic among occupants of the affected premises, a situation that could lead to property damage, personal injury or death. False alarms also place fire fighters and other emergency personnel in poten-

tial danger during the unnecessary emergency response. This can jeopardize other lives and property in the community by committing emergency forces to a false situation when they might be needed at an actual emergency elsewhere.

**401.6 Emergency evacuation drills.** The sounding of a fire alarm signal and the carrying out of an emergency evacuation drill in accordance with the provisions of Section 405 shall be allowed.

❖ This section specifically allows fire alarm signals to be utilized as part of emergency evacuation drills. Without this provision, Section 401.3.1 would not allow the activation of the alarm signal during an emergency evacuation drill.

**401.7 Unplanned evacuation.** Evacuations made necessary by the unplanned activation of a fire alarm system or by any other emergency shall not be substituted for a required evacuation drill.

❖ This section makes it clear that unplanned evacuations will not be applied toward fulfillment of the number of drills required. Evacuation drills are intended to provide for an assessment of the adequacy of an emergency action plan and the response of the building occupants. Occupants may or may not be forewarned of a pending drill depending on the circumstances. Responsible staff prepares for and conducts the drills, a key aspect of which is having monitors in place to assess individual and group performance. An unplanned evacuation does not allow for effective monitoring of performance and, therefore, must not be counted as a required drill.

**401.8 Interference with fire department operations.** It shall be unlawful to interfere with, attempt to interfere with, conspire to interfere with, obstruct or restrict the mobility of or block the path of travel of a fire department emergency vehicle in any way, or to interfere with, attempt to interfere with, conspire to interfere with, obstruct or hamper any fire department operation.

❖ A potential hazard when fire departments respond to an emergency is the inability to perform operations because of physical obstructions, restricted mobility or human interference. This section prohibits any type of interference with emergency response operations. The delay of even a few minutes can cause serious property damage, injuries or fatalities.

## SECTION 402 DEFINITIONS

**402.1 Definitions.** The following terms are defined in Chapter 2:

### EMERGENCY EVACUATION DRILL.

### LOCKDOWN.

❖ Definitions of terms can help in the understanding and application of the code requirements. This sec-

tion directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2, in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

### SECTION 403 EMERGENCY PREPAREDNESS REQUIREMENTS

**403.1 General.** In addition to the requirements of Section 401, occupancies, uses and outdoor locations shall comply with the emergency preparedness requirements set forth in Sections 403.2 through 403.12.3.3. Where a fire safety and evacuation plan is required by Sections 403.2 through 403.11.4, evacuation drills shall be in accordance with Section 405 and employee training shall be in accordance with Section 406.

❖ Section 403 contains the occupancy-specific requirements for emergency preparedness. This section primarily notes when a fire safety and evacuation plan is required, but also provides specific requirements as necessary. For instance, seating plans must be provided for Group A occupancies or, in the case of Group I-2 occupancies, specific requirements are provided for staff training. Section 403 also has a section with special requirements to address the need for fire watches and planning for large gatherings (see Section 403.12).

The occupancies addressed by this section were chosen based on the density and location of occupants, the layout of the building or the limitations of the occupants during an emergency. The *Evacuation Planning Guide for Stadiums* published by the U.S. Department of Homeland Security (DHS) provides useful guidance for evacuation planning in large assembly structures. The principles used in that document could also be applied to the other occupancy groups listed in this section. Two additional resources to better understand the evacuation needs of specific types of structures such as tall buildings and airports are the SFPE *Engineering Guide: Fire Safety for Very Tall Buildings* and *Egress Design Solutions*.

**403.2 Group A occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for Group A *occupancies*, other than those occupancies used exclusively for purposes of religious worship with an occupant load less than 2,000, and for buildings containing both a Group A occupancy and an atrium. Group A occupancies shall comply with Sections 403.2.1 through 403.2.4.

❖ Group A occupancies are a special concern because of the high density and number of occupants. Additionally, occupants in Group A occupancies are generally not very familiar with the building. Due to lack of losses associated with those attending religious wor-

ship services, such occupancies are given an exception to the application of these requirements of less than 2,000 people.

**403.2.1 Seating plan.** In addition to the requirements of Section 404.2, the fire safety and evacuation plans for assembly occupancies shall include a detailed seating plan, *occupant load* and *occupant load* limit. Deviations from the *approved* plans shall be allowed provided the *occupant load* limit for the occupancy is not exceeded and the *aisles* and exit accessways remain unobstructed.

❖ Proper planning for an assembly occupancy must consider the number, capacity and physical arrangement of exits. In turn, these factors will dictate how seating may be arranged to prevent obstruction of aisles and exits. The number of seats provided may not exceed what is permitted by the number, arrangement and capacity of exits. Floor area factors are only one element in determining whether the exit capacity is adequate. Additionally, the egress plan must be approved by the fire code official with a copy of the approved plan maintained on the premises for review by employees and inspectors. Many facilities have several approved plans to accommodate various situations and functions. The seating plan selected for any event should reflect the needs of the group and the requirement to keep aisles and exits clear. Deviations from an approved plan may be permitted only if they do not obstruct the complete egress path, including aisles and exits.

**403.2.2 Announcements.** In theaters, motion picture theaters, auditoriums and similar assembly occupancies in Group A used for noncontinuous programs, an audible announcement shall be made not more than 10 minutes prior to the start of each program to notify the occupants of the location of the exits to be used in the event of a fire or other emergency.

**Exception:** In motion picture theaters, the announcement is allowed to be projected upon the screen in a manner *approved by the fire code official*.

❖ Announcements are intended to familiarize occupants with life safety system features they may need to use if a fire occurs. Information is the most valuable commodity during fires and other emergencies; however, it is often difficult, if not impossible, to override the emotion and confusion caused by a fire or other emergency. Studies have generally shown, however, that occupants do not panic as once thought; therefore, it is imperative that occupants receive information necessary for them to make decisions before an emergency occurs. To convey information and motivate an adaptive response to fires or other emergencies, the message must stimulate interest and speak directly to the topic. Many movie theaters currently use “trailers” or “shorts” to market concession items, as well as fire safety. These messages can be especially effective if they are specific and adequately distinguished from other promotions.

Any message should reflect the life safety strategy and must point out specific features of the occupancy. Occupants in most theaters and auditoriums are usually expected to leave the building immediately upon notification of a fire using the nearest available exit. This is largely a reflection on the building type and arrangement of exits. In these cases, the locations of all exits must be identified. Raising the house lights along the egress path or modulating aisle lighting at appropriate times during the message can reinforce the message.

This section specifically requires an audible announcement, but the exception for motion picture theaters would allow the message to be visually displayed upon the screen as approved. A combination of both an audible and visual message would most likely be the most effective. This section also has a maximum time from the start of the show to provide such announcements. An announcement that comes too early will lose its effectiveness.

**403.2.3 Fire watch personnel.** Fire watch personnel shall be provided where required by Section 403.12.1.

❖ This section links to Section 403.12.1, which establishes the authority of the fire code official to require a fire watch as necessary.

**403.2.4 Crowd managers.** Crowd managers shall be provided where required by Section 403.12.3.

❖ Assembly occupancies contain many occupants potentially unfamiliar with the building. The larger the number of occupants in a single space, the more critical that crowd managers be available to direct people. Section 403.12.3 requires crowd managers when a gathering exceeds 1,000 people.

**403.3 Ambulatory care facilities.** Ambulatory care facilities shall comply with the requirements of Sections 403.3.1 through 403.3.3 as well as 401 and 404 through 406.

❖ Ambulatory care facilities, similar to Group I-1 Condition 2 and Group I-2 occupancies, use a “defend-in-place” method of occupant protection. Defend in place is a widely used approach to protecting occupants who are bedridden, unconscious or otherwise unable to self-preserve in a fire event. The method relies on both active and passive fire protection systems as well as the actions of trained staff and responders. The heavy emphasis on staff action requires a comprehensive fire safety and evacuation plan. Any building containing an ambulatory health-care occupancy will, by definition, contain occupants who may be incapable of self-preservation. The intent of the current IBC requirements for ambulatory care is to create a type of defend-in-place environment. Sections 403.3.1 through 403.3.4 provide requirements for ambulatory care that are more specific than those provided in Sections 404 and 405.

**403.3.1 Fire evacuation plan.** The fire safety and evacuation plan required by Section 404 shall include a description of special staff actions. This shall include procedures for stabi-

lizing patients in a defend-in-place response, staged evacuation, or full evacuation in conjunction with the entire building if part of a multitenant facility.

❖ Fire safety and evacuation plans must be developed, reviewed and approved to support this strategy. The reference to “defend in place” is added in Section 404.2.2 to recognize the defend-in-place method. This is not a new concept. The IBC and legacy codes have been written to support this concept, and fire safety and evacuation plans must acknowledge this strategy. The term “defend in place” is defined in the IBC. Fire safety plans should describe in the life safety strategy the method of notifying occupants, including the use of a private-mode alarm system as allowed by code. Procedures for dealing with occupants in a defend-in-place strategy should also be described so that it is clear what the staff will be trained on and what the first responders should expect to encounter. Fire evacuation plans are required to describe the special actions of staff, especially staff that must stabilize a patient prior to moving. This will be the basis of the staff education and training. This will also help the code official understand the expected performance of the building. It is imperative that the building and fire official know the size and location of the facility as well as the number of patients who are incapable of self-preservation. This information will help the building official determine the proper classification and mitigations required. It will also allow the fire official to preplan the response for a particular building. Any special characteristics of the means of egress, such as path to the adjacent smoke compartment and special locking arrangements, should also be described to aid in verifying code compliance. Practically, these documents will be the basis for staff training as well.

**403.3.2 Fire safety plan.** A copy of the plan shall be maintained at the facility at all times. The plan shall include all of the following in addition to the requirements of Section 404:

1. Locations of patients who are rendered incapable of self-preservation.
2. Maximum number of patients rendered incapable of self-preservation.
3. Area and extent of each ambulatory care facility.
4. Location of adjacent smoke compartments or refuge areas, where required.
5. Path of travel to adjacent smoke compartments.
6. Location of any special locking, delayed egress or access control arrangements.

❖ This section sets out information required for the fire safety plan specific to ambulatory care facilities. Fire safety plans are required to show the location where incapable patients are likely to be. They are required to show the location of smoke compartments, routes of travel, patient movement elevators and any locking constraints that might affect the horizontal evacuation

of patients. All of these will be essential to robust staff training as well as operational planning for first responders.

**403.3.3 Staff training.** Employees shall be periodically instructed and kept informed of their duties and responsibilities under the plan. Records of instruction shall be maintained. Such instruction shall be reviewed by the staff not less than every two months. A copy of the plan shall be readily available at all times within the facility.

❖ In ambulatory care facilities, due to the condition of the occupants, the actions of the staff are critical to the success of the fire evacuation plan. Therefore, staff training on a regular basis is necessary. This section requires that the staff review the fire evacuation plan and fire safety plan regularly. These plans always need to be available for review.

**403.3.4 Emergency evacuation drills.** Emergency evacuation drills shall comply with Section 405. Emergency evacuation drills shall be conducted not less than four times per year.

**Exceptions:** The movement of patients to safe areas or to the exterior of the building is not required.

❖ This section requires not less than four evacuation drills each year. This requirement is more restrictive than what Table 405.2 would require. Therefore, although Table 405.2 requires only annual evacuation drills, they must be done four times a year. This is similar to what is required for Group I-2 occupancies. Such drills are limited to the employees. The exception emphasizes that patient participation is not required.

**403.4 Group B occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for buildings containing a Group B occupancy where the Group B occupancy has an *occupant load* of 500 or more persons or more than 100 persons above or below the lowest *level of exit discharge* and for buildings having an ambulatory care facility.

❖ This section requires a fire and evacuation plan when the number of occupants in a Group B occupancy becomes large. The increased risk when such occupants are not located on the level of exit discharge is also addressed. Generally, Group B occupancies are not used for sleeping and occupants are familiar with their surroundings. This section is for Group B occupancies that are not considered ambulatory care facilities. Ambulatory care facilities are also Group B occupancies but would be addressed more specifically by Section 403.3. Group F and M occupancies have the same occupant load and location trigger for fire safety and evacuation plans (see Sections 403.6 and 403.9).

**403.5 Group E occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for Group E occupancies and for buildings containing both a Group E occupancy and an atrium.

Group E occupancies shall comply with Sections 403.5.1 through 403.5.3.

❖ Group E occupancies are among the primary occupancies requiring emergency evacuation drills. They are among the few occupancies that require all occupants to participate in evacuation drills. The effectiveness of pre-emergency planning in Group E occupancies has been significant, as evidenced by a remarkable decline in tragic fires in schools over the years. The evacuation skills learned by children in school are often carried with them into adulthood.

**403.5.1 First emergency evacuation drill.** The first emergency evacuation drill of each school year shall be conducted within 10 days of the beginning of classes.

❖ Group E occupants vary from year to year as children enter and leave grade levels. In addition, even though a child may be in the same school for a number of years, location within the building and leaders change. It is important, therefore, that the first evacuation drill occurs within the first 10 days of school. This provides students with nearly immediate training and the school and emergency responders with information about where problems exist. Additionally, in more recent years schools have been immersing students with disabilities into the general classroom. The location and number of these students vary each year. The ability to evacuate them must be assessed early in the school year.

**403.5.2 Time of day.** Emergency evacuation drills shall be conducted at different hours of the day or evening, during the changing of classes, when the school is at assembly, during the recess or gymnastic periods, or during other times to avoid distinction between drills and actual fires.

❖ If evacuation drills are done routinely, they will be easily distinguished as drills and not an actual fire. This is potentially dangerous because the behavior patterns will be different and actual preparedness for emergencies will be lessened. Time of day, therefore, should be varied whether it is convenient or not. A fire will not differentiate between a convenient and an inconvenient time.

**403.5.3 Assembly points.** Outdoor assembly areas shall be designated and shall be located a safe distance from the building being evacuated so as to avoid interference with fire department operations. The assembly areas shall be arranged to keep each class separate to provide accountability of all individuals.

❖ A key element in safe evacuation is the exit discharge portion of the evacuation route. Once occupants are outside the building, they need to be located far enough away to avoid further hazards. Additionally, there is a potential for people at the assembly point to interfere with the emergency operations of the fire department, which may not be present during an evacuation drill. Locations, therefore, need to be des-

ignated such that they avoid hazards and keep the evacuated occupants away from probable paths of emergency response. Also, to simplify accounting for the occupants once outside, the code requires each class to remain together as a group and separate from other classes.

**403.6 Group F occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for buildings containing a Group F occupancy where the Group F occupancy has an *occupant load* of 500 or more persons or more than 100 persons above or below the lowest *level of exit discharge*.

❖ Group F occupancies require a fire safety and evacuation plan under the same occupant load and location conditions as Group B and M occupancies. Essentially, when the occupant load begins to get large or increases on a level other than the level of exit discharge, such plans become more critical (see commentary, Section 403.4).

**403.7 Group H occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for Group H occupancies.

❖ This section requires that all Group H occupancies have a fire safety and evacuation plan. These occupancies, regardless of size or type, tend to contain significant hazards that make the need for preplanning critical. Semiconductor facilities have more specific requirements found in Section 403.7.1.

**403.7.1 Group H-5 occupancies.** Group H-5 occupancies shall comply with Sections 403.7.1.1 through 403.7.1.4.

❖ Group H-5 occupancies are semiconductor fabrication facilities. These types of facilities are unique in that they have a very large allowable area and house a significant amount of hazardous materials. Essentially, the building is divided into fabrication areas, hazardous production materials (HPM) rooms (which are Group H occupancy storage rooms) and networks of service corridors and spaces. The area of the building needs to be large to incorporate all of the operations needed by the semiconductor industry. To facilitate these operations, a special package of requirements and occupancy classification was created. This package is found within the occupancy requirements in the IBC and Chapter 27 of the code. As part of the package, special emergency preparedness and preparation are also required. Sections 403.7.1.1 through 403.7.1.4 provide specific requirements for emergency preparedness and preparation. These requirements are in addition to others pertaining to hazardous materials found in Section 407.

**403.7.1.1 Plans and diagrams.** In addition to the requirements of Section 404 and Section 407.6, plans and diagrams shall be maintained in *approved* locations indicating the approximate plan for each area, the amount and type of HPM stored, handled and used, locations of shutoff valves for HPM

supply piping, emergency telephone locations and locations of exits.

❖ The requirements for plans and diagrams are in addition to those required in Sections 404 and 407. More specifically, the additional details required include the approximate plan for each area of the building. This includes the amount of HPM stored, handled and used in both the fabrication areas and the HPM rooms. Additionally, since it is typical that such facilities tend to pipe HPM throughout the building for efficiency, all shutoff valves must be identified. Finally, exits must be clearly marked. This is specifically necessary because many service corridors for the transport of materials are not considered part of the means of egress. These details will assist both the occupants and the emergency responders.

**403.7.1.2 Plan updating.** The plans and diagrams required by Sections 404, 403.7.1.1 and 407.6 shall be maintained up to date and the *fire code official* and fire department shall be informed of major changes.

❖ Semiconductor facilities are constantly changing because of the needs of new technology; therefore, the types and amounts of materials and their application are constantly changing. These changes must be accounted for within the plans and diagrams required in Sections 403.7.1.1 and 407; otherwise, the critical information needed by the emergency responders may not be available.

**403.7.1.3 Emergency response team.** Responsible persons shall be designated as an on-site emergency response team and trained to be liaison personnel for the fire department. These persons shall aid the fire department in preplanning emergency responses, identifying locations where HPM is stored, handled and used, and be familiar with the chemical nature of such material. An adequate number of personnel for each work shift shall be designated.

❖ This section is similar to Section 407.4, but has some specific requirements unique to semiconductor facilities. More specifically, liaisons familiar with the location of HPM and hazards related to those materials must be on site. For example, semiconductor facilities make use of silane gas, which is a pyrophoric material—it will instantly ignite when exposed to atmospheric conditions. Knowing the characteristics of the material, where it is located and the quantity used is critical to the responding emergency personnel.

**403.7.1.4 Emergency drills.** Emergency drills of the on-site emergency response team shall be conducted on a regular basis but not less than once every three months. Records of drills conducted shall be maintained.

❖ This section requires employees to conduct drills every 3 months to practice specific emergency procedures for the facilities. Again, this requirement is specific to semiconductor facilities because of their

unique layout and contents. The emergency responders rely heavily on the on-site actions of the employees because of their intimate knowledge of the site and the complexity of these buildings. Records must be maintained.

**403.8 Group I occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for Group I occupancies. Group I occupancies shall comply with Sections 403.8.1 through 403.8.3.4.

❖ Group I occupancies are those where occupants are often incapable of self-preservation due to their physical condition or they are physically able but under restraint. Therefore, fire safety and evacuation plans are critical and also have some specific needs unique from other occupancies.

**403.8.1 Group I-1 occupancies.** Group I-1 occupancies shall comply with Sections 403.8.1.1 through 403.8.1.7.

❖ A Group I-1 occupancy is one that houses more than 16 individuals who live in a supervised residential care facility on a 24-hour basis. This would include residential board and care homes, congregate care facilities, social rehabilitation facilities, alcohol and drug centers, assisted living facilities and convalescent facilities. Generally, occupants of these facilities are able to respond to an emergency with some assistance from staff. Note that there are two levels of Group I-1 occupancies (Condition 1 and Condition 2). These are further clarified in Section 202 but, essentially, those found in Condition 2 need additional protection due to an increased need for assistance.

**403.8.1.1 Fire safety and evacuation plan.** The fire safety and evacuation plan required by Section 404 shall include special employee actions, including fire protection procedures necessary for residents, and shall be amended or revised upon admission of any resident with unusual needs.

❖ This section is in addition to the general requirements found in Section 404. It specifies that requirements based on the particular needs of residents must be included as part of the plan. These plans must be reviewed each time a new occupant arrives to assess whether there are any special features that need to be included in the plan to address those particular needs. Group R-4 occupancies are being addressed in a similar manner (see Section 403.10.3.1).

**403.8.1.1.1 Fire evacuation plan.** The fire evacuation plan required by Section 404 shall include a description of special staff actions. In addition to the requirements of Section 404, plans in Group I-1 Condition 2 occupancies shall include procedures for evacuation through a refuge area in an adjacent smoke compartment and then to an exterior assembly point.

❖ Similar to ambulatory care facilities, the actions of the staff are critical and must be addressed beyond the requirements of Section 404. This is only applicable to Group I-1 Condition 2 occupancies where the residents depend more on the staff than they do in a

Group I-1 Condition 1 occupancy. Group I-1 Condition 2 occupancies depend on the concept of smoke compartments similar to Group I-2 occupancies (see Section 420.4 of the *International Building Code*).

**403.8.1.1.2 Fire safety plans.** A copy of the fire safety plan shall be maintained at the facility at all times. Plans shall include the following in addition to the requirements of Section 404:

1. Location and number of resident sleeping rooms.
2. Location of special locking or egress control arrangements.

❖ This section requires that Group I-1 occupancies provide the location and number of residents sleeping and any special locking or egress control arrangements. This assists in search and rescue and understanding how the residents may be hampered in their evacuation. This information is critical for preplanning by both staff and the fire department. This applies to conditions of Group I-1 occupancies. The same requirement is provided for Group R-4 occupancies, which are essentially smaller Group I-1 occupancies.

**403.8.1.2 Employee training.** Employees shall be periodically instructed and kept informed of their duties and responsibilities under the plan. Such instruction shall be reviewed by employees at intervals not exceeding two months. A copy of the plan shall be readily available at all times within the facility.

❖ These types of facilities are normally occupied by people who have the ability to evacuate or relocate with a certain level of assistance from the staff; therefore, employee training is critical. Again, residents in Group I-1 Condition 2 occupancies will need more evacuation assistance than in Group I-1 Condition 1 occupancies. Group I-1 Condition 2 occupancies utilize the concept of smoke compartments. Additional training in this regard is necessary for employees. This section requires that training occur every 2 months because the needs of the occupants may change over time as certain physical or mental conditions progress or new occupants arrive.

**403.8.1.3 Resident training.** Residents capable of assisting in their own evacuation shall be trained in the proper actions to take in the event of a fire. In Group I-1 Condition 2 occupancies, training shall include evacuation through an adjacent smoke compartment and then to an exterior assembly point. The training shall include actions to take if the primary escape route is blocked. Where the resident is given rehabilitation or habilitation training, methods of fire prevention and actions to take in the event of a fire shall be a part of the rehabilitation training program. Residents shall be trained to assist each other in case of fire to the extent their physical and mental abilities permit them to do so without additional personal risk.

❖ As noted, Group I-1 occupants are capable of responding to an emergency but will most likely need direction from staff and perhaps physical assistance to ensure the appropriate response. This is more the

case with Group I-1 Condition 2 occupancies. Unlike other Group I occupancies, I-1 occupancies rely on the abilities of residents to take some level of responsibility for their own evacuation or relocation; therefore, training residents in these occupancies is critical. One major element that must be communicated to residents is what to do when the main exit route is blocked.

If residents are receiving rehabilitation or habilitation, fire prevention and appropriate actions to take during a fire should be communicated as part of the sessions. This section also requires the occupants to assist one another as long as a physical or mental condition would not limit their ability to do so.

Since Group I-1 Condition 2 occupancies utilize the concept of smoke compartments, occupants must be trained to evacuate to the adjacent smoke compartment to the refuge area.

**403.8.1.4 Drill frequency.** In addition to the evacuation drills required in Section 405.2, employees shall participate in drills an additional two times a year on each shift. Twelve drills with all occupants shall be conducted in the first year of operation. Drills are not required to comply with the time requirements of Section 405.4.

❖ Occupants of Group I-1 facilities need to be reminded often of evacuation procedures given their sometimes limited abilities to recall procedures, changes in the residents' abilities over time and the introduction of new residents to the facility. Therefore, this section requires more frequent drills than Table 405.2. Employees on each shift are required to participate in additional drills. Each shift potentially has different staff and also different conditions due to the time of day. Another very specific difference from Table 405.2 is that such facilities are required to have, essentially, monthly drills for the first year. Over time the occupants and staff will change, but this sets the tone for how the facility operates. This also increases staff awareness of procedures.

**403.8.1.5 Drill times.** Drill times are not required to comply with Section 405.4.

❖ This provides the flexibility to create an appropriate schedule that works with these facilities. The residents participate, making it slightly more difficult to follow Section 405.4.

**403.8.1.6 Resident participation in drills.** Emergency evacuation drills shall involve the actual evacuation of residents to a selected assembly point and shall provide residents with experience in exiting through all required exits. All required exits shall be used during emergency evacuation drills.

❖ This section clarifies that drills must include all occupants, not just staff. In other institutional occupancies where the occupants are not capable or it is not desirable to evacuate them on their own, inclusion of the residents in drills is not necessary. Since dependence is placed on the residents to react in Group I-1 occupancies, their involvement is critical. This section is designed to promote resident familiarity with all the

exits that are available in the building. This will help residents understand that, during emergencies, there are multiple paths to safety. Note that, in Group I-1 Condition 2 occupancies, smoke compartments are used and occupants will typically need to simply move to the adjoining smoke compartment to defend in place.

**403.8.1.7 Emergency evacuation drill deferral.** In severe climates, the *fire code official* shall have the authority to modify the emergency evacuation drill frequency specified in Section 405.2.

❖ It is not appropriate to send residents of Group I-1 occupancies outside during extreme weather conditions unnecessarily. Generally, the occupants of such facilities have failing health or are more susceptible to illness than the average population. This section provides the authority to the fire code official to make adjustments for these reasons.

**403.8.2 Group I-2 occupancies.** Group I-2 occupancies shall comply with Sections 403.8.2.1 through 403.8.2.3 as well as 401 and 404 through 406.

❖ Group I-2 occupancies as well as ambulatory care facilities and Group I-1 Condition 2 occupancies use a “defend-in-place” method of occupant protection. Defend in place is a widely used approach to protect occupants who are bedridden, unconscious or otherwise unable to self-preserve in a fire event. The method relies on both active and passive fire protection systems as well as the actions of trained staff and responders. The heavy emphasis on staff action requires a comprehensive fire safety and evacuation plan. Any building containing an ambulatory health-care occupancy will, by definition, contain occupants who may be incapable of self-preservation. The intent of the current IBC requirements for Group I-2 occupancies is to create a type of defend-in-place environment. Sections 403.8.2.1 through 403.8.2.3 provide requirements for Group I-2 occupancies that are more specific than what is provided in Sections 404 and 405.

**403.8.2.1 Fire evacuation plans.** The fire safety and evacuation plans required by Section 404 shall include a description of special staff *actions*. Plans shall include all of the following in addition to the requirements of Section 404.

1. Procedures for evacuation for patients with needs for containment or restraint and post-evacuation containment, where present.
2. A written plan for maintenance of the means of egress.
3. Procedure for a defend-in-place strategy.
4. Procedures for a full-floor or building evacuation, where necessary.

❖ Staff actions are critical to the success of a fire evacuation plan for Group I-2 occupancies; therefore, procedures need to be documented. In addition to the requirements of Section 404, this section provides four more-specific requirements for the fire evacua-

tion plan. These requirements include how patients are to be evacuated and documentation of maintenance plans for means of egress in such facilities. Procedures for defend-in-place strategy must be documented so that each shift is familiar with those strategies. Defend-in-place procedures depend upon the use of refuge areas that need to be maintained. In some cases, the defend-in-place evacuation may need to escalate to full-floor or building evacuation. Such evacuations need to be documented, as well.

**403.8.2.2 Fire safety plans.** A copy of the plan shall be maintained at the facility at all times. Plans shall include all of the following in addition to the requirements of Section 404:

1. Location and number of patient sleeping rooms and operating rooms.
2. Location of adjacent smoke compartments or refuge areas.
3. Path of travel to adjacent smoke compartments.
4. Location of special locking, delayed egress or access control arrangements.
5. Location of elevators utilized for patient movement in accordance with the fire safety plan, where provided.

❖ Fire safety plans should describe the method of notifying occupants, including the use of a private-mode alarm system as allowed by code. Procedures for dealing with occupants in a defend-in-place strategy should also be described so that it is clear what the staff will be trained on and what the first responders should expect to encounter. It is imperative that the building and fire code officials know the size and location of the facility as well as the number of patients who are incapable of self-preservation. This information will help the building official determine the proper classification and mitigations required. It will also allow the fire official to preplan the response for a particular building. Any special characteristics of the means of egress, such as path to the adjacent smoke compartment and special locking arrangements, should also be described to aid in verifying code compliance. Practically, these documents will be the basis for staff training as well.

**403.8.2.3 Emergency evacuation drills.** Emergency evacuation drills shall comply with Section 405.

**Exceptions:**

1. The movement of patients to safe areas or to the exterior of the building is not required.
  2. Where emergency evacuation drills are conducted after visiting hours or where patients or residents are expected to be asleep, a coded announcement shall be an acceptable alternative to audible alarms.
- ❖ Group I-2 occupancies are required to comply with the evacuation drill frequency established in Section 405. However, Group I-2 occupancies do not evacuate occupants from the building but instead utilize a

defend-in-place strategy. This is related to the conditions of the patients found in such facilities. Therefore, Exception 1 clarifies that evacuation to the exterior is not required. Exception 2 allows the use of coded signals for staff evacuation drills. This avoids disturbing patients or alarming visitors. The drills in such facilities do not involve the patients.

**403.8.3 Group I-3 occupancies.** Group I-3 occupancies shall comply with Sections 403.8.3.1 through 403.8.3.4.

❖ Group I-3 occupancies are institutional occupancies where the occupants are under restraint. Typically, the occupants are physically able but are restrained from moving freely. Several levels of restraint in such occupancies are described in more detail in Chapter 2 under the definition of “Group I-3 occupancies.” As in Group I-2 occupancies, the only participants in drills will be staff. These requirements are in addition to the requirements of Sections 404 and 405.

**403.8.3.1 Employee training.** Employees shall be instructed in the proper use of portable fire extinguishers and other manual fire suppression equipment. Training of new employees shall be provided promptly upon entrance to duty. Refresher training shall be provided not less than annually.

❖ Group I-3 facilities are more likely to have incendiary activity; therefore, staff must be trained in the use of various fire protection equipment, including fire extinguishers. Additionally, any new employees must be immediately trained in the use of this equipment. Because of difficulties presented by relocating or evacuating confinees, fires should be managed, when practical, to minimize the threat to occupants. Since combustibles are strictly limited in most of these occupancies, accidental fires generally remain small—at least long enough to be manageable. Incendiary fires often pose greater challenges and generally reflect a breakdown in security discipline. Notwithstanding this problem, fire extinguisher training, and even incipient fire brigades, may be especially effective elements of a fire safety plan in restrained-care occupancies. This training is required of new employees before they can begin their official duties. This training must then be refreshed once a year.

**403.8.3.2 Employee staffing.** Group I-3 occupancies shall be provided with 24-hour staffing. An employee shall be within three floors or 300 feet (91 440 mm) horizontal distance of the access door of each resident housing area. In Group I-3 Conditions 3, 4 and 5, as defined in Chapter 2, the arrangement shall be such that the employee involved can start release of locks necessary for emergency evacuation or rescue and initiate other necessary emergency actions within 2 minutes of an alarm.

**Exception:** An employee shall not be required to be within three floors or 300 feet (91 440 mm) horizontal distance of the access door of each resident housing area in areas in which all locks are unlocked remotely and auto-

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matically in accordance with Section 408.4 of the *International Building Code*.

- ❖ Group I-3 occupancies place a lot of importance on the actions of staff in emergencies. This section provides specific direction regarding the staff's locations and actions in an emergency. Staff members responsible for initiating the relocation or evacuation of confinees must be constantly alert to potential fire hazards and incipient fires. If a fire occurs, 2 minutes will seem like a long time to confined people. When a remote-release locking system is neither required nor provided, the number of locks requiring manual unlocking should be limited with due regard to staff and confinee safety. This may require additional staff to accomplish the unlocking procedure in a timely manner. This section does have a specific exception for systems that utilize a remote locking and unlocking system.

**403.8.3.3 Notification.** Provisions shall be made for residents in Group I-3 Conditions 3, 4 and 5, as defined in Chapter 2, to readily notify an employee of an emergency.

- ❖ Group I-3 occupancies under Use Conditions 3, 4 and 5 where the occupants are very limited in their freedom would be considered moderate- and high-security facilities. Because the occupants are so limited and could be located remotely from guards or other staff members as a result of confinement within a compartment, a method is necessary for staff notification of a fire. In open cell blocks, staff members may be within earshot of occupants but generally this requirement necessitates monitors, intercoms or other communication appliances.

**403.8.3.4 Keys.** Keys necessary for unlocking doors installed in a *means of egress* shall be individually identifiable by both touch and sight.

- ❖ Keys must be distinctive from one another so they may be promptly and reliably identified under emergency conditions. Fumbling for the right key can cost valuable seconds, and possibly lives, in the event of a fire (see Commentary Figure 403.8.3.4).

**403.9 Group M occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for buildings containing a Group M occupancy where the Group M occupancy has an *occupant load* of 500 or more persons or more than 100 persons above or below the lowest level of *exit discharge* and for buildings containing both a Group M occupancy and an atrium.

- ❖ This section requires a fire and evacuation plan when the number of occupants in a Group M occupancy becomes large. An increased risk is also addressed when such occupants are not located on the level of exit discharge. This is the same requirement as that provided for Group B and F occupancies. However, Group M occupants may not be quite as familiar with their surroundings but the staff in such facilities are available to direct occupants during an emergency. Also, this is an occupancy where people do not sleep (see Sections 403.4 and 403.6).

**403.10 Group R occupancies.** Group R occupancies shall comply with Sections 403.10.1 through 403.10.3.6.

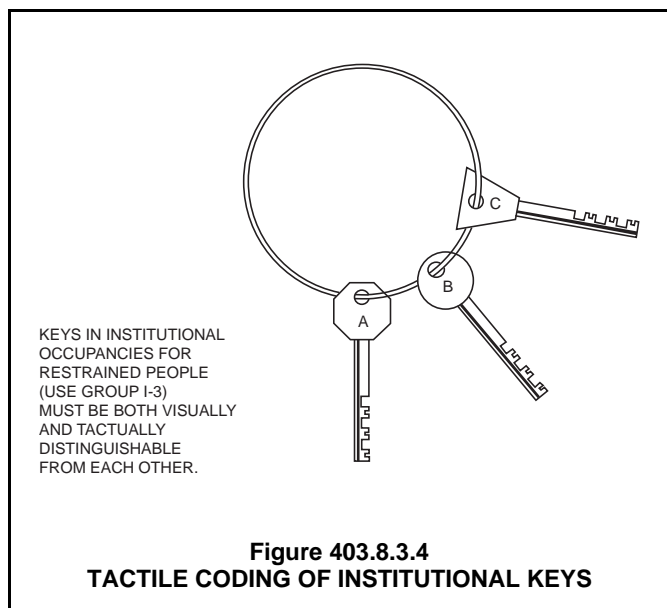
- ❖ This section provides fire safety and evacuation plans specific to Group R-1, R-2 and R-4 occupancies. These are occupancies where people sleep, thus the need for fire safety and evacuation plans is more critical.

**403.10.1 Group R-1 occupancies.** An approved fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for Group R-1 occupancies. Group R-1 occupancies shall comply with Sections 403.10.1.1 through 403.10.1.3.

- ❖ Group R-1 occupancies are residential occupancies that include hotels and boarding houses. These occupancies contain residents that are temporary in nature; therefore, they are more unfamiliar with their surroundings than Group R-2 and R-3 occupants. Sections 403.10.1.1 through 403.10.1.3 provide specific requirements that take into account characteristics of Group R-1 occupancies.

**403.10.1.1 Evacuation diagrams.** A diagram depicting two evacuation routes shall be posted on or immediately adjacent to every required egress door from each hotel or motel sleeping unit.

- ❖ This section requires an evacuation plan diagram to be posted in each hotel or motel sleeping unit. Both the format of the diagram and its location must be approved by the fire code official. This diagram is to display both a primary and a secondary exit route in case a fire or other obstacle blocks the primary route. The plan should be prepared so that the orientation of rooms in relation to the exits is accurately portrayed and easily discernible to the occupant. Often, additional safety information is included on the plan diagram, such as fire alarm box and fire extinguisher locations; however, those added items should not clutter the diagram to the extent that they detract from



the clarity of its primary purpose of showing exit routes and exit locations.

**403.10.1.2 Emergency duties.** Upon discovery of a fire or suspected fire, hotel and motel employees shall perform the following duties:

1. Activate the fire alarm system, where provided.
2. Notify the public fire department.
3. Take other action as previously instructed.

❖ This section contains specific actions employees are to take if a fire occurs. The requirement that they first activate the fire alarm and then call the fire department is intended to avoid a situation in which the employee first investigates or calls security. Immediate notification of the occupants facilitates evacuation or relocation as necessary. Notifying the fire department as early as possible will enable fire fighters to reach the building at an earlier stage in the fire.

**403.10.1.3 Fire safety and evacuation instructions.** Information shall be provided in the fire safety and evacuation plan required by Section 404 to allow guests to decide whether to evacuate to the outside, evacuate to an *area of refuge*, remain in place, or any combination of the three.

❖ The procedures for isolating occupants from a fire depend on the layout and overall fire protection design of a building. For example, a hotel in a high-rise building may be specifically designed to evacuate in phases; therefore, the occupants need to know the procedures to facilitate a smooth and organized reaction to a fire. The appropriate actions that are available should be communicated. Options may include occupants remaining in their rooms, evacuating or relocating.

**403.10.2 Group R-2 occupancies.** Group R-2 occupancies shall comply with Sections 403.10.2.1 through 403.10.2.3.

❖ Group R-2 occupancies are permanent residential occupancies that house multiple occupants in multiple dwelling units. Typically, this includes apartment buildings, dormitories and other related residential occupancies. Generally, the occupants tend to be familiar with their surroundings but may be sleeping when an emergency occurs. Sections 403.10.2.1 through 403.10.2.3 provide specific requirements in addition to the general requirements of Chapter 4. This section deals with Group R-2 occupancies generally and, more specifically, with Group R-2 college and university buildings.

**403.10.2.1 College and university buildings.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for Group R-2 college and university buildings. Group R-2 college and university buildings shall comply with Sections 403.10.2.1.1 and 403.10.2.1.2.

❖ This section establishes the applicability of certain provisions to college and university residence halls and dormitories classified in Group R-2. Fire rep-

resents a significant risk to life and property in dormitory occupancies, particularly at colleges and universities. The large number of young people living in close proximity to one another creates the potential for a relatively small fire to have serious and possibly fatal consequences. Applying these requirements in conjunction with the drills required by Table 405.2 will enhance the likelihood of occupants being familiar with exiting buildings under emergency conditions at varying times throughout the day.

**403.10.2.1.1 First emergency evacuation drill.** The first emergency evacuation drill of each school year shall be conducted within 10 days of the beginning of classes.

❖ The residents of Group R-2 college and dormitory occupancies typically change each year. It is important, therefore, that the first evacuation drill occurs within the first 10 days of school.

**403.10.2.1.2 Time of day.** Emergency evacuation drills shall be conducted at different hours of the day or evening, during the changing of classes, when school is at assembly, during recess or gymnastic periods or during other times to avoid distinction between drills and actual fires. One required drill shall be held during hours after sunset or before sunrise.

❖ If evacuation drills are done routinely, they will become easily distinguishable as drills and not an actual fire. This is potentially dangerous because the behavior patterns will be different and actual preparedness for an emergency will be lessened. Time of day, therefore, should be varied whether or not it is convenient. A fire will not differentiate between a convenient and an inconvenient time. At least one of the drills required by Table 405.2 must be conducted between sunset and sunrise so that residents can experience nighttime evacuation.

**403.10.2.2 Emergency guide.** Fire emergency guides shall be provided for Group R-2 occupancies. Guide contents, maintenance and distribution shall comply with Sections 403.10.2.2.1 through 403.10.2.2.3.

❖ The next few sections lay out the requirements for emergency guides for Group R-2 occupancies. This includes what is to be in the guide, obtaining approval from the fire code official and distribution requirements. The guide in general will better inform the residents and provide preplanning tools for the fire department.

**403.10.2.2.1 Guide contents.** A fire emergency guide shall describe the location, function and use of fire protection equipment and appliances accessible to residents, including fire alarm systems, smoke alarms and portable fire extinguishers. Guides shall include an emergency evacuation plan for each *dwelling unit*.

❖ The guide must contain the intended evacuation plan for each unit and information about the various fire protection features provided to occupants. Providing this information to residents increases the likelihood of a proper response, which in turn increases resident

safety and makes the fire department's job a little easier when responding to a scene.

**403.10.2.2.2 Emergency guide maintenance.** Emergency guides shall be reviewed and approved by the *fire code official*.

❖ This section makes it clear that the fire code official must sign off on the emergency guide contents. This will make fire department response consistent with the features of the building.

**403.10.2.2.3 Emergency guide distribution.** A copy of the emergency guide shall be given to each tenant prior to initial occupancy.

❖ This section requires that a guide illustrating the fire safety features of the building be provided to each dwelling unit. There is no purpose in having a guide to assist residents if there is no requirement that it be distributed. This must occur before they become occupants.

**403.10.2.3 Evacuation diagrams for dormitories.** A diagram depicting two evacuation routes shall be posted on or immediately adjacent to every required egress door from each dormitory *sleeping unit*. Evacuation diagrams shall be reviewed and updated as needed to maintain accuracy.

❖ The same concept is used for Group R-1 occupancies; this simply increases the information available to occupants. Group R-2 dormitory occupants are typically more transient than most occupants of Group R-2 occupancies (see commentary for Section 403.10.1.1).

**403.10.3 Group R-4 occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for Group R-4 occupancies. Group R-4 occupancies shall comply with Sections 403.10.3.1 through 403.10.3.6.

❖ A Group R-4 occupancy is a residential care/assisted living facility for more than five but not more than 16 residents. The occupants are similar to those found in a Group I-1 occupancy; therefore, they are capable of self-preservation but, may have mental or physical conditions that could impede their reactions.

**403.10.3.1 Fire safety and evacuation plan.** The fire safety and evacuation plan required by Section 404 shall include special employee actions, including fire protection procedures necessary for residents, and shall be amended or revised upon admission of a resident with unusual needs.

❖ This section is in addition to the general requirements found in Section 404. It specifies that requirements based on the particular needs of residents must be included as part of the plan. These plans must be reviewed each time a new occupant arrives to assess any special features that need to be included in the plan to address those particular needs. This is the same requirement as provided for Group I-1 occupancies.

**403.10.3.1.1 Fire safety plans.** A copy of the plan shall be maintained at the facility at all times. Plans shall include the following in addition to the requirements of Section 404:

1. Location and number of resident sleeping rooms.
2. Location of special locking or egress control arrangements.

❖ This section requires that fire safety plans in Group R-4 occupancies provide the location and number of residents sleeping and any special locking or egress control arrangements. This assists in search and rescue and understanding how the residents may be hampered in their evacuation. This information is critical for preplanning by both staff and the fire department. This is the same requirement as provided for Group I-1 occupancies (see Section 403.8.1.1.2).

**403.10.3.2 Employee training.** Employees shall be periodically instructed and kept informed of their duties and responsibilities under the plan. Records of instruction shall be maintained. Such instruction shall be reviewed by employees at intervals not exceeding two months. A copy of the plan shall be readily available at all times within the facility.

❖ These types of facilities are normally occupied by people who have the ability to evacuate or relocate with a certain level of assistance from the staff; therefore, employee training is critical. Residents of Group R-4 Condition 2 occupancies will need more assistance in evacuation than in Group R-4 Condition 1. This section requires that training occur every 2 months because the needs of the occupants may change over time as certain physical or mental conditions progress or new occupants arrive.

**403.10.3.3 Resident training.** Residents capable of assisting in their own evacuation shall be trained in the proper actions to take in the event of a fire. The training shall include actions to take if the primary escape route is blocked. Where the resident is given rehabilitation or habilitation training, methods of fire prevention and actions to take in the event of a fire shall be a part of the rehabilitation training program. Residents shall be trained to assist each other in case of fire to the extent their physical and mental abilities permit them to do so without additional personal risk.

❖ As noted, Group R-4 occupants are capable of responding to an emergency, but most likely will need direction from staff and perhaps physical assistance. This is more the case with Group R-4 Condition 2 occupancies. Group R-4 occupancies, similar to Group I-1 occupancies, rely on the abilities of residents to take some level of responsibility for their own evacuation or relocation; therefore, training residents in these occupancies is critical. One major element that must be communicated to residents is what to do when the main exit route is blocked.

If residents are receiving rehabilitation or habilitation, fire prevention and appropriate actions to take during a fire should be communicated as part of the sessions. This section also requires the occupants to

assist one another as long as a physical or mental condition would not limit their ability to do so.

Since Group I-1 Condition 2 occupancies utilize the concept of smoke compartments, occupants must be trained how to evacuate to the adjacent smoke compartment to the refuge area.

**403.10.3.4 Drill frequency.** In addition to the evacuation drills required in Section 405.2, employees shall participate in drills an additional two times a year on each shift. Twelve drills with all occupants shall be conducted in the first year of operation.

❖ Occupants of Group R-4 facilities need to be reminded often of evacuation procedures given their sometimes limited capabilities to recall procedures, changes in their abilities over time and the introduction of new residents to the facility. Therefore, this section requires more frequent drills than Table 405.2. Employees on each shift are required to participate in additional drills. Each shift potentially has different staff and also different conditions due to the time of day. Another very specific difference from Table 405.2 is that such facilities are required to have, essentially, monthly drills for the first year. Over time the occupants and staff will change, but this sets the tone for how the facility operates. This also increases staff awareness of procedures.

**403.10.3.5 Drill times.** Drill times are not required to comply with Section 405.4.

❖ This provides the flexibility to create an appropriate schedule that works with Group R-4 facilities. The residents participate, making it slightly more difficult to follow Section 405.4.

**403.10.3.6 Resident participation in drills.** Emergency evacuation drills shall involve the actual evacuation of residents to a selected assembly point and shall provide residents with experience in exiting through all required exits. All required exits shall be used during emergency evacuation drills.

**Exception:** Actual exiting from emergency escape and rescue windows shall not be required. Opening the emergency escape and rescue window and signaling for help shall be an acceptable alternative.

❖ This section clarifies that drills must include all occupants, not just the staff. Since dependence is placed on the residents to react in Group R-4 occupancies, their involvement is critical. This section is designed to promote resident familiarity with all the exits that are available in the building. This will help residents understand that, during emergencies, there are multiple paths to safety.

**403.11 Special uses.** Special uses shall be in accordance with Sections 403.11.1 through 403.11.4.

❖ The next several sections are focused on special uses that require fire safety and evacuation plans, including:

- Malls and mall buildings.

- High-rise buildings.
- Underground buildings.
- Occupant evacuation elevators.

**403.11.1 Covered and open mall buildings.** Covered and open mall buildings shall comply with the requirements of Sections 403.11.1.1 through 403.11.1.6.

❖ A covered mall building is a special use as described in Section 402 of the IBC and as defined in Chapter 2 of the code. Generally, a covered mall building is a single building housing multiple occupancies including, but not limited to, retail, assembly, drinking, dining and entertainment in which two or more tenants have a main entrance into a mall area. A mall area is also defined in Chapter 2 of the IBC as “a roofed or covered mall building that serves as access for two or more tenants and does not exceed three levels that are open to each other”; therefore, it presents some unique issues concerning fire department response to an emergency.

An open mall is an uncovered common pedestrian walk that is open to the sky above and to tenant spaces within the open mall building, and typically connects to the anchor buildings. Unless noted otherwise, open malls must comply with all IBC provisions. The open mall building includes all of the buildings wherein two or more tenants have a main entrance into one or more open malls. Because open malls are characterized by there not being a roof connecting one side of the pedestrian mall to the other, the open mall “building” may actually be a collection of separate buildings that all rely on a shared pedestrian concourse for egress. Similar to the covered mall building, the open mall “building” does not include the anchor buildings. Unless noted otherwise, open mall buildings have to comply with all provisions for covered mall buildings.

The requirements of Sections 403.11.1.1 through 403.11.1.6 are related primarily to the complexity of the building and provide appropriate information to emergency responders so they can more effectively respond to a fire or other emergency.

**403.11.1.1 Malls and mall buildings exceeding 50,000 square feet.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for covered malls exceeding 50,000 square feet (4645 m<sup>2</sup>) in aggregate floor area and for open mall buildings exceeding 50,000 square feet (4645 m<sup>2</sup>) in aggregate area within the perimeter line.

❖ The requirement for fire safety and evacuation plans for both covered malls and open malls is only applicable when such malls become larger. Smaller malls simplify the evacuation process and detailed information such as a lease plan is not required.

**403.11.1.2 Lease plan.** In addition to the requirements of Section 404.2.2, a lease plan that includes the following information shall be prepared for each covered and open mall building:

1. Each occupancy, including identification of tenant.

2. Exits from each tenant space.
3. Fire protection features, including the following:
  - 3.1. Fire department connections.
  - 3.2. Fire command center.
  - 3.3. Smoke management system controls.
  - 3.4. Elevators, elevator machine rooms and controls.
  - 3.5. Hose valve outlets.
  - 3.6. Sprinkler and standpipe control valves.
  - 3.7. Automatic fire-extinguishing system areas.
  - 3.8. Automatic fire detector zones.
  - 3.9. Fire barriers.

❖ Item 1 assists the emergency responders by requiring detailed documentation regarding the identification of each tenant, location and occupancy. This will let them locate the highest density of occupants and the types of hazards that may be anticipated.

Item 2 is the identification of exits. This will assist emergency responders in the identification of necessary access routes and how they may interact with the exits.

Item 3 is a report of the available fire protection features. These features, such as identification of the fire detector zones, will help responders quickly assess where a fire is located. If the mall has a smoke control system, access to the controls may be necessary; therefore, the location of those controls is critical. This information gives the fire department a general feel for how the building is intended to perform during a fire. This information is valuable in the sense that they will have more information to promote effective use of the fire protection features installed. If little information is provided, the fire department could actually disrupt the essential activation of a system, such as smoke control.

**403.11.1.3 Lease plan approval.** The lease plan shall be submitted to the *fire code official* for approval, and shall be maintained on site for immediate reference by responding fire service personnel.

❖ The lease plan must be approved. This allows the fire department to determine whether all necessary information, from the perspective of the responders, is addressed. Also, this section requires that the lease plan is available on site for use by the emergency responders.

**403.11.1.4 Lease plan revisions.** The lease plans shall be revised annually or as often as necessary to keep them current. Modifications or changes in tenants or occupancies shall not be made without prior approval of the *fire code official* and building official.

❖ This section provides the authority to require a review of the lease plan at least once each year. In addition, the fire code official has the authority to ask for more frequent reviews of the plan.

If a change occurs in the building, the lease plan may no longer be valid; therefore, this section

requires that no changes to any tenant space be made without approval and review by the fire code official. These changes would have to be documented in the lease plan.

**403.11.1.5 Tenant identification.** Tenant identification shall be provided for secondary *exits* from occupied tenant spaces that lead to an *exit corridor* or directly to the exterior of the building. Tenant identification shall be posted on the exterior side of the *exit* or exit access door and shall identify the business name and address using plainly legible letters and numbers that contrast with their background.

**Exception:** Tenant identification is not required for anchor stores.

❖ Identifying secondary exits from tenant spaces that enter into an exit passageway or lead directly outside is a critical need for emergency responders. This identification needs to contain the business name and address. Having multiple tenants within a building makes this identification necessary. Anchor stores do not need these labels, since they are fairly recognizable without them.

**403.11.1.6 Unoccupied tenant spaces.** The fire safety and evacuation plan shall provide for compliance with the requirements for unoccupied tenant spaces in Section 311.

❖ This section addresses the hazards posed by a tenant space that is not in use or that is not under the supervision of employees. These spaces are more likely to be targeted by vandalism and possibly incendiary activity. Generally, a fire can grow unnoticed in such spaces as a result of the lack of supervision or activity in the space. This section simply references Section 311.6, where requirements dealing with vacant premises are found. To reduce the risks in unsupervised tenant spaces, several requirements in Section 311.6 focus on reducing the fire ignition, growth and spread potential by limiting combustibles in the space, securing the space through the use of locks and installing fire separations constructed of  $\frac{1}{2}$ -inch-thick (12.7 mm) gypsum or similar materials. Note that mall buildings are required to be sprinklered throughout and that the systems in the tenant spaces must be independent of the mall area.

**403.11.2 High-rise buildings.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for high-rise buildings.

❖ High-rise buildings can involve many different uses, such as business, assembly and residential. The types of occupancies on their own may or may not have specific requirements for fire safety and evacuation plans, but due to the fact that the building is tall, evacuation and fire safety become more complex. Such buildings tend to use phased evacuation, but may have other unique evacuation requirements such as the need for full-building evacuation or assisting those who cannot use stairways. The types of evacuation strategies for high rises vary. More detailed discussion on these strategies can be found in the SFPE *Engineering Guide: Fire Safety for Very*

*Tall Buildings* (ICC and SFPE 2013) and *Egress Design Solutions* (Tubbs and Meacham 2005).

**403.11.3 Underground buildings.** An approved fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for underground buildings.

❖ Like high-rise buildings, underground buildings can contain a variety of uses. Those uses may not, on their own, require unique fire safety and evacuation plans, but since the building is located below grade, evacuation and fire fighting become more complex. Therefore, it is important that a fire safety and evacuation plan be required in accordance with Section 404. Note that Item 4 in Section 404.2.1 specifically addresses those unable to use the stairways.

**403.11.4 Buildings using occupant evacuation elevators.** In buildings using occupant evacuation elevators in accordance with Section 3008 of the *International Building Code*, the fire safety and evacuation plan and the training required by Sections 404 and 406, respectively, shall incorporate specific procedures for the occupants using such elevators.

❖ This is not a specific use but instead is an evacuation strategy that is very different than what the general public has been taught about the use of elevators during fires. The successful use of such elevators depends greatly on preplanning and training as to how they are to be used by building occupants. This section requires that when these elevators are used, specific procedures be worked into the fire safety and evacuation plans and into employee training. Note that Item 3 in Section 404.2.1 specifically requires these procedures to be included in the fire evacuation plans. It should be noted that this ties in with the requirements for high-rise buildings and how they are intended to be evacuated. As with high-rise buildings, a good resource for extensive discussion on occupant evacuation and evacuation using elevators can be found in the SFPE *Engineering Guide: Fire Safety for Very Tall Buildings* and *Egress Design Solutions* (Tubbs and Meacham 2005).

**403.12 Special requirements for public safety.** Special requirements for public safety shall be in accordance with Sections 403.12.1 through 403.12.3.3.

❖ The following requirements authorize a jurisdiction to require fire watches, address large public assemblies and provide specific requirements for crowd managers.

**403.12.1 Fire watch personnel.** Where, in the opinion of the *fire code official*, it is essential for public safety in a place of assembly or any other place where people congregate, because of the number of persons, or the nature of the performance, exhibition, display, contest or activity, the *owner*, agent or lessee shall provide one or more fire watch personnel, as required and *approved*. Fire watch personnel shall comply with Sections 403.12.1.1 and 403.12.1.2.

❖ Even though Chapter 31 requires standby personnel in tents and membrane structures because of the inherently higher life safety risks associated with such

occupancies, this section gives the fire code official the authority to require fire watch personnel in indoor or outdoor venues where people congregate where the number of persons or the nature of the performance, exhibition, display, contest or activity is such that the presence of fire watch personnel are essential to public safety (see commentary, Section 202, definition of “Fire watch”).

**403.12.1.1 Duty times.** Fire watch personnel shall remain on duty while places requiring a fire watch are open to the public, or when an activity requiring a fire watch is being conducted.

❖ This section establishes the key times a fire watch should be conducted. Once it is established that a fire watch is necessary, it is critical that it be conducted while the public is present. Also, it may be necessary for the fire watch to occur based upon a specific hazard or activity even while not open to the public.

**403.12.1.2 Duties.** On-duty fire watch personnel shall have the following responsibilities:

1. Keep diligent watch for fires, obstructions to *means of egress* and other hazards.
2. Take prompt measures for remediation of hazards and extinguishment of fires that occur.
3. Take prompt measures to assist in the evacuation of the public from the structures.

❖ Fire watch personnel provide temporary fire safety where there are potential fire and life safety hazards that could affect large numbers of assembled people. Such personnel does not simply watch for a fire but is also present to prevent fire by identifying and controlling fire hazards; monitoring and maintaining the availability of the means of egress; and taking initial action to suppress a fire should one occur. Fire watch personnel also provide a method of notifying the fire department if a fire should occur.

**403.12.2 Public safety plan for gatherings.** Where the *fire code official* determines that an indoor or outdoor gathering of persons has an adverse impact on public safety through diminished access to buildings, structures, fire hydrants and fire apparatus access roads or where such gatherings adversely affect public safety services of any kind, the *fire code official* shall have the authority to order the development of or prescribe a public safety plan that provides an *approved* level of public safety and addresses the following items:

1. Emergency vehicle ingress and egress.
2. Fire protection.
3. Emergency egress or escape routes.
4. Emergency medical services.
5. Public assembly areas.
6. The directing of both attendees and vehicles, including the parking of vehicles.
7. Vendor and food concession distribution.

8. The need for the presence of law enforcement.
9. The need for fire and emergency medical services personnel.

❖ This section is important because it grants the fire code official the authority to require the development of or to prescribe a specific plan for large gatherings. Such gatherings could include outdoor festivals, demonstrations or receptions. If such assemblies include the use of tents and canopies, Chapter 31 would also apply.

Again, the primary aim of this section is to address the fact that these large gatherings may hamper the ability of the fire department and other emergency responders to access and protect buildings and building occupants.

Further, this section provides some specific issues to be addressed, including: the direction of traffic; vendor and food concession distributors; and the need for law enforcement and medical services.

**403.12.3 Crowd managers for gatherings exceeding 1,000 people.** Where facilities or events involve a gathering of more than 1,000 people, crowd managers shall be provided in accordance with Sections 403.12.3.1 through 403.12.3.3.

❖ This section is similar to the requirement for standby personnel for tents in Section 3104.20. Large assemblies of people create the need for crowd management due to the increased potential for panic and fear in emergency situations. It is the intent of this section that crowd managers can be personnel already assigned and employed by the facility, provided that they are trained as crowd managers to fulfill this requirement. At the time of an emergency, the trained crowd managers would take on additional responsibilities to control and direct the audience or attendees in a safe manner.

**403.12.3.1 Number of crowd managers.** The minimum number of crowd managers shall be established at a ratio of one crowd manager for every 250 persons.

**Exception:** Where approved by the *fire code official*, the number of crowd managers shall be permitted to be reduced where the facility is equipped throughout with an *approved automatic sprinkler system* or based upon the nature of the event.

❖ The minimum number of crowd managers would be four, based on the minimum requirements of Section 403.12.3. Since the fire and life safety profile of a facility is improved where an automatic sprinkler system is installed throughout, the fire code official is authorized by this section to reduce the crowd manager-to-occupant ratio for events on a case-by-case basis (see commentary, Section 3104.20).

**403.12.3.2 Training.** Training for crowd managers shall be *approved*.

❖ Training is critical for crowd managers to be effective. This section provides the mechanism to ensure such training occurs. There are various crowd manager training courses available.

**403.12.3.3 Duties.** The duties of crowd managers shall include, but not be limited to:

1. Conduct an inspection of the area of responsibility and identify and address any egress barriers.
2. Conduct an inspection of the area of responsibility to identify and mitigate any fire hazards.
3. Verify compliance with all permit conditions, including those governing pyrotechnics and other special effects.
4. Direct and assist the event attendees in evacuation during an emergency.
5. Assist emergency response personnel where requested.
6. Other duties required by the *fire code official*.
7. Other duties as specified in the fire safety plan.

❖ The exact duties and responsibilities of individuals employed as crowd managers are not defined here other than the requirement that they be trained and present. They could serve as ushers, tour guides, service supervisors for table seating or in some other capacity related to making sure occupants are moved to or from assigned places in an orderly way. The key to the success of this section is that crowd managers must be trained in crowd management procedures appropriate to the activity being carried on in the facility and they must be present in the required numbers. Training of personnel and the duties assigned to them would have to be approved by the fire code official. See also the commentary to Section 3104.20 for further information on crowd managers.

## SECTION 404 FIRE SAFETY, EVACUATION AND LOCKDOWN PLANS

**404.1 General.** Where required by Section 403, fire safety, evacuation and lockdown plans shall comply with Sections 404.2 through 404.4.1.

❖ This section simply states that all fire safety, evacuation and lockdown plans must comply with Section 404. Section 403 outlines, for many different occupancies and uses, when this section would apply. In addition, Section 403 provides specific requirements that are intended to be addressed along with the requirements in Section 404.

**404.2 Contents.** Fire safety and evacuation plan contents shall be in accordance with Sections 404.2.1 and 404.2.2.

❖ The two primary plans required by Section 404.3 are a fire evacuation plan and a fire safety plan. The fire evacuation plan focuses primarily on the procedures for the evacuation of the occupants in an emergency. The fire safety plan focuses on the overall understanding of the fire protection package of the building as it pertains to the layout of the building, the contents of the building, the means of egress system, the fire hazards and the identification of key contacts during an emergency.

**404.2.1 Fire evacuation plans.** Fire evacuation plans shall include the following:

1. Emergency egress or escape routes and whether evacuation of the building is to be complete by selected floors or areas only or with a defend-in-place response.
  2. Procedures for employees who must remain to operate critical equipment before evacuating.
  3. Procedures for the use of elevators to evacuate the building where occupant evacuation elevators complying with Section 3008 of the *International Building Code* are provided.
  4. Procedures for assisted rescue for persons unable to use the general *means of egress* unassisted.
  5. Procedures for accounting for employees and occupants after evacuation has been completed.
  6. Identification and assignment of personnel responsible for rescue or emergency medical aid.
  7. The preferred and any alternative means of notifying occupants of a fire or emergency.
  8. The preferred and any alternative means of reporting fires and other emergencies to the fire department or designated emergency response organization.
  9. Identification and assignment of personnel who can be contacted for further information or explanation of duties under the plan.
  10. A description of the emergency voice/alarm communication system alert tone and preprogrammed voice messages, where provided.
- ❖ The primary focus of evacuation plans is to prepare for and define roles for evacuation and relocation of occupants during an emergency. The fire evacuation plan is important for both emergency responders and building or facility occupants. It focuses the occupants' activities on facilitating a smoother evacuation or relocation process and provides the fire department with critical information on the building and the location of the occupants. Keep in mind that these requirements apply to all occupancies listed in Section 404.2. The occupancy- and use-specific requirements are located within Section 403; therefore, the requirements listed here are general and will vary based on many factors, such as the occupants' mobility and familiarity with the building.

Item 1 requires that specific escape routes be defined. This is important because the building is generally designed to facilitate a particular pattern of evacuation or relocation in an emergency. For instance, as noted earlier, a high-rise building will most likely be evacuated in phases. If floors begin evacuating before intended, the evacuation of the occupants in the fire area may be delayed. Also, if everyone tries to use the same exits in a facility, such as a multiplex theater, evacuation of the building will be delayed. As stated earlier, studies have shown that people tend to exit the way they enter a building.

Note that the code sometimes requires a certain level of redundancy to account for occupants using the same exits. For example, the IBC requires that the main exit of multiplex theaters be sized for at least half of the occupants even though plenty of egress width may be available elsewhere in the building. The more coordinated the plan, the more evenly the exits will be used.

Item 2 requires that specific procedures for evacuation be provided to those employees who must operate critical equipment before evacuation. These procedures are necessary to ensure a clear understanding to the occupant when evacuation is critical and the operation should be abandoned.

Item 3 requires that specific procedures be provided when occupant evacuation elevators are used. This is critical as each building may have unique aspects regarding the use of such elevators and the types of evacuations they may undertake.

Item 4 provides for the inclusion of procedures relative to those occupants unable to evacuate using the general egress features who, therefore, may need assisted rescue. It is important that there be adequate information and procedures established and available to staff and fire fighters so that assistance can be offered to anyone who needs help using the general means of egress as quickly as possible.

Item 5 simply states that a plan be developed to account for all occupants after evacuation or relocation. This is important not only to the occupants but also to the emergency responders to assess their actions when arriving at the scene.

Item 6 has two roles. First, it provides a designated person for occupants to look to for assistance in an emergency. This will reduce the stress of the situation. Second, when the emergency responders arrive they will have a specific contact to help them assess the situation. These contacts can also be beneficial to emergency responders when preplanning their response to that specific facility.

Item 7 requires that the notification to the occupants of the emergency be standardized. The approach will vary based on occupancy and use. For instance, all occupants in a multiplex theater would be notified, whereas in a correctional facility or hospital only staff will be notified. Also, if the method is standardized, it is easier to differentiate between emergency and nonemergency signals, which facilitates a smoother reaction when an emergency does occur.

Item 8 is focused on the notification of emergency responders. They are more likely to get the notification of an emergency if a standard protocol exists. This can vary from one occupancy or use to another, but as long as a straightforward, consistent method is used, it will facilitate a quicker response. Note that Section 401.3.2 requires direct contact with the fire department once the fire alarm signal is activated; therefore, no intermediate steps, such as an investigation, are allowed.

As with Item 6, Item 9 requires a specific contact who is familiar with the plan and how the building operates. This information is helpful for the emergency responders in their preplanning activities. Without a specific contact, the process of getting vital information can become much more difficult for the fire department. In a large building or facility, the safety officer or similar person is most appropriate for such a role.

Item 10 requires documentation of the voice/alarm communications system alert tone and preprogrammed voice messages. This provides emergency responders with a better understanding of the information provided to occupants to better assess the appropriate response. Additionally, if conditions in that building change, the plan can be evaluated to see whether this aspect of the notification system needs to be revised. For instance, if the procedures for evacuation have changed, the voice announcement may need to be revised.

**404.2.2 Fire safety plans.** Fire safety plans shall include the following:

1. The procedure for reporting a fire or other emergency.
2. The life safety strategy including the following:
  - 2.1. Procedures for notifying occupants, including areas with a private mode alarm system.
  - 2.2. Procedures for occupants under a defend-in-place response.
  - 2.3. Procedures for evacuating occupants, including those who need evacuation assistance.
3. Site plans indicating the following:
  - 3.1. The occupancy assembly point.
  - 3.2. The locations of fire hydrants.
  - 3.3. The normal routes of fire department vehicle access.
4. Floor plans identifying the locations of the following:
  - 4.1. Exits.
  - 4.2. Primary evacuation routes.
  - 4.3. Secondary evacuation routes.
  - 4.4. Accessible egress routes.
    - 4.4.1. Areas of refuge.
    - 4.4.2. Exterior areas for assisted rescue.
  - 4.5. Refuge areas associated with *smoke barriers* and *horizontal exits*.
  - 4.6. Manual fire alarm boxes.
  - 4.7. Portable fire extinguishers.
  - 4.8. Occupant-use hose stations.
  - 4.9. Fire alarm annunciators and controls.
5. A list of major fire hazards associated with the normal use and occupancy of the premises, including maintenance and housekeeping procedures.
6. Identification and assignment of personnel responsible for maintenance of systems and equipment installed to prevent or control fires.
7. Identification and assignment of personnel responsible for maintenance, housekeeping and controlling fuel hazard sources.

❖ This section requires an overall fire safety plan with emphasis on the building and building site layout and hazards. More specifically, information, such as the evacuation and relocation aspects of the building layout, needs to be clarified; the list of specific hazards associated with normal use of the building needs to be noted and fire department access road locations need to be provided.

This plan also includes identification of specific personnel charged with managing fire protection systems and equipment and with fire prevention duties, such as controlling combustibles on site. Having specific personnel assigned to perform this duty will work to increase the likelihood of these actions occurring.

The requirements of this plan provide the building owner and occupants a better understanding of how to react in an emergency and how to decrease the likelihood of an emergency occurring. Additionally, this report assists emergency responders during periodic inspections and evaluations of the plans and, more importantly, when responding to an emergency. Generally, buildings that have fairly rigid and well-maintained plans and procedures in place reduce not only the likelihood and magnitude of an incident within the jurisdiction but also the burden to emergency responders.

**404.2.3 Lockdown plans.** Where facilities develop a lockdown plan, it shall be in accordance with Sections 404.2.3.1 through 404.2.3.3.

❖ The provisions of this section introduce the requirements for plans and procedures for lockdowns (see commentary to the definition in Section 202). Note that the code does not require a lockdown plan; however, if a lockdown plan is developed, it must be strictly supervised in order to maintain occupant safety at an acceptable level. Many facilities are adopting procedures that can significantly affect fire and life safety, such as using the fire alarm system to signal a security emergency, locking doors with devices that prevent egress in violation of the provisions of Chapter 10 of the code, and chaining exit discharge doors from the inside to prevent occupants from leaving the building. It is important that plans for security threats do not include procedures that result in violations of life safety and actually increase the

hazard to the occupants. The sections that follow intend to establish the conditions for lockdown plans so that they will not decrease the level of life safety in the event of fire.

**404.2.3.1 Lockdown plan contents.** Lockdown plans shall be *approved* by the *fire code official* and shall include the following:

1. Initiation. The plan shall include instructions for reporting an emergency that requires a lockdown.
  2. Accountability. The plan shall include accountability procedures for staff to report the presence or absence of occupants.
  3. Recall. The plan shall include a prearranged signal for returning to normal activity.
  4. Communication and coordination. The plan shall include an *approved* means of two-way communication between a central location and each secured area.
- ❖ Lockdown plans often include procedures for locking occupants into individual rooms within the building. If the lockdown plan is not reviewed for life safety precautions, it could have a negative impact on fire and life safety. To reduce the likelihood of an inadequate or substandard plan, approval of the plan by the fire code official is required.

In accordance with Item 1, the plan must include a well thought out list of exactly what types of situations will warrant the implementation of a lockdown and how and to whom those “trigger” situations will be reported. Key to the success of a lockdown is the ability to account for all building occupants. To increase the likelihood that everyone will be properly accounted for, Item 2 requires that specific accountability procedures to be followed by lockdown supervisors be included in the plan. When the reason for a lockdown has been mitigated and it is safe to again move about within or reenter a building, Item 3 requires that an “all-clear” signal must be done by an authorized person by a means used only for that purpose and readily recognizable as such. Item 4 requires that a central “command” location be pre-planned and that a reliable means of two-way communication be provided in order to keep locked-down occupants apprised of the status of the situation, thus reducing their level of anxiety and the likelihood of panic.

Note that although the code does not assume simultaneous events, it would be advisable for the lockdown plan to include procedures to be followed if a fire alarm occurs during a lockdown.

**404.2.3.2 Training frequency.** The training frequency shall be included in the lockdown plan. The lockdown drills shall not substitute for any of the fire and evacuation drills required in Section 405.2.

- ❖ To utilize lockdown training and the lessons learned from it to the best advantage, training should be conducted on a regular basis to familiarize staff and occupants with the lockdown plan. Training should be

designed and practiced to reinforce lockdown procedures as adaptive planned responses to stressful and potentially dangerous situations. It is important to note that lockdown training and drills may not be counted toward the required number of fire and evacuation drills so as not to diminish the impact of either (see also commentary, Section 406.3.3).

**404.2.3.3 Lockdown notification.** The method of notifying building occupants of a lockdown shall be included in the plan. The method of notification shall be separate and distinct from the fire alarm signal.

- ❖ Area-wide notification systems, ranging from low-tech sirens to text-message alerts on cell phones, are among several means of notification available for lockdown announcements. Whatever the method chosen for a particular occupancy, it must be separate and distinct from the building fire alarm system to avoid a miscue that could trigger an inappropriate response to a threatening situation unrelated to a fire.

**404.3 Maintenance.** Fire safety and evacuation plans shall be reviewed or updated annually or as necessitated by changes in staff assignments, occupancy or the physical arrangement of the building.

- ❖ In order to be of optimum value to a facility, plans must accurately reflect building conditions. Plans must be reviewed annually or when building changes affecting the instructions or procedures in the fire safety or emergency evacuation plan occur. Such a review should prompt an immediate revision and redistribution of the plan to all concerned parties, including emergency response personnel.

**404.4 Availability.** Fire safety and evacuation plans shall be available in the workplace for reference and review by employees, and copies shall be furnished to the *fire code official* for review upon request.

- ❖ This essentially requires that these plans be easily accessible to building occupants and the fire code official. If the plans are difficult to access, they are less likely to be updated when necessary and are more likely to be lost or forgotten. This places a burden on the emergency responders when planning methods of response, and puts the occupants of the building at a higher risk during an emergency. Having the documents readily available makes review and use for training occupants more likely.

**404.4.1 Distribution.** The fire safety and evacuation plans shall be distributed to the tenants and building service employees by the *owner* or *owner’s* agent. Tenants shall distribute to their employees applicable parts of the fire safety plan affecting the employees’ actions in the event of a fire or other emergency.

- ❖ Fire safety and evacuation plans are only effective when all building occupants have been informed of the contents of the plan. In the case of a multiple-tenant building, the plan must address individual tenant spaces. Distribution to all affected occupants is important for a coordinated response to an emergency.

This section requires that the building owner or the owner's agent distribute the plan to all tenants and building service employees. Since the owner or agent of the owner usually does not have direct access to the tenants' employees, the individual tenants would then have the responsibility to distribute the applicable portion of the plan to their employees. This provides for a wider distribution of the responsibility to plan for emergencies and to follow the requirements of the plan.

## SECTION 405 EMERGENCY EVACUATION DRILLS

**405.1 General.** Emergency evacuation drills complying with Sections 405.2 through 405.9 shall be conducted not less than annually where fire safety and evacuation plans are required by Section 403 or where required by the *fire code official*. Drills shall be designed in cooperation with the local authorities.

❖ The fire safety and evacuation plans required by Sections 403 and 404 are critical components of life safety strategies in high-density occupancies and extraordinary buildings, such as high-rise buildings. Many times such plans are developed with the best of intentions and available expertise, but fail to adequately consider certain site- or area-specific conditions. Just as emergency operations and hazardous material response plans require operational drills to verify their continued viability and effectiveness, so too do evacuation plans require periodic implementation to gauge effectiveness in achieving their objectives. Since not all of the occupancies that are required to prepare and maintain fire safety and evacuation plans by Section 403 are required to conduct drills by Table 405.2, this section requires at least an annual drill to exercise the required plan.

An additional benefit of an annual drill is the enhanced recognition by occupants, particularly in the case of a high-rise structure, of the possibility of selected-floor evacuation. Given the generally heightened awareness following the events of September 11, 2001, building occupants understandably exhibit a greater reluctance to remain inside a building in the event of an emergency. A complete building evacuation may be unnecessary in a large number of cases and may actually work counter to effective fire-ground operations if uncontrolled. An annual drill in these instances would serve to reinforce the local jurisdiction's preferences regarding evacuation, as well as provide a verification tool that the plan, as developed, is functional and presents opportunities for critique and improvement. The use of an annual drill could easily be incorporated with specific additional training to satisfy the requirements in Section 406 as well.

**405.2 Frequency.** Required emergency evacuation drills shall be held at the intervals specified in Table 405.2 or more

frequently where necessary to familiarize all occupants with the drill procedure.

❖ To utilize fire drills and the lessons that they teach to the best of their advantage, drills should be conducted on a regular basis to familiarize both staff and residents with the evacuation plan. The element of surprise is not necessarily of significant benefit in those occupancies where residents may be prone to maladaptive behavior. Drills should be designed and practiced to reinforce relocation or evacuation behaviors as adaptive planned responses to stressful and potentially dangerous situations. Drills should be scheduled so that all staff members on all shifts have an opportunity to participate in them. Practice makes perfect, and when it comes to effective egress, there is no substitute for fire drills at regular intervals so that all occupants are familiar with the plan's details and their particular responsibilities in implementing them. Truly effective drills test the plan by varying conditions and force occupants to adapt. Many conditions can combine to affect available safe egress time, and drills should incorporate some allowance for unanticipated conditions, such as delayed detection, rapid fire growth, reduced staffing or poor weather conditions, as may be appropriate for the occupancy. Discovering deficiencies in the evacuation plan should be encouraged, and every opportunity should be taken to improve the plans.

**TABLE 405.2.** See page 4-23.

❖ Table 405.2 provides varying evacuation drill frequencies based on building occupancy. The table also prescribes who should be involved in these drills. The level of participation is based on the type of occupancy. In some cases, this is further qualified by the number or location of such occupants with respect to the lowest level of fire department vehicle access. It is unreasonable, for example, in a Group A occupancy such as a hospital or correctional facility, to require the general public to participate in an evacuation drill. It is potentially dangerous to involve anyone but the employees in such drills.

The overall strategy for these occupancies is to provide a package of relevant information before an emergency and to have the employees facilitate and direct occupants during an emergency. The necessary participants in the drills are related to the overall emergency strategies for those buildings. Note that Group B, E, I-1 assisted living, I-4, R-2 and R-4 occupancies require that everyone be involved. This is related to the fact that occupants are generally able to evacuate. In the case of educational occupancies, drills serve as a learning tool for children to carry through their lives. Schools have generally stressed these drills because of large losses in fires, such as in 1958 at Our Lady of Angels School in Chicago. In terms of Group I-1, I-4 and R-4 facilities, the occupants generally are able to evacuate with some assis-

tance. In Group R-2 occupancies, the occupants are usually able-bodied and it is in their best interest to be familiar with the egress routes. More occupancy-specific discussion is provided in the commentary for

**TABLE 405.2  
FIRE AND EVACUATION DRILL  
FREQUENCY AND PARTICIPATION**

GROUP OR OCCUPANCY	FREQUENCY	PARTICIPATION
Group A	Quarterly	Employees
Group B <sup>b</sup>	Annually	All occupants
Group B <sup>b, c</sup> (Ambulatory care facilities)	Annually	Employees
Group B <sup>b</sup> (Clinic, outpatient)	Annually	Employees
Group E	Monthly <sup>a</sup>	All occupants
Group F	Annually	Employees
Group I-1	Semiannually on each shift	All occupants
Group I-2	Quarterly on each shift <sup>a</sup>	Employees
Group I-3	Quarterly on each shift <sup>a</sup>	Employees
Group I-4	Monthly on each shift <sup>a</sup>	All occupants
Group R-1	Quarterly on each shift	Employees
Group R-2 <sup>d</sup>	Four annually	All occupants
Group R-4	Semiannually on each shift <sup>a</sup>	All occupants

- a. In severe climates, the *fire code official* shall have the authority to modify the emergency evacuation drill frequency.
- b. Emergency evacuation drills are required in Group B buildings having an *occupant load* of 500 or more persons or more than 100 persons above or below the lowest level of exit discharge.
- c. Emergency evacuation drills are required in ambulatory care facilities in accordance with Section 403.3.
- d. Emergency evacuation drills in Group R-2 college and university buildings shall be in accordance with Section 403.10.2.1. Other Group R-2 occupancies shall be in accordance with Section 403.10.2.2.

### Section 403.

**405.3 Leadership.** Responsibility for the planning and conduct of drills shall be assigned to competent persons designated to exercise leadership.

- ❖ This section requires a focal point in the planning and execution of evacuation drills. Having a single point of contact streamlines the process and provides a necessary leadership role.

**405.4 Time.** Drills shall be held at unexpected times and under varying conditions to simulate the unusual conditions that occur in case of fire.

- ❖ If fire and emergency drills are a routine planned occurrence, they will not simulate actual reaction to an emergency but will provide an inaccurate and most likely optimistic outcome; therefore, the drills need to occur at random.

**405.5 Record keeping.** Records shall be maintained of required emergency evacuation drills and include the following information:

1. Identity of the person conducting the drill.
2. Date and time of the drill.
3. Notification method used.
4. Employees on duty and participating.
5. Number of occupants evacuated.
6. Special conditions simulated.
7. Problems encountered.
8. Weather conditions when occupants were evacuated.
9. Time required to accomplish complete evacuation.

- ❖ Documenting the frequency and efficiency of emergency evacuation drills not only aids the fire code official in verifying that drills complying with these provisions have been performed but may also help administrators identify trends in emergency evacuation drill performance. Accurate records help life safety planners determine the adequacy of their plans. Identifying issues such as problems encountered and weather conditions helps to further determine which elements create the largest delays and why.

**405.6 Notification.** Where required by the *fire code official*, prior notification of emergency evacuation drills shall be given to the *fire code official*.

- ❖ In some cases, the fire code official will want prior notification of evacuation drills because he or she may need to prepare for such an event. This section provides the fire code official with the authority to require such notification.

**405.7 Initiation.** Where a fire alarm system is provided, emergency evacuation drills shall be initiated by activating the fire alarm system.

- ❖ To simulate conditions normally experienced during an emergency, the emergency notification procedures, which would include a fire alarm system in many cases, must be used.

**405.8 Accountability.** As building occupants arrive at the assembly point, efforts shall be made to determine if all occupants have been successfully evacuated or have been accounted for.

- ❖ This requirement is key to the success of evacuation plans. If a method is not available to account for the occupants once evacuation or relocation is complete, search and rescue activities will be more difficult for the emergency responders. Also, it would be difficult to measure the success of the plan.

**405.9 Recall and reentry.** An electrically or mechanically operated signal used to recall occupants after an evacuation shall be separate and distinct from the signal used to initiate the evacuation. The recall signal initiation means shall be manually operated and under the control of the person in charge of the premises or the official in charge of the inci-

dent. Persons shall not reenter the premises until authorized to do so by the official in charge.

- ❖ This section is primarily aimed at the concern that occupants will be confused if similar signals are used to notify them of an alarm and for reentry. This confusion has the consequences of slowing or even halting evacuation during an actual emergency. Additionally, to make sure that occupants do not go back into the building prematurely, any reentry signal must be operated manually to avoid a situation where it automatically sounds. Finally, this section specifically prohibits reentry until authorization is provided by the official in charge at the scene.

### SECTION 406 EMPLOYEE TRAINING AND RESPONSE PROCEDURES

**406.1 General.** Where fire safety and evacuation plans are required by Section 403, employees shall be trained in fire emergency procedures based on plans prepared in accordance with Section 404.

- ❖ In most cases, the success of an evacuation and fire safety plan hinges on the appropriate reactions of the building occupants. The main activity that building occupants must undertake is removing themselves from the hazards. In some cases, fire safety and evacuation plans involve additional actions by the employees of the facility. For instance, in the case of hospitals, the nurses and other hospital staff must relocate care recipients; therefore, specific training is required for those activities.

Additionally, employees must be trained based on the specific fire safety and fire evacuation plans.

**406.2 Frequency.** Employees shall receive training in the contents of fire safety and evacuation plans and their duties as part of new employee orientation and not less than annually thereafter. Records of training shall be maintained.

- ❖ This section requires that employee training occur during new employee indoctrination and annually thereafter. A record of this training must be provided to the fire code official when requested. This section provides a minimum criterion for the training frequency for all occupancies addressed by Chapter 4. Section 403 may require more restrictive training frequencies.

**406.3 Employee training program.** Employees shall be trained in fire prevention, evacuation and fire safety in accordance with Sections 406.3.1 through 406.3.4.

- ❖ This is a general section that requires all employees to be trained in fire prevention, evacuation and fire safety in accordance with the subsections that follow. These provisions are primarily intended as a mechanism to ensure that training occurs, not as a requirement for establishing training criteria.

**406.3.1 Fire prevention training.** Employees shall be apprised of the fire hazards of the materials and processes to

which they are exposed. Each employee shall be instructed in the proper procedures for preventing fires in the conduct of their assigned duties.

- ❖ If a fire can be prevented, evacuation and relocation of the occupants will also be avoided. Employees must be made aware of the potential hazards related to their particular area of the facility and what can be done to avoid a hazardous situation. Having specific procedures increases the likelihood that proper fire prevention techniques will be followed. Generally, people tend to be unaware of many hazards unless they are alerted to them. An example is the use of space heaters.

**406.3.2 Evacuation training.** Employees shall be familiarized with the fire alarm and evacuation signals, their assigned duties in the event of an alarm or emergency, evacuation routes, areas of refuge, exterior assembly areas and procedures for evacuation.

- ❖ In the event that an emergency does occur, employees must be prepared to assist in the evacuation or relocation of occupants. This training will vary widely from one occupancy type to another. In a high-rise building only some of the occupants will be evacuated at a time, whereas a school will evacuate all occupants at once. This section requires that the training occurs.

**406.3.3 Fire safety training.** Employees assigned fire-fighting duties shall be trained to know the locations and proper use of portable fire extinguishers or other manual fire-fighting equipment and the protective clothing or equipment required for its safe and proper use.

- ❖ Any time employees are to take specific action during a fire event, proper training is required. This section holds the building owner or operator responsible for making sure the training occurs.

**406.4 Emergency lockdown training.** Where a facility has a lockdown plan, employees shall be trained on their assigned duties and procedures in the event of an emergency lockdown.

- ❖ If a facility goes to the trouble of creating a lockdown plan, it stands to reason that it would want its staff to be versed in the plan's contents. Training should be scheduled so that all staff members on all shifts or occupants, as applicable, have an opportunity to participate. Practice makes perfect, and when it comes to effective lockdowns, there is no substitute for training at regular intervals so that all staff and occupants are familiar with the plan's details and their particular responsibilities in implementing it. Drills should be scheduled to test the plan by varying conditions, forcing occupants to adapt and respond instinctively to emergencies without panicking and allowing the staff to identify weaknesses in the preparations.

Many conditions can conspire to affect lockdown success and drills should incorporate some allowance for unanticipated conditions as may be appropriate for the occupancy. Discovering deficiencies in

the plan should be encouraged, and every opportunity should be taken to improve the plans (see also commentary, Section 404.2.3.2).

## SECTION 407 HAZARD COMMUNICATION

**407.1 General.** The provisions of Sections 407.2 through 407.7 shall be applicable where hazardous materials subject to permits under Section 5001.5 are located on the premises or where required by the *fire code official*.

❖ This section is specific to buildings and facilities that contain hazardous materials over the permitted amounts listed in Section 105.6. Knowledge related to which hazardous materials are on site is critical for several reasons. First, it assists emergency responders in knowing what to expect when responding to a scene. Second, it provides emergency responders with an idea of incidents that may occur at a building or facility. Lastly, it provides a better understanding to the occupants of the potential hazards present and how to avoid emergencies.

Facilities that store, use or handle hazardous materials on a large scale generally depend heavily on the actions of the employees to prevent or minimize hazardous materials incidents. Therefore, the occupants play a strong role in the overall protection of the building. These types of requirements would, in the past, have been found only within the hazardous materials section of the code. These provisions have also been located within this chapter because of the nature of the information. These requirements are aimed at preparing both the occupants and the emergency responders. Hazardous materials present a wide range of problems because of the significant variation of properties and reactions; therefore, a reference to these requirements has been included in Chapter 4. These specific provisions are found in Section 5001.

This section states that when subject to permit requirements, hazardous materials must also be addressed. This section has requirements for the submittal of Material Safety Data Sheets (MSDS); the labeling or marking of hazardous materials through placarding and related identification; training; the compilation, when required, of both HMIS and HMMP; and finally, the submittal of a closure plan when a facility is being shut down.

**407.2 Material Safety Data Sheets.** Material Safety Data Sheets (MSDS) for all hazardous materials shall be either readily available on the premises as a paper copy, or where *approved*, shall be permitted to be readily retrievable by electronic access.

❖ MSDS provide critical information about individual chemicals and their related hazards. This section requires that these data sheets be readily available on the premises or, where equivalent access can be achieved, as approved by the *fire code official*, they may be retrievable by electronic means. This allows availability for review by both employees and emer-

gency responders. An appropriate location may be the security room at a facility or perhaps the main office. These sheets can potentially play a role in the response to an emergency. For example, if a chemical is noted as being water reactive on the MSDS, depending on the level of water reactivity, applying water to that spill may not be an appropriate response.

**407.3 Identification.** Individual containers of hazardous materials, cartons or packages shall be marked or labeled in accordance with applicable federal regulations. Buildings, rooms and spaces containing hazardous materials shall be identified by hazard warning signs in accordance with Section 5003.5.

❖ This section requires two activities related to the identification of hazardous materials. First, chemicals must be specifically labeled. Second, rooms or areas where the materials are located must be specifically labeled. In this case, the code essentially requires placarding as defined in Section 5003.5, which references NFPA 704.

**407.4 Training.** Persons responsible for the operation of areas in which hazardous materials are stored, dispensed, handled or used shall be familiar with the chemical nature of the materials and the appropriate mitigating actions necessary in the event of a fire, leak or spill. Responsible persons shall be designated and trained to be liaison personnel for the fire department. These persons shall aid the fire department in preplanning emergency responses and identification of where hazardous materials are located, and shall have access to Material Safety Data Sheets and be knowledgeable in the site emergency response procedures.

❖ This section requires training specific to the hazards of the materials located and used at a particular building or facility. As noted, the actions taken will vary based on the hazards associated with the materials. Additionally, this section requires a specific group of persons to be designated as points of contact for the fire department. Having specific points of contact is critical because it eases planning and response procedures. These contacts also provide the fire department with specific persons who are more familiar with the hazards of the building or facility. The fire department is charged with responding to many different businesses within a community. Having specified contacts at facilities containing hazardous materials helps them prepare and respond.

**407.5 Hazardous Materials Inventory Statement.** Where required by the *fire code official*, each application for a permit shall include a Hazardous Materials Inventory Statement (HMIS) in accordance with Section 5001.5.2.

❖ An HMIS is further described in Chapter 50 but is essentially a document listing all the hazardous materials found on site. This documentation includes information such as the type and amount of specific hazards associated with the material and how it is used. All of this information can be very important for emergency planning and preparedness. An HMIS is

## EMERGENCY PLANNING AND PREPAREDNESS

required only if the fire code official specifically requires one. See Appendix H for further information on HMIS and HMMP preparation.

**407.6 Hazardous Materials Management Plan.** Where required by the *fire code official*, each application for a permit shall include a Hazardous Materials Management Plan (HMMP) in accordance with Section 5001.5.1. The *fire code official* is authorized to accept a similar plan required by other regulations.

❖ As with the HMIS, an HMMP is necessary only when the fire code official specifically requires one. This document is somewhat different from the HMIS in that it is geared to the layout of the building and the location and use of the hazardous materials. This document provides a better understanding of how the facility operates. This information in turn provides more detailed information to the emergency responders. This plan will also include such information as the location of aisles; the type and location of emergency equipment available; and location of specific shutoff valves and other operating equipment. The detailed requirements for HMMPs are located in Chapter 50. See Appendix H for further information on HMIS and HMMP preparation.

**407.7 Facility closure plans.** The permit holder or applicant shall submit to the *fire code official* a facility closure plan in accordance with Section 5001.6.3 to terminate storage, dispensing, handling or use of hazardous materials.

❖ It is important for emergency responders to be made aware of the closure of a plant that uses or stores hazardous materials. First, closure means a readjustment in their planning. Second, the extent of the closure must be communicated so that the emergency responders are made aware of hazards that may still be present. Any hazards that are still present may potentially be more dangerous since the facility is now unattended; therefore, the building owner must develop a plan that is acceptable to the fire code official. In some cases, a facility will be only temporarily closed, which would mean maintaining a permit and continuing inspections.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

*Evacuation Planning Guide for Stadiums.* Washington, DC: U.S. Department of Homeland Security, 2008.

*SFPE Engineering Guide: Fire Safety for Very Tall Buildings* (ICC and SFPE 2013)

*Egress Design Solutions* (Tubbs and Meacham 2005).

## Part III—Building and Equipment Design Features

# Chapter 5: Fire Service Features

### General Comments

The requirements of this chapter apply to all occupancies and pertain to access roads; access to building openings and roofs; premises identification; key boxes; hazards to fire fighters; fire protection water supplies; fire command centers; and fire department access to equipment.

### Purpose

This chapter contains the requirements for fire service access to the property that is to be protected, including access roads, security devices and access through openings in the building.

The chapter also addresses fire-fighter hazards, the requirements for a fire department command center and fire-fighter access to equipment, such as fire suppression equipment, air-handling equipment, emergency power equipment and access to the roof. In addition, this chapter addresses the fire protection water supply.

### SECTION 501 GENERAL

**501.1 Scope.** Fire service features for buildings, structures and premises shall comply with this chapter.

❖ This chapter contains requirements that will enable the fire service to respond to an emergency on the premises of a building or structure.

**501.2 Permits.** A permit shall be required as set forth in Sections 105.6 and 105.7.

❖ Permits must be obtained from the fire code official. Permit fees, if any, must be paid prior to the issuance of the permit. There are two types of permits: operational and construction. The operational permits required by this section are for the use or operation of fire protection valves and fire hydrants (see Section 105.6.16) or the use or removal from service of a private fire hydrant (see Section 105.6.37). The construction permit (see Section 105.7.13) allows the applicant to install or modify private fire hydrants. See Section 105 for additional information on permits.

**501.3 Construction documents.** *Construction documents* for proposed fire apparatus access, location of *fire lanes*, security gates across fire apparatus access roads and *construction documents* and hydraulic calculations for fire hydrant systems shall be submitted to the fire department for review and approval prior to construction.

❖ The integrity of the design of fire apparatus access roads and private fire hydrant systems is critical to successful fire department operations in protecting

lives and property. Construction documents must be drawn to scale and clearly show the details of the indicated features in order for the fire department to properly evaluate fire service features and issue approvals. While this section is primarily for new installations, if a security gate was not on the original construction plans for fire apparatus access, this section reinforces that a security gate installed at a later time requires a construction plan to be submitted and approved prior to construction.

**501.4 Timing of installation.** Where fire apparatus access roads or a water supply for fire protection are required to be installed, such protection shall be installed and made serviceable prior to and during the time of construction except when *approved* alternative methods of protection are provided. Temporary street signs shall be installed at each street intersection where construction of new roadways allows passage by vehicles in accordance with Section 505.2.

❖ Buildings under construction are quite vulnerable to fire and other types of construction incidents, such as injuries from falling objects. Access roads and water for fire protection are essential for fire-fighting purposes. Temporary street signs are also valuable to emergency responders because the streets in new developments will most likely not be familiar to them or be on their maps.

Marked access roads and an emergency water supply should be in place before any large amount of combustible building materials is placed on site and before any construction is initiated.

**SECTION 502  
DEFINITIONS**

**502.1 Definitions.** The following terms are defined in Chapter 2:

**AGENCY.**

**FIRE APPARATUS ACCESS ROAD.**

**FIRE COMMAND CENTER.**

**FIRE DEPARTMENT MASTER KEY.**

**FIRE LANE.**

**KEY BOX.**

**TRAFFIC CALMING DEVICES.**

❖ Definitions of terms can help in the understanding and application of code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2, or in another *International Code*® (I-Code®) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (also see the commentary to Sections 201 through 201.4).

**SECTION 503  
FIRE APPARATUS ACCESS ROADS**

**503.1 Where required.** Fire apparatus access roads shall be provided and maintained in accordance with Sections 503.1.1 through 503.1.3.

❖ This section introduces the requirements for dedicated fire apparatus access roads serving new and relocated buildings in the jurisdiction. The requirements are to be established in coordination with the local fire service to accommodate the jurisdiction's fire apparatus and equipment. The intent of the requirements is to provide the fire department with sufficient access to buildings to enable efficient fire suppression and rescue operations.

**503.1.1 Buildings and facilities.** *Approved* fire apparatus access roads shall be provided for every facility, building or portion of a building hereafter constructed or moved into or within the jurisdiction. The fire apparatus access road shall comply with the requirements of this section and shall extend to within 150 feet (45 720 mm) of all portions of the facility and all portions of the *exterior walls* of the first story of the building as measured by an *approved* route around the exterior of the building or facility.

**Exceptions:**

1. The *fire code official* is authorized to increase the dimension of 150 feet (45 720 mm) where any of the following conditions occur:
  - 1.1. The building is equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1, 903.3.1.2 or 903.3.1.3.
  - 1.2. Fire apparatus access roads cannot be installed because of location on property,

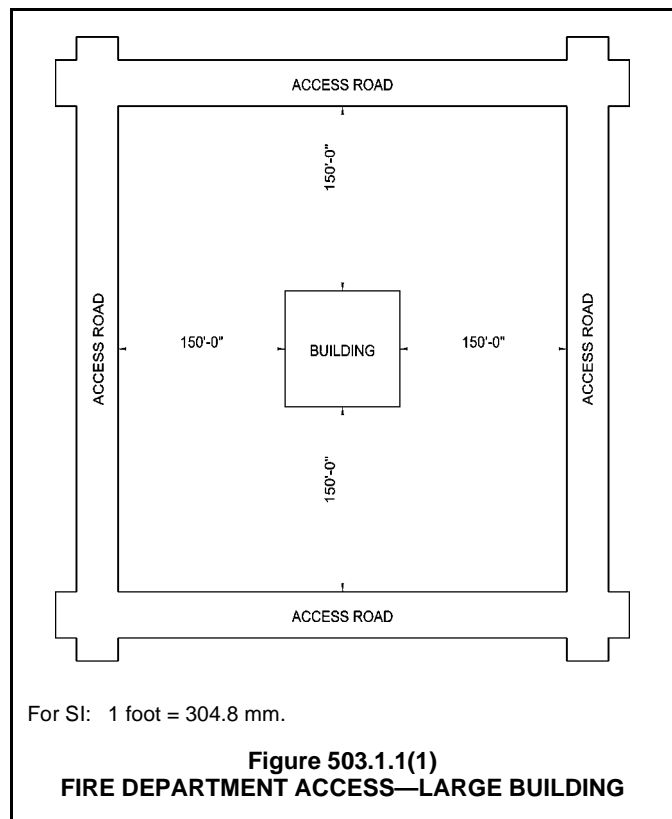
topography, waterways, nonnegotiable grades or other similar conditions, and an *approved* alternative means of fire protection is provided.

1.3. There are not more than two Group R-3 or Group U occupancies.

2. Where approved by the *fire code official*, fire apparatus access roads shall be permitted to be exempted or modified for solar photovoltaic power generation facilities.

❖ This section establishes a requirement for a fire apparatus access road and the maximum distance from buildings or facilities to fire apparatus access roads. The provisions are intended to limit the maximum length of hose needed to reach any point along the exterior of a building or facility from a fire department vehicle. Large-area buildings may require a fire apparatus access road on all four sides. An access road is required to extend to within 150 feet (45 720 mm) of all portions along the exterior wall of the grade level story of each new or relocated building [see Commentary Figure 503.1.1(1)]. The 150-foot (45 720 mm) distance is based on the standard length of preconnected hoses carried on fire apparatus and is not intended to be measured to any point within the building.

A long, narrow building may require fire department access roads on two sides only, if all portions of the exterior of the grade level story are within 150 feet (45 720 mm) of the access road [see Commentary Figure 503.1.1(2)].



Small buildings may require an access road on one side only, if the access road is within 150 feet (45 720 mm) of all portions of the grade level floor [see Commentary Figure 503.1.1(3)].

In a case where new construction creates an addition (“...portion of a building hereafter constructed...”) to an existing building, the new building as completed should be evaluated as it relates to compliance with this section because the new addition increases the fuel load and potential fire-fighting complications. An addition to a building may require the construction of a new fire apparatus access road or the reconfiguration of an existing fire apparatus access road. This is consistent with the prescriptive compliance method provisions of Section 402.1 of the *International Existing Building Code*® (IEBC®) [formerly Section 3403.1 of the *International Building Code*® (IBC®)] which require that the “...existing building together with the addition are no less conforming...than the existing building...was prior to the addition.” This is also consistent with Section 1101.2 of the IEBC, which states, “An addition shall not create or extend any nonconformity in the existing building to which the addition is being made with regard to fire safety, means of egress, or the capacity of mechanical, plumbing, or electrical systems.” In other words, an existing, non-conforming condition should not be made more non-conforming by construction of the addition. Note also that, since an addition is an increase in the area or height of an existing building, when a new building is erected immediately adjacent to an existing building, and they are separated by a fire wall constructed in accordance with Section 706 of the IBC, they are considered a separate building, not an addition to the existing structure. In that scenario, only the new building would be subject to this section. In any event, each case must be evaluated independently, especially if site topography or other conditions can slow or limit the response.

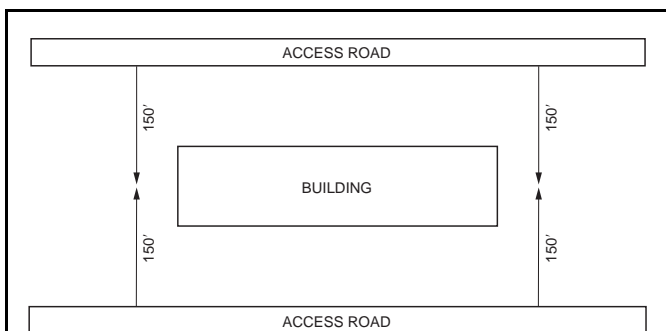
Condition 1.1 of Exception 1 states that the 150-foot (45 720 mm) distance may be increased, with the approval of the fire code official, when the building is

equipped throughout with an NFPA 13, 13R or 13D automatic sprinkler system, as applicable. The code does not give the fire code official guidance on how much of an increase over 150 feet (45 720 mm) is reasonable. The fire code official must make the determination based on the response capabilities of his or her emergency response units and the anticipated magnitude of the incident.

The “alternative means” in Condition 1.2 of Exception 1 may include standpipes, automatic sprinklers, remote fire department connections or additional fire hydrants.

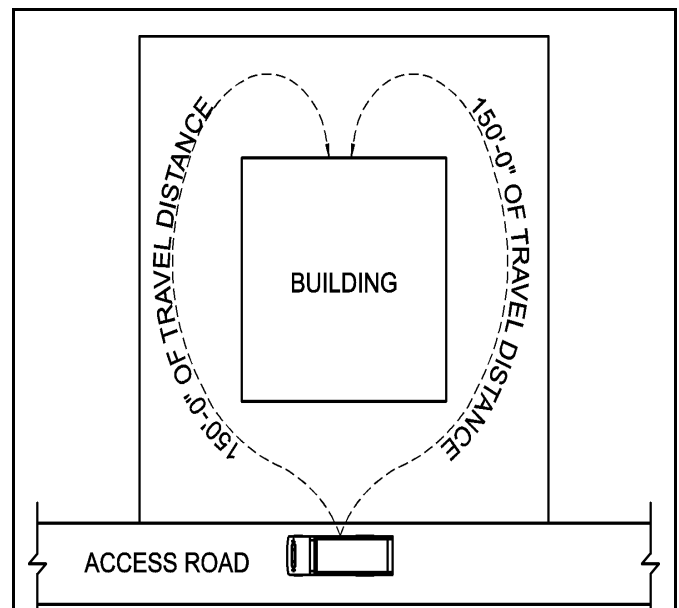
The Group R-3 facilities noted in Condition 1.3 of Exception 1 include one- and two-family dwellings and townhouses not falling within the scope of the *International Residential Code*® (IRC®); care facilities that accommodate five or fewer people; and congregate living facilities (nontransient) with 16 or fewer persons or congregate living facilities (transient) with 10 or fewer persons, among others. Group U occupancies are utility and miscellaneous accessory buildings or structures. Note that, since Section 903.2.8.1 requires that Group R-3 buildings be equipped throughout with automatic sprinkler systems, this condition is redundant with Condition 1.1. Note also that there is no exception for nonsprinklered buildings built under the IRC. See “Occupancy Classification” for the definitions of “Residential Group R” and “Miscellaneous Group U” in Section 202; the IRC Commentary, Section R101.2; and the IBC Commentary, Section 310.1.

Exception 2 addresses photovoltaic panel system/array power generation facilities and provides guid-



For SI: 1 foot = 304.8 mm.

**Figure 503.1.1(2)**  
**FIRE DEPARTMENT ACCESS ON TWO SIDES**



For SI: 1 foot = 304.8 mm.

**Figure 503.1.1(3)**  
**SMALL BUILDING ACCESS**

ance to jurisdictions in determining if a fire apparatus road is needed for hazard mitigation or if it can be exempted. Consideration must be given to the purpose of fire apparatus access roads within these facilities and how the provisions would be applied. Several issues arise when applying Section 503 of the code to ground-mounted photovoltaic systems/arrays. When considering the issues listed below, the fire code official should also consider other available code requirements that provide for appropriate hazard mitigation and risk reduction. Issues for consideration include:

1. Risk/hazard to be mitigated.
2. Risk/hazard to fire fighters or other emergency responders.
3. Interest of public safety and welfare.
4. Economics.
5. Intended access use.
6. Fuel load of the facility and adjacent areas that impact the facility.
7. Array configuration (tightly spaced, access aisles, height).
8. Actual hazard to public safety and welfare.

A question that often arises is whether code requirements pertaining to fire apparatus access roads are intended to be applicable to residential development sites upon which buildings are constructed under the provisions of the IRC. For information on this topic, see the commentary to Section 102.5.

Another question that arises is whether this section is intended to preclude locating a new building directly on a lot line, often referred to as a “zero lot line building.” While it is true that some very large area buildings may require a fire apparatus access road on all four sides, this section does not specifically deal with exterior walls that may be located on the lot line in such buildings where the distance to a portion of that wall exceeds 150 feet (45 720 mm) from a fire apparatus access road. As such, the fire code official must determine the code’s application in accordance with Section 102.9 and in consideration of the exception to this section.

In determining the application, however, it should be considered that, in order for the fire department access contemplated by this section to be effective, an exterior wall would need to have openings in it through which access to the interior of the building could be achieved by hose streams or personnel. In the case of an exterior wall constructed on a property line with a zero-foot fire separation distance, Table 602 of the IBC requires that such walls have a fire-resistance rating of between 1 and 3 hours (depending on the occupancy group assigned to the building) and IBC Section and Table 705.8 require that such walls be without any openings. As such, access to the first (or any) floor level of that exterior wall would appear to provide little or no tactical usefulness to the fire department, especially if code-

complying access is provided to other sides of the building.

**503.1.2 Additional access.** The *fire code official* is authorized to require more than one fire apparatus access road based on the potential for impairment of a single road by vehicle congestion, condition of terrain, climatic conditions or other factors that could limit access.

❖ Additional access roads may be required by the fire code official based on his or her knowledge of traffic patterns, local weather conditions, terrain or the anticipated magnitude of a potential incident.

**503.1.3 High-piled storage.** Fire department vehicle access to buildings used for *high-piled combustible storage* shall comply with the applicable provisions of Chapter 32.

❖ Chapter 32 has special requirements for building access in occupancies with high-piled storage, but the requirements for fire apparatus access roads are the same as those required in this chapter.

**503.2 Specifications.** Fire apparatus access roads shall be installed and arranged in accordance with Sections 503.2.1 through 503.2.8.

❖ The dimensions of fire department access roads are based on the size, height and turning radius of emergency vehicles and the fact that emergency vehicles may be required to pass each other on the access road.

**503.2.1 Dimensions.** Fire apparatus access roads shall have an unobstructed width of not less than 20 feet (6096 mm), exclusive of shoulders, except for *approved* security gates in accordance with Section 503.6, and an unobstructed vertical clearance of not less than 13 feet 6 inches (4115 mm).

❖ The dimensions in this section are established to give fire apparatus continuous and unobstructed access to buildings and facilities.

This section requires that the unobstructed width of a fire apparatus access road must not be less than 20 feet (6096 mm). The intent of the minimum 20-foot (6096 mm) width is to provide space for fire apparatus to pass one another during fire-ground operations. The need to pass may occur when engines are parked for hydrant hook-up, laying hose or when trucks are performing aerial ladder operations. When an engine company is connected to a fire hydrant parallel to the curb using a front suction connection and using a side-discharge port on the pump, the horizontal distance that is needed to make a no-kink bend in the discharge fire hose can be considerable, especially when a large-diameter hose (LDH) is being used. The roadway width needed to accommodate such a common operational scenario would be the width of the apparatus plus the no-kink bending radius of the discharge hose, leaving minimal roadway width for other apparatus to squeeze by, if needed. Including adjacent road shoulders in the 20-foot (6096 mm) width measurement could yield sub-standard and inadequate driving surfaces for appa-

tus and, as such, shoulders are not to be included in the minimum width.

The minimum vertical clearance of 13 feet, 6 inches (4115 mm) is the standard clearance used for highway bridges and underpasses. The vertical clearance requirement would apply in cases where a building or portion of a building, such as a canopy or porte-cochere, projects over all or a portion of the required width of the fire apparatus access road. Conversely, if the full required width of the fire apparatus access road is provided outside of the footprint of the projecting building element, the vertical clearance requirement would not apply. It is not the intent of this section that all projecting elements be constructed with a 13-foot, 6-inch (4115 mm) vertical clearance, regardless of whether they encroach upon the required width of a fire apparatus access road. Appendix D contains additional guidance on fire apparatus access road dimensions. It is important to note that the appendices are not considered part of the code unless specifically adopted (see Section 1 of the sample adopting ordinance on page xxi of the code).

**503.2.2 Authority.** The *fire code official* shall have the authority to require or permit modifications to the required access widths where they are inadequate for fire or rescue operations or where necessary to meet the public safety objectives of the jurisdiction.

❖ Fire departments respond to many types of emergency situations and the jurisdictions they serve may have traffic safety criteria that impact the design of access roadways used by emergency response vehicles. This section authorizes the fire code official to require greater, or to allow lesser, access-width dimensions based on the size and maneuverability of the anticipated emergency response apparatus, including mutual-aid apparatus from neighboring communities or agencies, among other considerations.

**503.2.3 Surface.** Fire apparatus access roads shall be designed and maintained to support the imposed loads of fire apparatus and shall be surfaced so as to provide all-weather driving capabilities.

❖ This provision does not specify a particular type of surface. It is written in performance language; therefore, the surface must carry the load of the anticipated emergency response vehicles and be driveable in all kinds of weather.

The term “all-weather driving capabilities” would typically require some type of paved or hard surface. Gravel would be prone to problems in areas subject to heavy rain or in snowy climates where plowing could reduce the gravel roadbed to mud very quickly. Alternatives to concrete or asphalt, such as interlocking pavers, may be used when approved by the fire code official. Jurisdictions may benefit from developing a local policy outlining specific design require-

ments for fire apparatus access roads to clarify local interpretations of the section. The policy should include local requirements for surfacing and include acceptable surfacing materials.

**503.2.4 Turning radius.** The required turning radius of a fire apparatus access road shall be determined by the *fire code official*.

❖ The turning radius of an access road should be based on the turning radius of the anticipated responding emergency vehicles and must be approved by the fire code official.

**503.2.5 Dead ends.** Dead-end fire apparatus access roads in excess of 150 feet (45 720 mm) in length shall be provided with an *approved* area for turning around fire apparatus.

❖ In consideration of the hazards inherent in attempting to back emergency vehicles, especially larger ones such as tower ladders, out of a long dead-end roadway, this section is intended to create a safer situation by requiring that dead-end access roads over 150 feet long (45 720 mm) be equipped with an approved turnaround designed for the largest anticipated emergency-response vehicles. Appendix D contains examples of dead-end turnaround configurations. It is important to note that the appendices are not considered part of the code unless specifically adopted (see Section 1 of the sample adopting ordinance on page xxi of the code).

**503.2.6 Bridges and elevated surfaces.** Where a bridge or an elevated surface is part of a fire apparatus access road, the bridge shall be constructed and maintained in accordance with AASHTO HB-17. Bridges and elevated surfaces shall be designed for a live load sufficient to carry the imposed loads of fire apparatus. Vehicle load limits shall be posted at both entrances to bridges where required by the *fire code official*. Where elevated surfaces designed for emergency vehicle use are adjacent to surfaces that are not designed for such use, *approved* barriers, *approved* signs or both shall be installed and maintained where required by the *fire code official*.

❖ Bridges and elevated surfaces must be capable of carrying the weight of emergency response apparatus and must be marked with signage posting the weight limit of the bridge or elevated surface. Evaluation of bridges should be done in cooperation with the appropriate local or state agency having jurisdiction over private or public roadway bridges.

**503.2.7 Grade.** The grade of the fire apparatus access road shall be within the limits established by the *fire code official* based on the fire department’s apparatus.

❖ Generally, any grade exceeding 10 percent [e.g., greater than a 10-foot (3048 mm) rise in a 100-foot (30 480 mm) length] is required to have the approval of the fire code official. See Appendix D for additional guidance on fire apparatus access roads. Note that the appendices are not considered part of the code unless specifically adopted (see Section 1 of the sample adopting ordinance on page xxi of the code).

**503.2.8 Angles of approach and departure.** The angles of approach and departure for fire apparatus access roads shall be within the limits established by the *fire code official* based on the fire department’s apparatus.

❖ The angle of approach is the angle between the ground and a line running from the bottom of the front tire to the lowest-hanging point directly in front of it, which is usually the front bumper of the apparatus. This angle gives an indication of how steep an incline the vehicle can clear when approaching that angle.

The angle of departure is the angle between the ground and a line running from the bottom of the rear tire to the lowest-hanging point directly behind it, which is usually the rear step/tailboard of the apparatus. Similar to the approach angle, this angle indicates how steep an incline the vehicle can clear when departing from that angle.

These design aspects of a fire apparatus access road are crucial to successful navigation by apparatus and must be tailored to accommodate each piece of fire apparatus of the jurisdiction. See Commentary Figure 503.2.8.

**503.3 Marking.** Where required by the *fire code official*, approved signs or other approved notices or markings that include the words NO PARKING—FIRE LANE shall be provided for fire apparatus access roads to identify such roads or prohibit the obstruction thereof. The means by which *fire lanes* are designated shall be maintained in a clean and legible condition at all times and be replaced or repaired when necessary to provide adequate visibility.

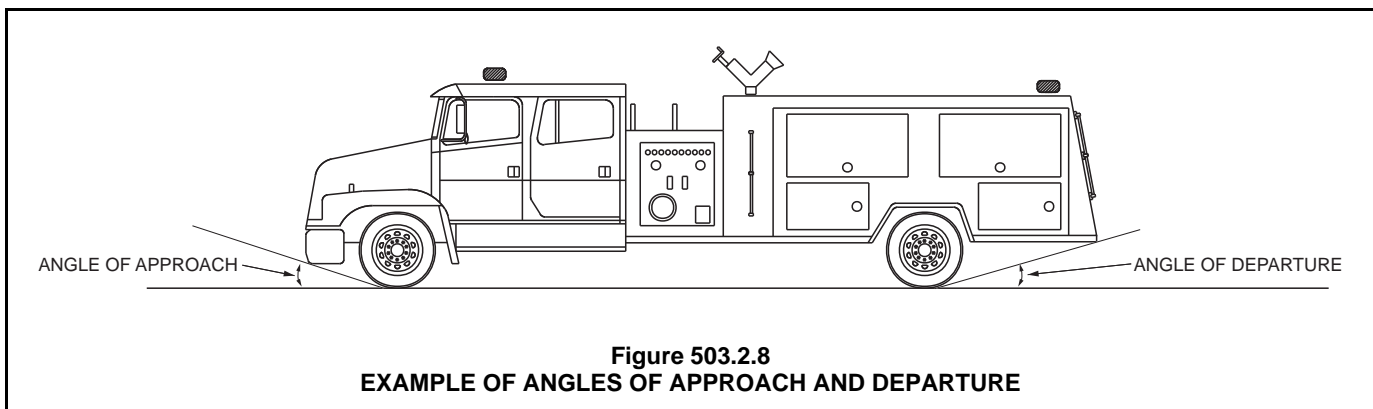
❖ Fire department access roads are normally designated on private property to provide fire service access; therefore, maintenance of the access roads, signage and any supplementary markings (pavement marking, curbs markings, etc.) are the responsibility of the owner of the property on which the fire apparatus road is located. Signage and supplemental markings should be in accordance with applicable local or state motor vehicle laws and should be enforced with the cooperation of the local police agency. Appendix D contains examples of signage. It is important to note that the appendices are not considered part of the code unless specifically adopted (see Section 1 of the sample adopting ordinance on page xxi of the code.

**503.4 Obstruction of fire apparatus access roads.** Fire apparatus access roads shall not be obstructed in any manner, including the parking of vehicles. The minimum widths and clearances established in Sections 503.2.1 and 503.2.2 shall be maintained at all times.

❖ To enforce “no parking” in fire apparatus access roads (fire lanes), the roads must be clearly marked. Some jurisdictions cite the building owner if the fire apparatus road is not properly marked and posted, and cite the vehicle for parking or blocking the access road if the access road is clearly marked. Other jurisdictions place the responsibility for marking the access roads, as well as the policing of “no parking” zones, on the building owner. In some states, motor vehicle laws may stipulate that fire apparatus access roads/fire lanes posted on private property may only be enforced by a traffic citation where an enforcement contract has been executed between the property owner and the local jurisdiction, that all markings be in accordance with the motor vehicle code and that the designated roadways be described in detail in the local “no parking” ordinances of the jurisdiction.

**503.4.1. Traffic calming devices.** Traffic calming devices shall be prohibited unless approved by the *fire code official*.

❖ This section prohibits the installation of traffic calming devices on fire apparatus access roads unless the devices are approved by the fire code official. What it doesn’t do is detail how that approval is to be made within various jurisdictions. Each jurisdiction has its own traffic pattern emergency response challenges. The purpose of this requirement is to ensure that the fire department is part of this decision-making process. In most jurisdictions, the design and construction or review and approval of traffic calming devices is the responsibility of the municipal public works, transportation or engineering department. As a result, the fire code official and the appropriate engineering staff will need to work closely with one another to ensure that traffic calming devices, when approved, not only meet traffic engineering needs but also have the least impact on response time to emergencies. Traffic officials and fire code officials both have the responsibility to ensure that all public interests are properly considered in their decision-making process since both sets of officials have detailed regulations



**Figure 503.2.8**  
**EXAMPLE OF ANGLES OF APPROACH AND DEPARTURE**

to provide for those interests. See the commentary to the Section 202 definition of “Traffic calming device” for further discussion.

**503.5 Required gates or barricades.** The *fire code official* is authorized to require the installation and maintenance of gates or other *approved* barricades across fire apparatus access roads, trails or other accessways, not including public streets, alleys or highways. Electric gate operators, where provided, shall be *listed* in accordance with UL 325. Gates intended for automatic operation shall be designed, constructed and installed to comply with the requirements of ASTM F2200.

❖ The fire code official may require the installation and maintenance of gates or barricades across fire apparatus roads to prevent unauthorized vehicles from blocking or parking in the access road. The design and dimensions of the gates or barricades must be approved by the fire code official. Additionally, the gate or barricade must be operable or removable by the responding emergency units to provide them with quick access.

This section also addresses an important public safety issue regarding automatic operation of vehicular gates. Protection is needed from potential entrapment of individuals between an automatically moving gate and a stationary object or surface in close proximity to such gate. Gates intended for automation require specific design, construction and installation to accommodate entrapment protection to minimize or eliminate excessive gate gaps, openings and protrusions identified as contributing to the hazard of entrapments that have historically caused numerous serious injuries and deaths.

This section references two appropriate standards that deal with automatic gate safety: UL 325 and ASTM F2200. UL 325 is an ANSI-recognized safety standard containing provisions governing gate openers. Gate openers listed to the requirements of UL 325 provide an improved level of assurance that safety requirements have been met for such openers. ASTM F2200 is a consensus document containing provisions governing the construction of vehicular gates intended for automation, and has been harmonized with the applicable provisions of UL 325.

**503.5.1 Secured gates and barricades.** Where required, gates and barricades shall be secured in an *approved* manner. Roads, trails and other accessways that have been closed and obstructed in the manner prescribed by Section 503.5 shall not be trespassed on or used unless authorized by the *owner* and the *fire code official*.

**Exception:** The restriction on use shall not apply to public officers acting within the scope of duty.

❖ The owner may secure the fire apparatus access road and restrict its use to emergency vehicles only, if warranted. If there is a need to secure gates or barricades, jurisdictions may require a padlock or key switch (on electrically operated gates) designed for the same key as key boxes provided in accordance

with Section 506. Occasionally, electronically operated gates are required to be provided with a backup mechanism or breakaway feature in case the primary operating means fails.

The exception makes it clear that the securing of fire apparatus access roads is not intended to impede the legitimate and necessary use of the road by duly authorized public officers, such as police officers or other municipal personnel.

**503.6 Security gates.** The installation of security gates across a fire apparatus access road shall be *approved* by the fire chief. Where security gates are installed, they shall have an *approved* means of emergency operation. The security gates and the emergency operation shall be maintained operational at all times. Electric gate operators, where provided, shall be *listed* in accordance with UL 325. Gates intended for automatic operation shall be designed, constructed and installed to comply with the requirements of ASTM F2200.

❖ This section does not require that security gates be installed, but since they can affect fire department operations, their installation must be approved by the fire chief. Where installed, security gates must be operable in an emergency by the emergency response units and the means of operation must be acceptable to the fire chief. Electrically operated gates should also include a manual method of operation (also see commentary, Section 503.5.1).

This section requires ongoing maintenance of security gates so that ready access to the roadway may be accomplished. If gates are not maintained in a manner that prevents appreciable delay of emergency response, the fire code official has the authority to have gates removed because they would be considered an obstruction of the required roadway width as regulated in Section 503.4.

This section also addresses an important public safety issue regarding automatic operation of vehicular gates. Protection is needed from potential entrapment of individuals between an automatically moving gate and a stationary object or surface in close proximity to such gate. Gates intended for automation require specific design, construction and installation to accommodate entrapment protection to minimize or eliminate excessive gate gaps, openings and protrusions identified as contributing to the hazard of entrapments that have historically caused numerous serious injuries and deaths.

This section references two appropriate standards that deal with automatic gate safety: UL 325 and ASTM F2200. UL 325 is an ANSI-recognized safety standard containing provisions governing gate openers. Gate openers listed to the requirements of UL 325 provide an improved level of assurance that safety requirements have been met for such openers. ASTM F2200 is a consensus document containing provisions governing the construction of vehicular gates intended for automation, and has been harmonized with the applicable provisions of UL 325.

## SECTION 504 ACCESS TO BUILDING OPENINGS AND ROOFS

**504.1 Required access.** Exterior doors and openings required by this code or the *International Building Code* shall be maintained readily accessible for emergency access by the fire department. An *approved* access walkway leading from fire apparatus access roads to exterior openings shall be provided when required by the *fire code official*.

❖ The exterior openings referred to in this section are typically exit discharge doors, since such openings provide fire department access directly into the building or to a fire-resistance-rated enclosure from which to operate in multiple-story buildings. This section also includes access openings for rack or high-piled storage buildings required by Section 3206.6. Under certain circumstances, in order for emergency response personnel to get equipment from the emergency apparatus to the building, the fire code official is authorized to require approved walkways from the apparatus access road to the building openings on grade level.

**504.2 Maintenance of exterior doors and openings.** Exterior doors and their function shall not be eliminated without prior approval. Exterior doors that have been rendered non-functional and that retain a functional door exterior appearance shall have a sign affixed to the exterior side of the door with the words THIS DOOR BLOCKED. The sign shall consist of letters having a principal stroke of not less than  $\frac{3}{4}$  inch (19.1 mm) wide and not less than 6 inches (152 mm) high on a contrasting background. Required fire department access doors shall not be obstructed or eliminated. Exit and *exit access* doors shall comply with Chapter 10. Access doors for *high-piled combustible storage* shall comply with Section 3206.6.1.

❖ This section pertains to emergency access openings and to all exterior doors that have a functional appearance from the outside but are not operable. Doors that are part of the required means of egress or that are required by Section 3206.6 must not be rendered unusable or blocked. Only doors not required by the code or the IBC for means of egress may be blocked or made unusable. Even then, they must be marked from the outside so that emergency personnel will not attempt to use them.

**504.3 Stairway access to roof.** New buildings four or more stories above grade plane, except those with a roof slope greater than four units vertical in 12 units horizontal (33.3-percent slope), shall be provided with a *stairway* to the roof. *Stairway* access to the roof shall be in accordance with Section 1011.12. Such *stairway* shall be marked at street and floor levels with a sign indicating that the *stairway* continues to the roof. Where roofs are used for roof gardens or for other purposes, *stairways* shall be provided as required for such occupancy classification.

❖ The stairway to the roof, required by this section, must comply with Sections 1011.12 through 1011.12.2. If the stairway to the roof serves as a

means of egress from an occupied roof, then the stairway must be equipped with all the components of an exit stairway, such as the required riser and tread dimensions, handrails, etc. If the stairway to the roof is not required for roof egress, Section 1011.14 allows the stairway segment from the top floor to the roof to be an alternating tread device. The access to the roof is required for fire-fighter use and not the general public; therefore, the door leading to the roof may be secured in a manner approved by the fire code official with due consideration given to whether the door is an egress element for the roof. These provisions apply only to new buildings four or more stories in height (see commentary, Sections 1011.12 and 1023.9).

## SECTION 505 PREMISES IDENTIFICATION

**505.1 Address identification.** New and existing buildings shall be provided with *approved* address identification. The address identification shall be legible and placed in a position that is visible from the street or road fronting the property. Address identification characters shall contrast with their background. Address numbers shall be Arabic numbers or alphabetical letters. Numbers shall not be spelled out. Each character shall be not less than 4 inches (102 mm) high with a minimum stroke width of  $\frac{1}{2}$  inch (12.7 mm). Where required by the *fire code official*, address identification shall be provided in additional *approved* locations to facilitate emergency response. Where access is by means of a private road and the building cannot be viewed from the *public way*, a monument, pole or other sign or means shall be used to identify the structure. Address identification shall be maintained.

❖ Buildings must be provided and maintained with address identification that is easily identifiable by emergency responders from the emergency response vehicle. This should include the backs of buildings that face alleys or roads, since the emergency response unit may often be directed to the back entrance to a building, such as in a strip shopping center. The back door of each tenant space should have the numerical address and store name on or above the door.

This section also provides the fire code official with the authority to require additional address locations for facilities with unusual or problematic configurations, such as college or hospital campuses, strip malls, business parks, apartment complexes and other complex properties where identification of buildings is essential to emergency responders. The additional requirements proposed by the added language will assist various emergency responders in identifying specific addresses when an emergency response from locations other than the primary access point is required.

There are also situations where a building's setback from the street is so large that the building itself may not even be visible to emergency responders. In

such circumstances, this section requires that the road or driveway giving access to the building be marked to assist emergency responders in promptly identifying their access. It is important that such remote markings be reviewed and approved by the fire code official prior to installation.

**505.2 Street or road signs.** Streets and roads shall be identified with *approved* signs. Temporary signs shall be installed at each street intersection when construction of new roadways allows passage by vehicles. Signs shall be of an *approved* size, weather resistant and be maintained until replaced by permanent signs.

❖ The names of streets in new developments may not be on maps, making them hard for emergency responders to find. Temporary street signs must be installed before construction begins and replaced later with permanent signs.

**SECTION 506  
KEY BOXES**

**506.1 Where required.** Where access to or within a structure or an area is restricted because of secured openings or where immediate access is necessary for life-saving or fire-fighting purposes, the *fire code official* is authorized to require a key box to be installed in an *approved* location. The key box shall be of an *approved* type listed in accordance with UL 1037, and shall contain keys to gain necessary access as required by the *fire code official*.

❖ The fire code official has the authority to require special key vaults when, in his or her opinion, the need for rapid entry into facilities warrants it. The key boxes or vaults are located on the exterior of the building for ready access, and are openable with a special master key in the possession of the emergency responders. See Commentary Figures 506.1(1) and 506.1(2) and the commentary to the definitions of “Key box” and “Fire department master key” in Section 202.

The section also specifies a level of security for key boxes. Where a rapid-entry key box is required, there is an obligation to make sure that the key box required or approved by the fire code official is secure to prevent the key box from becoming a security threat. This section addresses the issue of security by requiring an approved key box to be listed in accordance with UL 1037. The major key box manufacturers have their rapid entry devices listed under this standard.

Section 506.1 is a discretionary provision based on the jurisdiction’s determination that the use of a key box is safer for fire fighters than performing manual forcible entry into a structure. If properly maintained in accordance with Section 506.2, a key box can also lower property losses because it expedites the entry of fire fighters into a structure without necessitating the damage associated with forcing entry. The decision for the use of key boxes rests solely with the fire code official.

**506.1.1 Locks.** An *approved* lock shall be installed on gates or similar barriers where required by the *fire code official*.

❖ The key box suppliers also have special padlocks and electronic key-operated switches that are controlled by the same fire department master key that opens the key vaults. These padlocks can be required by the fire code official for security gates (also see commentary, Sections 503.5, 503.5.1 and 503.6). The key-activated electronic switches may also be required for the control of certain equipment in the building, such as smoke control equipment, or to shut down a dangerous process.



**Figure 506.1(1)  
SURFACE-MOUNTED KEY BOX  
(Photo courtesy of Knox Company)**



**Figure 506.1(2)  
RECESSED-MOUNTED KEY BOX  
(Photo courtesy of Knox Company)**

**506.1.2 Key boxes for nonstandardized fire service elevator keys.** Key boxes provided for nonstandardized fire service elevator keys shall comply with Section 506.1 and all of the following:

1. The key box shall be compatible with an existing rapid entry key box system in use in the jurisdiction and *approved* by the *fire code official*.
2. The front cover shall be permanently labeled with the words “Fire Department Use Only—Elevator Keys.”
3. The key box shall be mounted at each elevator bank at the lobby nearest to the lowest level of fire department access.
4. The key box shall be mounted 5 feet 6 inches (1676 mm) above the finished floor to the right side of the elevator bank.
5. Contents of the key box are limited to fire service elevator keys. Additional elevator access tools, keys and information pertinent to emergency planning or elevator access shall be permitted where authorized by the *fire code official*.
6. In buildings with two or more elevator banks, a single key box shall be permitted to be used where such elevator banks are separated by not more than 30 feet (9144 mm). Additional key boxes shall be provided for each individual elevator or elevator bank separated by more than 30 feet (9144 mm).

**Exception:** A single key box shall be permitted to be located adjacent to a *fire command center* or the non-standard fire service elevator key shall be permitted to be secured in a key box used for other purposes and located in accordance with Section 506.1.

❖ Many jurisdictions have elevators built prior to the introduction of a standardized elevator key and, as a result, each building with an elevator requires its own elevator key. The key is most likely to be based on the model of the elevator and the year it was manufactured. This section sets forth requirements to assist jurisdictions in managing the issue of having different elevator keys in different buildings. These provisions specify where the key box is to be located inside the building and require it to be compatible with the rapid-entry existing key boxes that may already be in use in the jurisdiction. The exception allows key box installation adjacent to a fire command center or in other locations where approved by the fire code official. See the commentary to Sections 607.8 through 607.8.4 for a discussion of standardized fire service elevator keys.

**506.2 Key box maintenance.** The operator of the building shall immediately notify the *fire code official* and provide the new key where a lock is changed or rekeyed. The key to such lock shall be secured in the key box.

❖ In most cases, the owner of a building cannot open the key vault or box and must call the fire code official

to have someone open it to replace keys that have been changed. The building owner is responsible for maintaining the key box, as well as keeping the keys inside the box current.

## SECTION 507 FIRE PROTECTION WATER SUPPLIES

**507.1 Required water supply.** An *approved* water supply capable of supplying the required fire flow for fire protection shall be provided to premises upon which facilities, buildings or portions of buildings are hereafter constructed or moved into or within the jurisdiction.

❖ This section requires that adequate fire protection water be provided to premises upon which new buildings are constructed or onto which a building is moved, from either outside of the jurisdiction or another location within the jurisdiction. Note that this section states that the water supply must be capable of supplying the required fire flow to the premises; however, the means by which the fire flow is supplied is determined by the policies of the jurisdiction, such as a pumper taking suction from a hydrant, tanker or lake (also see Appendices B and C for further information on fire flows and fire hydrants). It is important to note that the appendices are not considered part of the code unless specifically adopted (see Section 1 of the sample adopting ordinance on page xxi of the code). The phrase “... hereafter constructed or moved ...” used in this section (and in Appendices B and C, if duly adopted) limits the application of water supply provisions to only newly erected or relocated buildings, as opposed to existing buildings or existing remodeled buildings.

A question that often arises is whether the code’s regulations pertaining to fire protection water supply are intended to be applicable to one- and two-family residential development sites upon which buildings are constructed under the provisions of the IRC. The IRC is intended to be a stand-alone code for the construction of detached one- and two-family dwellings and townhouses not more than three stories in height. As such, all of the provisions for the construction of buildings of those descriptions are to be regulated exclusively by the IRC and not by another I-Code. However, the IRC applies only to the construction of the structures of those buildings and not to the development of the site upon which such structures are built. Accordingly, where the code is adopted, its fire protection water supply provisions (including specifically adopted related appendices) apply. The code’s requirements address only land development requirements for providing fire protection water supply to residential sites on the same basis as to the rest of the community (also see commentary, Sections 102.5 and 503.1.1).

**507.2 Type of water supply.** A water supply shall consist of reservoirs, pressure tanks, elevated tanks, water mains or

other fixed systems capable of providing the required fire flow.

- ❖ A good water supply consists of an adequate source of water, distribution system and proper pressure for delivery. If the water source is not reliable, it should not be considered as an acceptable water supply.

**507.2.1 Private fire service mains.** Private fire service mains and appurtenances shall be installed in accordance with NFPA 24.

- ❖ Private fire service mains are often installed on private property where facilities are located well away from municipal water distribution systems. Private hydrants may not be installed on mains less than 6 inches (152 mm) in diameter (see Section 5.2.1 of NFPA 24). Where installed, private fire service mains, private hydrants, control valves, hose houses and related equipment must be installed and maintained in accordance with NFPA 24. Private (yard) hydrants may be tested, painted and marked in accordance with NFPA 291 where approved by the fire code official and the fire department.

**507.2.2 Water tanks.** Water tanks for private fire protection shall be installed in accordance with NFPA 22.

- ❖ Water tanks for private fire protection may be required where municipal water systems do not exist or are incapable of supplying sprinkler or standpipe demand, or where Section 403.2 of the IBC or Section 903.3.5.2 of the code requires a secondary water supply for high-rise buildings in Seismic Design Category C, D, E or F. NFPA 22 and Section 1509.3 of the IBC govern the installation of water tanks on buildings. Pressure tanks must bear the label of an approved agency and be installed in accordance with the manufacturer's instructions.

**507.3 Fire flow.** Fire requirements for buildings or portions of buildings and facilities shall be determined by an *approved* method.

- ❖ Appendix B of the code, which sets forth minimum fire flow requirements for one- and two-family dwellings and commercial buildings, offers one method for determining fire flow and its duration that could be approved by the fire code official. In areas that do not have a water supply, such as rural areas with no conventional water storage and distribution system, the jurisdiction may choose to utilize the methods contained in NFPA 1142, *Standard on Water Supplies for Suburban and Rural Firefighting*, the *International Wildland-Urban Interface Code*® (IWUIC®), or the Insurance Services Office's *Guide for Determination of Needed Fire Flow*. Appendix Table B105.1 bases fire flow on the type of construction and the square footage of the fire flow calculation area. All calculations in the table are based on a 20-pounds-per-square-inch (psi) (138 kPa) residual pressure. Note that the provisions of Section B103 provide for increases, reductions and specific alternative methods for determining flows. In addition to Section

B103, Sections 104.8 and 104.9 also provide the fire code official with authority concerning modifications and alternative methods. See the commentary to Appendix B for discussion of the fire flow requirements. It is important to note that the appendices are not considered part of the code unless specifically adopted (see Section 1 of the sample adopting ordinance on page xxi of the code).

**507.4 Water supply test.** The *fire code official* shall be notified prior to the water supply test. Water supply tests shall be witnessed by the *fire code official* or *approved* documentation of the test shall be provided to the *fire code official* prior to final approval of the water supply system.

- ❖ Whatever type of water supply is proposed in order to comply with Section 507.1, it must be tested in a manner that will verify it is capable of providing the required fire flow. The water supply system must be tested and the contractor is required to notify the fire code official prior to performing the test on the system. The fire code official will make the final approval by either witnessing the test or accepting the certification documentation. NFPA 291 contains recommended test methodology.

If the water supply system includes private fire service mains, NFPA 24, referenced in Section 507.2.1, contains the testing requirements for private fire service mains, as well as a test certificate form. It should be noted that the test certificate form has signature blocks only for the building owner's representative and the installing contractor's representative. There is no place on the form for the fire code official's signature, nor should he or she expose him or herself to liability of any kind for the installation by signing the form.

**507.5 Fire hydrant systems.** Fire hydrant systems shall comply with Sections 507.5.1 through 507.5.6.

- ❖ When fire hydrant systems are part of the approved water supply, the system must comply with this section.

**507.5.1 Where required.** Where a portion of the facility or building hereafter constructed or moved into or within the jurisdiction is more than 400 feet (122 m) from a hydrant on a fire apparatus access road, as measured by an *approved* route around the exterior of the facility or building, on-site fire hydrants and mains shall be provided where required by the *fire code official*.

**Exceptions:**

1. For Group R-3 and Group U occupancies, the distance requirement shall be 600 feet (183 m).
  2. For buildings equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, the distance requirement shall be 600 feet (183 m).
- ❖ The intent of this section is that not more than 400 feet (122 m) of hose will have to be laid out to reach all portions of the exterior grade level of the building.

**FIRE SERVICE FEATURES**

Each hydrant must be accessible to fire apparatus and the 400-foot (122 m) distance should be measured from the hydrant(s) to all portions of the exterior at ground level [see Commentary Figure 507.5.1(1)]. When on-site hydrants and mains are required to achieve compliance with the distance requirement, this section gives the fire code official the authority to determine and approve hydrant locations on the site.

This paragraph is not intended to prevent development in rural areas where fire hydrants are not available, as long as the fire code official has approved an alternative water supply. The alternative water supply could be a fire department water tanker or a static, all-weather water supply that is approved by the fire code official.

In recognition of the smaller relative size and fire hazard characteristics of one- and two-family dwellings and utility buildings, Exception 1 increases the 400-foot (122 m) distance to 600 feet (183 m) [see Commentary Figure 507.5.1(2)]. Note that the one- and two-family dwellings classified in Group R-3 are those that are not within the scope of the IRC. See Section 102.5.

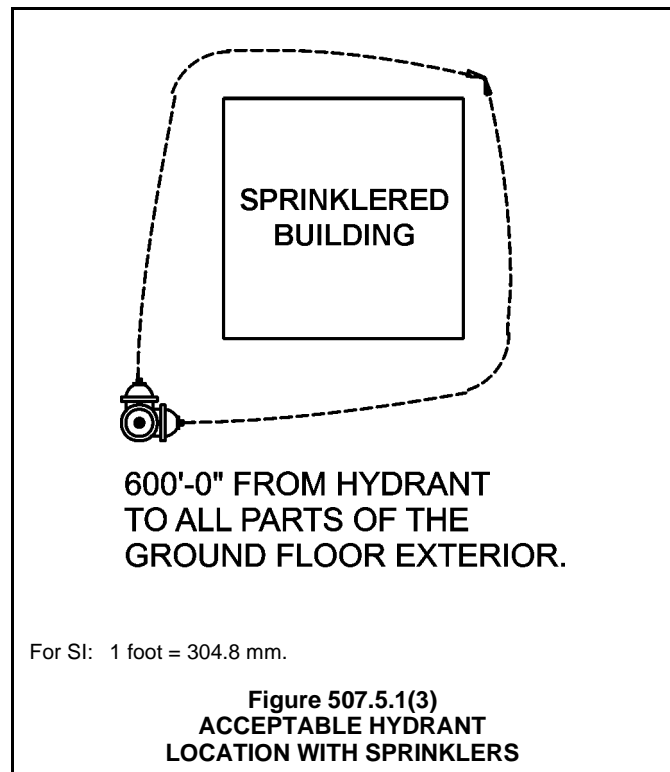
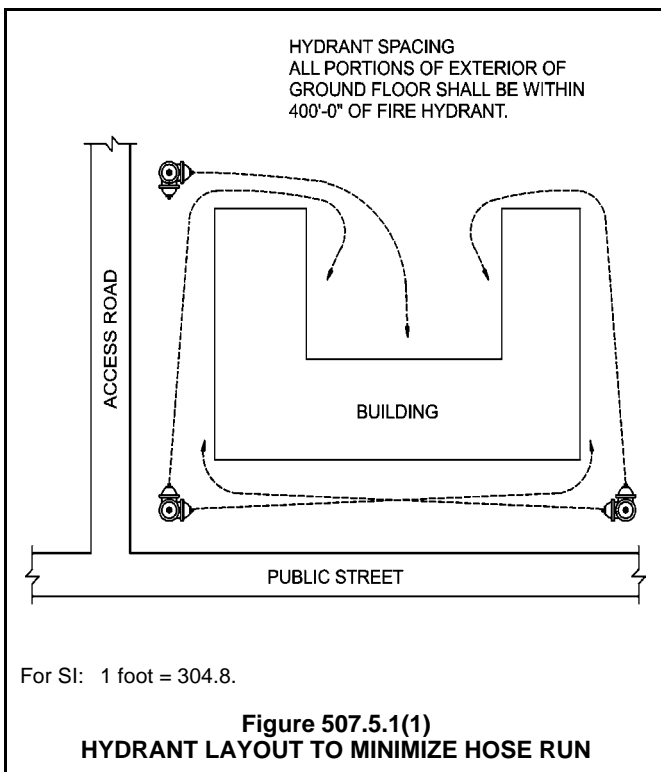
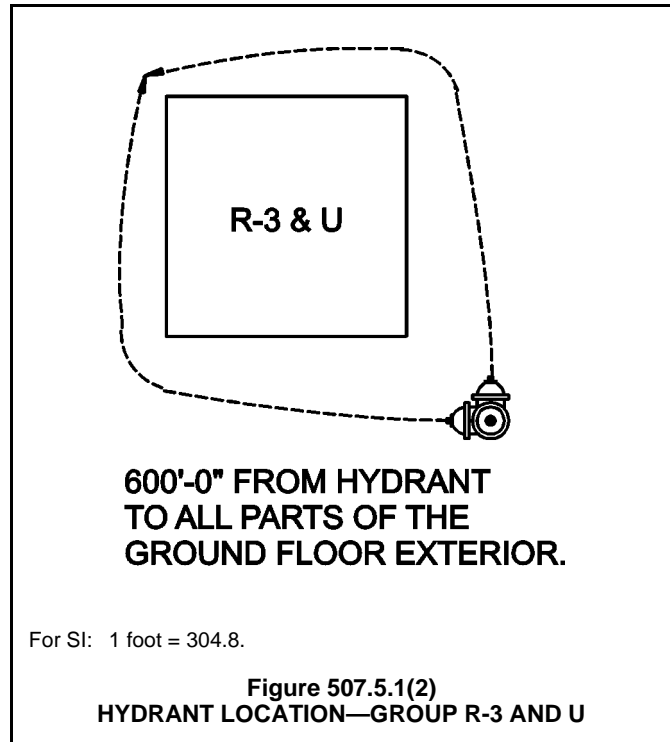
In recognition of the proven efficiency of sprinklers in applying water directly on the seat of the fire for buildings equipped throughout with automatic sprinklers in accordance with NFPA 13 or NFPA 13R, as applicable, Exception 2 increases the 400-foot (122 m) distance to 600 feet (183 m) [see Commentary Figure 507.5.1(3)].

**507.5.1.1 Hydrant for standpipe systems.** Buildings equipped with a standpipe system installed in accordance

with Section 905 shall have a fire hydrant within 100 feet (30 480 mm) of the fire department connections.

**Exception:** The distance shall be permitted to exceed 100 feet (30 480 mm) where *approved by the fire code official*.

❖ This section provides correlation with NFPA 14, Section 6.4.5.4, which requires that standpipe fire depart-



ment connections be placed within 100 feet (30 m) of a fire hydrant, unless otherwise approved by the authority having jurisdiction. However, that requirement is frequently missed where site work and approval has been based only on the fire apparatus access road and fire protection water supply requirements in this chapter. With the requirement now included in this section, the code user is directed to this requirement during the site design review stage and not as an afterthought as has often happened during the building permit site plan review. The exception provides design flexibility but protects operational needs of the fire department by requiring the fire code official to approve any increase in distance between the fire department connection (FDC) and the hydrant. Note that this requirement is not applicable to sprinkler connections since NFPA 13 does not have a distance requirement to a fire hydrant for connections serving only sprinkler systems.

**507.5.2 Inspection, testing and maintenance.** Fire hydrant systems shall be subject to periodic tests as required by the *fire code official*. Fire hydrant systems shall be maintained in an operative condition at all times and shall be repaired where defective. Additions, repairs, *alterations* and servicing shall comply with *approved* standards. Records of tests and required maintenance shall be maintained.

- ❖ The fire code official has the authority to require periodic tests and to specify the frequency of such tests. The generally accepted procedure is to inspect hydrants annually for proper operation and drainage by opening and closing the hydrants and lubricating all threads. This section also requires that written inspection and maintenance records be kept. Such records should indicate the date and time and the name of the person conducting the inspection or maintenance. These records must be maintained by the owner and should be made available to the fire code official for review when requested. This requirement relieves the fire code official of the administrative burden of maintaining test records.

**507.5.3 Private fire service mains and water tanks.** Private fire service mains and water tanks shall be periodically inspected, tested and maintained in accordance with NFPA 25 at the following intervals:

1. Private fire hydrants of all types: Inspection annually and after each operation; flow test and maintenance annually.
2. Fire service main piping: Inspection of exposed, annually; flow test every 5 years.
3. Fire service main piping strainers: Inspection and maintenance after each use.

Records of inspections, testing and maintenance shall be maintained.

- ❖ NFPA 25 is the Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems. Chapter 7 of that standard covers private fire service mains and Chapter 9 covers water stor-

age tanks. This section also requires that written inspection and maintenance records be kept. Such records should indicate the date and time and the name of the person conducting the inspection or maintenance. These records must be maintained by the owner and should be made available to the fire code official for review when requested. This requirement relieves the fire code official of the administrative burden of maintaining test records.

**507.5.4 Obstruction.** Unobstructed access to fire hydrants shall be maintained at all times. The fire department shall not be deterred or hindered from gaining immediate access to fire protection equipment or fire hydrants.

- ❖ Nothing can be allowed to be placed near a fire hydrant, FDC or control valve that would prevent responding fire fighters from immediately recognizing the device and gaining access to it. Plants and shrubs on public or private property are probably the most common object that can make fire hydrants, FDCs or fire protection system valves virtually invisible to responding fire apparatus engineers. In residential areas especially, some homeowners do not like “that ugly piece of iron” (i.e., a fire hydrant) in their yard, so they plant all manner of vegetation around it in an effort to hide it—a clear violation of this section. On construction sites, fire hydrants or FDCs are often hidden from view and access by deliveries of construction materials randomly dumped at the most convenient spot on the site without regard for the need of the fire department to gain immediate access to hydrants or FDCs.

**507.5.5 Clear space around hydrants.** A 3-foot (914 mm) clear space shall be maintained around the circumference of fire hydrants, except as otherwise required or *approved*.

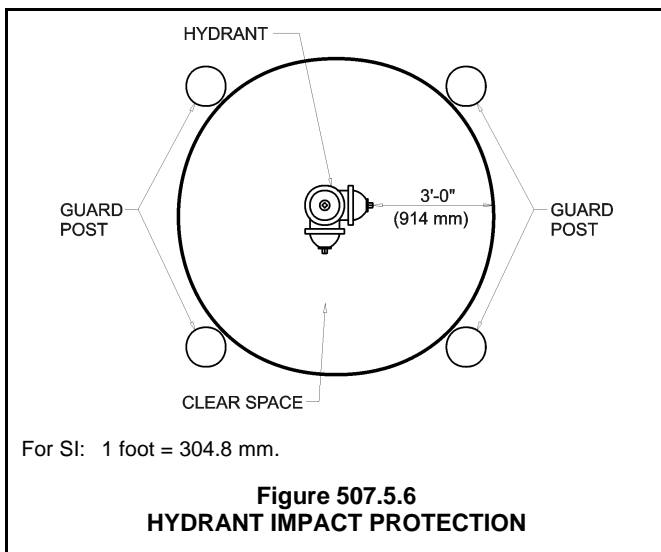
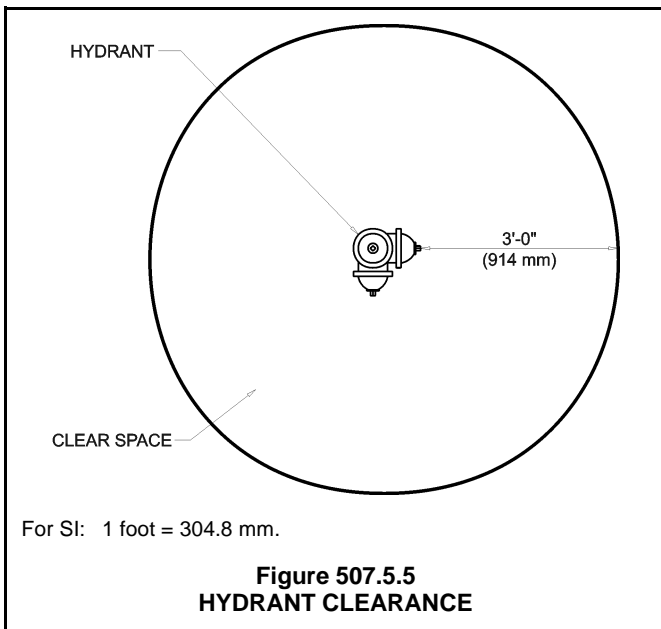
- ❖ Care must be taken so that fences, utility poles, barricades and other obstructions do not prevent access to and operation of fire hydrants. A clear space of 3 feet (914 mm) must be maintained around hydrants (see Commentary Figure 507.5.5) to allow easy hose connections to the hydrant and the efficient use of hydrant wrenches, spanner wrenches and other tools needed by the apparatus engineer. It is not the intent of this section to allow any of the obstructions described in Section 507.5.4 to exist as long as they are kept 3 feet (914 mm) from the hydrant, FDC or valve.

Though not specifically mentioned in this section, it is also important that hydrants be installed with the center of the outlet cap nuts at least 18 inches (457 mm) above adjoining grade to accommodate the free turning of a hydrant wrench when removing the caps (see NFPA 24, Chapter 7, for further information).

**507.5.6 Physical protection.** Where fire hydrants are subject to impact by a motor vehicle, guard posts or other *approved* means shall comply with Section 312.

- ❖ Section 312 requires vehicle impact protection by placing steel posts filled with concrete around the hydrant (see Commentary Figure 507.5.6). Section

312 gives the specifications for the posts. Note that the provisions of Section 507.5.5 apply to the installation of posts or other protective features.



**SECTION 508  
FIRE COMMAND CENTER**

**508.1 General.** Where required by other sections of this code and in all buildings classified as high-rise buildings by the *International Building Code*, a *fire command center* for fire department operations shall be provided and shall comply with Sections 508.1.1 through 508.1.6.

❖ Fire-ground operations usually involve establishing an incident command post where the incident command officer can observe what is happening; control arriving personnel and equipment; and direct the resources and fire-fighting operations effectively. Because of the difficulties in controlling a fire in a high-rise building, an adequately sized, protected,

readily accessible, separate room for this purpose within the building must be established to assist the incident command officer (see also the commentary to Section 202 for the definition of “Fire command center”).

A fire command center is also required by Section 909.16 in buildings containing smoke-protected assembly seating to house the fire fighter’s smoke control panel. Facilities with smoke-protected seating tend to be larger facilities that, at the very least, would already have a central security center that could also function as a fire command center where approved by the jurisdiction (see commentary, Section 909.16).

**508.1.1 Location and access.** The location and accessibility of the *fire command center* shall be *approved* by the fire chief.

❖ Because of its importance to fire suppression and rescue operations, the fire command center must be provided at a location that is acceptable to the fire department, usually near the front of the building near the main entrance, so that the first arriving command officer can access it quickly and undertake operations. Since fire-ground operations are based on local operational procedures, it is only reasonable that the fire chief of the jurisdiction have approval authority over the location of and access to the fire command center.

**508.1.2 Separation.** The *fire command center* shall be separated from the remainder of the building by not less than a 1-hour *fire barrier* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assembly* constructed in accordance with Section 711 of the *International Building Code*, or both.

❖ Because of its importance to fire suppression and rescue operations, the fire command center must be separated from the remainder of the building by 1-hour fire barriers and horizontal assemblies, including opening protectives, to protect the room, its contents and occupants from an incident in adjacent areas of the building, and to limit noise and distractions during command operations within the room.

**508.1.3 Size.** The *fire command center* shall be not less than 200 square feet (19 m<sup>2</sup>) in area with a minimum dimension of 10 feet (3048 mm).

❖ This section is intended to provide a minimum size and configuration of the fire command center that allows sufficient space for the necessary command personnel to effectively perform required tasks associated with a fire command center without interfering with each other. Fire command centers must be designed to accommodate several emergency response commanders wearing full protective equipment, provide space to review building emergency plans during incidents, collocate decision-makers within the incident command system (ICS), and interpret fire protection system and building system information generated by the features required by Section 508.1.5. Given the multiple uses of the fire command

center, a room any smaller would serve to compromise the effectiveness of incident management.

**508.1.4 Layout approval.** A layout of the *fire command center* and all features required by this section to be contained therein shall be submitted for approval prior to installation.

❖ The flow of critical tactical information into, within and out of a fire command center is, by its very nature, both high in volume and intense in nature, and has a direct bearing on the safety of building occupants and emergency response personnel at work at an incident. For that reason, the layout and arrangement of the fire command center must comport with the operational procedures of the local fire department to optimize the receipt, processing and dissemination of operational information and orders. Accordingly, the fire code official must review and approve the arrangement of the fire command center prior to the installation of any of the controls and features required by Section 508.1.5. Consistent with Section 508.1.1, given the operational importance of the fire command center, the fire code official should work closely with the jurisdiction's fire chief to make sure that all operational needs are identified and met during the design stages.

**508.1.5 Storage.** Storage unrelated to operation of the *fire command center* shall be prohibited.

❖ Fire command centers are unique rooms in unique buildings and are strictly reserved for emergency management operations. As such, they must be neat and orderly at all times so as not to obstruct or limit access to all of the system controls they contain. This section supports that need by prohibiting the storage within a fire command center of anything not directly related to the function of fire command.

**508.1.6 Required features.** The *fire command center* shall comply with NFPA 72 and shall contain the following features:

1. The emergency voice/alarm communication system control unit.
2. The fire department communications system.
3. Fire detection and alarm system annunciator.
4. Annunciator unit visually indicating the location of the elevators and whether they are operational.
5. Status indicators and controls for air distribution systems.
6. The fire fighter's control panel required by Section 909.16 for smoke control systems installed in the building.
7. Controls for unlocking *stairway* doors simultaneously.
8. Sprinkler valve and water-flow detector display panels.
9. Emergency and standby power status indicators.
10. A telephone for fire department use with controlled access to the public telephone system.

11. Fire pump status indicators.
12. Schematic building plans indicating the typical floor plan and detailing the building core, *means of egress*, *fire protection systems*, fire-fighter air-replenishment systems, fire-fighting equipment and fire department access, and the location of *fire walls*, *fire barriers*, *fire partitions*, *smoke barriers* and smoke partitions.
13. An *approved* Building Information Card that includes, but is not limited to, all of the following information:
  - 13.1. General building information that includes: property name, address, the number of floors in the building above and below grade, use and occupancy classification (for mixed uses, identify the different types of occupancies on each floor) and the estimated building population during the day, night and weekend;
  - 13.2. Building emergency contact information that includes: a list of the building's emergency contacts including but not limited to building manager, building engineer and their respective work phone number, cell phone number and e-mail address;
  - 13.3. Building construction information that includes: the type of building construction including but not limited to floors, walls, columns and roof assembly;
  - 13.4. *Exit access stairway* and *exit stairway* information that includes: number of *exit access stairways* and *exit stairways* in building; each *exit access stairway* and *exit stairway* designation and floors served; location where each *exit access stairway* and *exit stairway* discharges, *interior exit stairways* that are pressurized; *exit stairways* provided with emergency lighting; each *exit stairway* that allows reentry; *exit stairways* providing roof access; elevator information that includes: number of elevator banks, elevator bank designation, elevator car numbers and respective floors that they serve; location of elevator machine rooms, control rooms and control spaces; location of sky lobby; and location of freight elevator banks;
  - 13.5. Building services and system information that includes: location of mechanical rooms, location of building management system, location and capacity of all fuel oil tanks, location of emergency generator and location of natural gas service;
  - 13.6. *Fire protection system* information that includes: location of standpipes, location of fire pump room, location of fire department connections, floors protected by automatic sprinklers and location of different types of *automatic sprinkler systems* installed including but not limited to dry, wet and pre-action;

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- 13.7. Hazardous material information that includes: location and quantity of hazardous material.
  14. Work table.
  15. Generator supervision devices, manual start and transfer features.
  16. Public address system, where specifically required by other sections of this code.
  17. Elevator fire recall switch in accordance with ASME A17.1.
  18. Elevator emergency or standby power selector switch(es), where emergency or standby power is provided.
- ❖ The fire command center must contain all equipment necessary to enable the incident commander to monitor or control fire protection and other building service systems as listed in this section (also see commentary, Section 909.16). This room houses fire protection, smoke control and building system controls, as well as a work space for emergency responders. The room also contains schematic plans and a work table so that responders have the basic layout and geometry of the building and can identify locations of utility controls, standby or emergency power systems, and where hazardous materials are stored or used. Providing concise information in a uniform format is essential to fire fighters and emergency responders and improves their ability to utilize building systems to their advantage. This was confirmed during the National Institute of Science and Technology (NIST) investigations of the World Trade Center attacks on September 11, 2001. The Final Report on the collapse of the World Trade Center contained 30 key recommendations compiled by NIST designed to address the building vulnerabilities learned in that tragedy. Three of those 30 recommendations embrace increasing situational awareness and emergency communications of first responders in large-scale emergencies. As a result of that investigation, this section includes an Item 13 that prescribes requirements for the Building Information Card (BIC).

The BIC is divided into multiple information areas and is intended to be formatted as a single form to provide a quick, concise source of information about the building. The code does not prescribe any particular format or layout for the BIC and does not have any limits on the level of information required to satisfy the requirements. It should be recognized that the intent of the BIC is to provide an easily understood and consistent tool to emergency responders who are taking control of systems in high-rise and smoke-protected assembly buildings. Jurisdictions should develop a policy to ensure that BICs are prepared in a standard, consistent format to avoid confusing the responders, and yet provide the minimum information required so they can correctly and efficiently utilize all of the building features. The number and types of features required by this section can create a large vol-

ume of data, thus reinforcing the need for an approved layout as required by Section 508.1.4.

## SECTION 509 FIRE PROTECTION AND UTILITY EQUIPMENT IDENTIFICATION AND ACCESS

**509.1 Identification.** Fire protection equipment shall be identified in an *approved* manner. Rooms containing controls for air-conditioning systems, sprinkler risers and valves, or other fire detection, suppression or control elements shall be identified for the use of the fire department. *Approved* signs required to identify fire protection equipment and equipment location shall be constructed of durable materials, permanently installed and readily visible.

❖ In an emergency, it is vitally important that the fire department and other emergency responders be able to quickly locate and access critical controls for fire protection systems. Obstructed or poorly marked equipment can cause delays in fire-fighting operations while fire fighters locate other hose stations and stretch additional hose, for example. Valves and other controls are often located in rooms or other enclosures. Their location must be clearly identified with written or pictographic signs, which must be clearly visible and legible. Signs using the NFPA 170 symbols for fire protection equipment can provide standardized markings throughout a jurisdiction. White reflective symbols on a red reflective background are effective. For exterior signs, heavy-gage, sign-grade aluminum is recommended. Interior signs may be constructed of plastic, light-gage aluminum or other approved, durable, water-resistant material. As a general rule, fire protection piping, cabinets, enclosures, wiring, equipment and accessories are red or are identified by red or red/white markings. The manner of identification is subject to the approval of the fire code official.

**509.1.1 Utility identification.** Where required by the *fire code official*, gas shutoff valves, electric meters, service switches and other utility equipment shall be clearly and legibly marked to identify the unit or space that it serves. Identification shall be made in an *approved* manner, readily visible and shall be maintained.

❖ This section provides the fire code official with the authority to require utility identification for services serving multiunit/multibuilding properties, including facilities, campuses, strip malls, business parks, residential properties and similar locations where identification of utilities is considered essential to emergency responders. Note that this section does not prescribe any particular design requirements for utility identification markings. It should be recognized that the intent of the markings is to provide an easily understood and consistent tool to emergency responders who must secure utilities during emergency operations. Jurisdictions should develop a policy to ensure that utility identification markings are prepared in a standard, consistent format to avoid

confusing the responders, and yet provide the minimum information required so they can correctly and efficiently utilize them.

**509.2 Equipment access.** *Approved* access shall be provided and maintained for all fire protection equipment to permit immediate safe operation and maintenance of such equipment. Storage, trash and other materials or objects shall not be placed or kept in such a manner that would prevent such equipment from being readily accessible.

- ❖ This section requires immediate access to and working space around all fire suppression, protection, and detection system devices and control elements necessary for fire department use. It further prohibits obstruction of such equipment by materials or objects that may prevent such equipment from being immediately accessed by emergency responders.

## SECTION 510 EMERGENCY RESPONDER RADIO COVERAGE

**510.1 Emergency responder radio coverage in new buildings.** All new buildings shall have *approved* radio coverage for emergency responders within the building based upon the existing coverage levels of the public safety communication systems of the jurisdiction at the exterior of the building. This section shall not require improvement of the existing public safety communication systems.

### Exceptions:

1. Where *approved* by the building official and the *fire code official*, a wired communication system in accordance with Section 907.2.13.2 shall be permitted to be installed or maintained instead of an *approved* radio coverage system.
  2. Where it is determined by the *fire code official* that the radio coverage system is not needed.
  3. In facilities where emergency responder radio coverage is required and such systems, components or equipment required could have a negative impact on the normal operations of that facility, the *fire code official* shall have the authority to accept an automatically activated emergency responder radio coverage system.
- ❖ The provisions of Section 510 are concerned with the reliability of portable radios used by emergency responders inside buildings. This is in keeping with the philosophy inherent in the I-Codes that, when a facility grows too large or complex for effective fire response, fire protection features must be provided within the building. While modeling and other techniques may provide a good prediction as to whether a building will interfere with radio communications, the reality is that it is unknown if a building will need to install any type of radio system enhancements until after the building is constructed. Determining factors may include construction type, shadows of other buildings, size of the structure, etc. Though this section does not offer specific types of buildings that

should be targeted, discussions with public safety radio professionals found that, based on current radio technologies, these requirements should be applied in any building with one or more basements or below-grade building levels, underground buildings or buildings more than five stories in height.

Emergency responders use portable radios to communicate with other emergency responders, the incident commander and the public safety communications center. Building construction features and materials can absorb or block the radio frequency energy used to carry the signals inside or outside the building. Blockage or absorption of the radio frequency signal can prevent a critical message from an emergency responder from being received and acknowledged. Depending on the incident, this loss of information can place other emergency responders in greater danger, or may prevent an injured or disoriented emergency responder from communicating for assistance. The requirements apply to analog or digital radio systems and are applicable to all buildings.

This section requires that all buildings have approved radio coverage for emergency responders within the building. Approved radio coverage is based on the ability of the existing public safety communications system to transmit a signal inside and outside the building.

Where testing using the existing public safety communications system finds that the signal strengths are not satisfactory, Exception 1 allows for the alternative installation of a wired communication system in accordance with Section 907.2.13.2, which requires that such a system be designed in accordance with NFPA 72. When applying this exception, the concurrent approval of fire and building code officials is required.

Where testing using the existing public safety communications system finds that the signal strengths are satisfactory, Exception 2 allows the fire code official to waive the requirements when it is determined that emergency responder radio coverage is not needed. This exception does not give any criteria as to buildings that can be exempted. However, discussions with public safety radio professionals found that, based on current radio technologies, most wood frame or mixed construction Group R-1 and R-2 occupancies, single-family dwellings, townhomes and buildings with an area less than 50,000 square feet (4645 m<sup>2</sup>) without basements, should engender little concern for loss of radio signal strength inside the building or an inability to transmit to an outdoor receiver.

Exception 3 provides a means for the fire code official to allow the installation of a manual or automatic switch that turns on the emergency responder radio coverage system (ERRCS) when it is needed. These systems allow emergency responders to operate their radios inside telephone central offices (COs) or similar occupancies without disrupting telephone network

operations, including calls for service to a jurisdiction's public safety answering point via 9-1-1. Exception 3 also recognizes that operating public safety radio systems in certain buildings with electronic equipment sensitive to radio frequency (RF) energy can cause damage to the equipment, or worse, impact the operations of a local or regional computer network. One such occupancy is a telephone CO, which is where landline and cellular telephone signals are received and dispatched to the recipient caller. It is not uncommon for a telephone CO to be capable of receiving and processing over  $\frac{1}{4}$  million telephone calls within a 1-minute period. Telephone COs serve an important public safety function because they process emergency or information calls routed via 9-1-1 to a jurisdiction's public safety answering point.

Exception 3 was written to address testing sponsored by the major telecommunications companies and performed at Underwriters Laboratories (UL). The purpose of the tests was to determine the impact of operating handheld radios within a telephone CO. Telephone COs contain an array of digital and analog equipment that receives and routes telephone calls. Some of the equipment, such as digital switches that receive and route calls over landline and cellular circuits, is sensitive to the RF energy generated by handheld radios. Testing by UL confirmed that portable radios programmed to operate in many of the public safety frequency ranges can cause severe service interruptions to equipment in telephone COs. The level of impact to the telephone CO equipment is dependent on the radio's wattage and its sphere of radiation at the antenna. Conversely, the impact of the telephone CO equipment and radio operation inside the building is also dependent on whether the equipment is electrically shielded or unshielded from stray RF energy.

**510.2 Emergency responder radio coverage in existing buildings.** Existing buildings shall be provided with *approved* radio coverage for emergency responders as required in Chapter 11.

❖ See the commentary to Section 1103.2.

**510.3 Permit required.** A construction permit for the installation of or modification to emergency responder radio coverage systems and related equipment is required as specified in Section 105.7.5. Maintenance performed in accordance with this code is not considered a modification and does not require a permit.

❖ A construction permit must be obtained in accordance with Section 105.7.5 prior to the installation of the ERRCS system and for any modification or alteration to the system to ensure that the work is done correctly and any parts replacement will be compatible with the existing system components. Note that normal maintenance required for the system would not require a permit.

**510.4 Technical requirements.** Systems, components and equipment required to provide the emergency responder radio

coverage system shall comply with Sections 510.4.1 through 510.4.2.5.

❖ This section simply introduces Sections 510.4.1 through 510.4.2.5, which are the technical requirements for the ERRCS.

**510.4.1 Radio signal strength.** The building shall be considered to have acceptable emergency responder radio coverage when signal strength measurements in 95 percent of all areas on each floor of the building meet the signal strength requirements in Sections 510.4.1.1 and 510.4.1.2.

❖ This section introduces the minimum acceptable signal criteria that must be achieved and maintained throughout 95 percent of all areas on each floor of a building, as indicated in Sections 510.4.1.1 and 510.4.1.2.

**510.4.1.1 Minimum signal strength into the building.** A minimum signal strength of -95 dBm shall be receivable within the building.

❖ This section requires that a minimum signal strength of -95 dBm be received by radios inside the building. The "dBm" abbreviation represents a measured power level stated in decibels relative to 1 milliwatt (mW) and indicates the strength of the signal as compared to 1 mW.

**510.4.1.2 Minimum signal strength out of the building.** A minimum signal strength of -95 dBm shall be received by the agency's radio system when transmitted from within the building.

❖ This section requires that a minimum signal strength of -100 dBm to the outside of the building be receivable by the local public safety communications system. The "dBm" abbreviation represents a measured power level stated in decibels relative to 1 milliwatt (mW) and indicates the strength of the signal as compared to 1mW.

**510.4.2 System design.** The emergency responder radio coverage system shall be designed in accordance with Sections 510.4.2.1 through 510.4.2.5.

❖ This section simply introduces Sections 510.4.2.1 through 510.4.2.5 as the system design criteria for the ERRCS.

**510.4.2.1 Amplification systems allowed.** Buildings and structures that cannot support the required level of radio coverage shall be equipped with a radiating cable system, a distributed antenna system with Federal Communications Commission (FCC)-certified signal boosters, or other system approved by the *fire code official* in order to achieve the required adequate radio coverage.

❖ There are several methods to provide the amplification needed by fire departments in structures identified as needing ERRCS. Any of the indicated methods is acceptable. The code allows for new technologies that will provide the required radio coverage if approved by the fire code official.

**510.4.2.2 Technical criteria.** The *fire code official* shall maintain a document providing the specific technical infor-

mation and requirements for the emergency responder radio coverage system. This document shall contain, but not be limited to, the various frequencies required, the location of radio sites, effective radiated power of radio sites, and other supporting technical information.

❖ In order to effectively install such systems, the fire code official must provide basic information such as the frequency range to be supported. For example, a fire department may provide a requirement such as “the frequency range which must be supported shall be 806 MHz to 824 MHz and 851 MHz TO 869 MHz.” The fire code official will likely need to provide a reference to the local communications center or provide details on radio sites in the jurisdiction.

**510.4.2.3 Standby power.** Emergency responder radio coverage systems shall be provided with standby power in accordance with Section 604. The standby power supply shall be capable of operating the emergency responder radio coverage system for a duration of not less than 24 hours.

❖ This section requires secondary power to operate the equipment in the case where the primary building power must be shutdown or is lost. The secondary power source, traditionally an engine-driven emergency generator or a backup battery system, must be capable of operating the in-building radio amplification system for a minimum 24-hour duration, which is significantly more than that of most life safety systems in the structure. The 24-hour value was selected to ensure the reliability of the signal boosters during long-term emergency operations such as response to natural disasters where utility-supplied electrical power is disabled. See also Section 604 of the code for secondary power system specifics and standards.

**510.4.2.4 Signal booster requirements.** If used, signal boosters shall meet the following requirements:

1. All signal booster components shall be contained in a National Electrical Manufacturer’s Association (NEMA) 4-type waterproof cabinet.
  2. Battery systems used for the emergency power source shall be contained in a NEMA 4-type waterproof cabinet.
  3. The signal booster system and battery system shall be electrically supervised and monitored by a supervisory service, or when *approved by the fire code official*, shall sound an audible signal at a constantly attended location
  4. Equipment shall have FCC certification prior to installation.
- ❖ If a building is equipped with a signal booster, this section requires that the amplifiers and the standby power source be located in a National Electrical Manufacturers Association (NEMA) Type 4 waterproof cabinet. A NEMA 4 cabinet is designed to protect personnel having incidental contact with the equipment and to protect the equipment from falling dirt, rain,

snow and windblown dust, and both splashing and hose-directed water. This section also requires that a malfunction of the signal booster or its standby power source transmit a trouble signal to an approved central or proprietary station. The code official is authorized to allow the trouble signal to be transmitted to a constantly attended location. The system is also required to be certified by the Federal Communication Commission (FCC) prior to installation.

**510.4.2.5 Additional frequencies and change of frequencies.** The emergency responder radio coverage system shall be capable of modification or expansion in the event frequency changes are required by the FCC or additional frequencies are made available by the FCC.

❖ Because of potential changes in public safety radio frequency bands, the code requires the capability for changing the frequency in the future.

**510.5 Installation requirements.** The installation of the public safety radio coverage system shall be in accordance with Sections 510.5.1 through 510.5.4.

❖ This section simply introduces the installation requirement sections of the appendix.

**510.5.1 Approval prior to installation.** Amplification systems capable of operating on frequencies licensed to any public safety agency by the FCC shall not be installed without prior coordination and approval of the *fire code official*.

❖ The installation of ERRCS in a building is similar to other building features where review of the plans and installation is required and covered under a permit. Part of the approval process for amplification systems operating on frequencies licensed to a public safety agency requires approval of the local fire code official.

**510.5.2 Minimum qualifications of personnel.** The minimum qualifications of the system designer and lead installation personnel shall include both of the following:

1. A valid FCC-issued general radio operators license.
2. Certification of in-building system training issued by a nationally recognized organization, school or a certificate issued by the manufacturer of the equipment being installed.

These qualifications shall not be required where demonstration of adequate skills and experience satisfactory to the *fire code official* is provided.

❖ This section is to ensure that a qualified person designs and installs the ERRCS in the building. The qualification may be from a school program in communications or a manufacturer’s training program. This section also allows the jurisdiction to accept a person or business upon adequate demonstration of skills and experience to the fire code official.

**510.5.3 Acceptance test procedure.** Where an emergency responder radio coverage system is required, and upon completion of installation, the building *owner* shall have the radio

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system tested to verify that two-way coverage on each floor of the building is not less than 90 percent. The test procedure shall be conducted as follows:

1. Each floor of the building shall be divided into a grid of 20 approximately equal test areas.
  2. The test shall be conducted using a calibrated portable radio of the latest brand and model used by the agency talking through the agency's radio communications system.
  3. Failure of not more than two nonadjacent test areas shall not result in failure of the test.
  4. In the event that three of the test areas fail the test, in order to be more statistically accurate, the floor shall be permitted to be divided into 40 equal test areas. Failure of not more than four nonadjacent test areas shall not result in failure of the test. If the system fails the 40-area test, the system shall be altered to meet the 90-percent coverage requirement.
  5. A test location approximately in the center of each test area shall be selected for the test, with the radio enabled to verify two-way communications to and from the outside of the building through the public agency's radio communications system. Once the test location has been selected, that location shall represent the entire test area. Failure in the selected test location shall be considered failure of that test area. Additional test locations shall not be permitted.
  6. The gain values of all amplifiers shall be measured and the test measurement results shall be kept on file with the building *owner* so that the measurements can be verified during annual tests. In the event that the measurement results become lost, the building *owner* shall be required to rerun the acceptance test to reestablish the gain values.
  7. As part of the installation a spectrum analyzer or other suitable test equipment shall be utilized to ensure spurious oscillations are not being generated by the subject signal booster. This test shall be conducted at the time of installation and subsequent annual inspections.
- ❖ This section provides a testing procedure to be followed upon completion of system installation and prior to acceptance of the system by the jurisdiction. The building owner or agent is responsible to see that the ERRCS is functioning properly prior to the building being occupied. Note that if there are problems as a result of the testing, the test area is to be altered to provide more specific data on the strength of the signal-boosting capability of the system. Testing results are to be kept on file by the building owner for annual testing verification. If the testing results are lost, a retest of the building shall be required to determine compliance levels.

**510.5.4 FCC compliance.** The emergency responder radio coverage system installation and components shall also com-

ply with all applicable federal regulations including, but not limited to, FCC 47 CFR Part 90.219.

- ❖ As with all radio systems, the ERRCS and its components must comply with all applicable FCC regulations.

**510.6 Maintenance.** The emergency responder radio coverage system shall be maintained operational at all times in accordance with Sections 510.6.1 through 510.6.3.

- ❖ This section simply introduces the installation requirements for the ERRCS.

**510.6.1 Testing and proof of compliance.** The emergency responder radio coverage system shall be inspected and tested annually or where structural changes occur including additions or remodels that could materially change the original field performance tests. Testing shall consist of the following:

1. In-building coverage test as described in Section 510.5.3.
2. Signal boosters shall be tested to verify that the gain is the same as it was upon initial installation and acceptance.
3. Backup batteries and power supplies shall be tested under load of a period of 1 hour to verify that they will properly operate during an actual power outage. If within the 1-hour test period the battery exhibits symptoms of failure, the test shall be extended for additional 1-hour periods until the integrity of the battery can be determined.
4. Other active components shall be checked to verify operation within the manufacturer's specifications.
5. At the conclusion of the testing, a report, which shall verify compliance with Section 510.5.3, shall be submitted to the *fire code official*.

- ❖ The testing of the signal boosters is to verify that the gain is equal to that produced during the initial acceptance, functional tests of the secondary power supply, and an inspection of any other components connected to the in-building amplification system. The inspection report must be submitted to the fire code official and requires documentation that the amplification system complies with the requirements in Section 510.5.3. This section authorizes the fire code official to require additional tests when structural changes or modifications occur that could materially change the performance of the signal boosting system.

**510.6.2 Additional frequencies.** The building *owner* shall modify or expand the emergency responder radio coverage system at his or her expense in the event frequency changes are required by the FCC or additional frequencies are made available by the FCC. Prior approval of a public safety radio coverage system on previous frequencies does not exempt this section.

- ❖ When additional frequencies are needed to change or expand the coverage of the ERRCS, the building

owner is the responsible person to ensure that the work is performed. Previous approvals of the system do not apply when changes are needed. Changes to the system are not exempt because of prior approval. If the change is needed, the work must be done.

**510.6.3 Field testing.** Agency personnel shall have the right to enter onto the property at any reasonable time to conduct field testing to verify the required level of radio coverage.

- ❖ Like all systems, ERRCS need to be tested to verify their continued sufficiency. Whether the test is an annual review of the system or an in-service familiarization test by an engine, truck or squad company, this section provides the ability of the personnel to enter the building at reasonable hours to test and operate the system. As with any inspection, the right of entry for testing the system is limited by constitutional constraints. See the commentary to Section 104.3 for further discussion on the right of entry.

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The following resource materials were used in the preparation of the commentary for this chapter of the code:

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# Chapter 6: Building Services and Systems

## General Comments

This chapter focuses on building systems and services as they relate to potential safety hazards and when and how they should be installed. In some cases, many of the provisions are located in other portions of the code. This chapter brings together all building system- and service-related issues for convenience and provides a more systematic view of buildings. The following building services and systems are addressed:

- Fuel-fired appliances (Section 603).
- Emergency and standby power systems (Section 604).
- Electrical equipment, wiring and hazards, including solar photovoltaic power systems (Section 605).
- Mechanical refrigeration (Section 606).
- Elevator recall and maintenance (Section 607).
- Stationary storage battery systems (Section 608).
- Commercial kitchen hoods (Section 609).
- Commercial kitchen cooking oil storage tank systems (Section 610).
- Hyperbaric facilities (Section 611).

Some of the sections specifically deal with installation while others deal with reducing the hazards from the use of the services or systems. For example, Section 605 notes that using too many extension cords on the building electrical system may present a fire hazard. On the other hand, the discussion of elevator recall and maintenance in Section 607 simply states when and how recall is required.

## Purpose

As technology progresses and societal expectations increase, building systems and services become more complex and numerous. The use of computers has resulted in a more frequent use of uninterruptible power supplies and emergency power, which are often powered through the use of lead-acid battery systems. In the past, these provisions were simply scattered throughout the code. These various building services and system requirements have been brought together in this chapter to simplify the code requirements and increase the likelihood that these elements are properly addressed.

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## SECTION 601 GENERAL

**601.1 Scope.** The provisions of this chapter shall apply to the installation, operation and maintenance of fuel-fired appliances and heating systems, emergency and standby power systems, electrical systems and equipment, mechanical refrigeration systems, elevator recall, stationary storage battery systems and commercial kitchen equipment.

❖ This section establishes the applicability of the chapter to a variety of building systems and services when they are being installed, during their operation and for long-term maintenance.

**601.2 Permits.** Permits shall be obtained for refrigeration systems, battery systems and solar photovoltaic power systems as set forth in Sections 105.6 and 105.7.

❖ Only three systems discussed in Chapter 6 require permits: the operation of refrigeration systems, the installation of storage battery systems and the installation of solar photovoltaic power systems. The permit for operation of refrigeration systems is intended to warn emergency responders that a potential haz-

ard exists. This information will better equip them to respond to such a call. The permit for installation of a storage battery system or a solar photovoltaic power system ensures the proper safety requirements and features are installed (see commentary, Section 105).

## SECTION 602 DEFINITIONS

**602.1 Definitions.** The following terms are defined in Chapter 2:

**BATTERY SYSTEM, STATIONARY LEAD-ACID.**

**BATTERY TYPES.**

**COMMERCIAL COOKING APPLIANCES.**

**CRITICAL CIRCUIT.**

**EMERGENCY POWER SYSTEM.**

**HOOD.**

**Type I.**

**Type II.**

**REFRIGERANT.****REFRIGERATION SYSTEM.****STANDBY POWER SYSTEM.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2, in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

### **SECTION 603 FUEL-FIRED APPLIANCES**

**603.1 Installation.** The installation of nonportable fuel gas appliances and systems shall comply with the *International Fuel Gas Code*. The installation of all other fuel-fired appliances, other than internal combustion engines, oil lamps and portable devices such as blow torches, melting pots and weed burners, shall comply with this section and the *International Mechanical Code*.

❖ The code regulates the installation of portable gas-fired appliances and portable appliances fueled by methods other than gaseous fuels. The *International Mechanical Code*<sup>®</sup> (IMC<sup>®</sup>) and the *International Fuel Gas Code*<sup>®</sup> (IFGC<sup>®</sup>) do not cover portable appliances. The code also has provisions that apply to appliances that are not portable and use fuels other than gas.

**603.1.1 Manufacturer's instructions.** The installation shall be made in accordance with the manufacturer's instructions and applicable federal, state and local rules and regulations. Where it becomes necessary to change, modify or alter a manufacturer's instructions in any way, written approval shall first be obtained from the manufacturer.

❖ Compliance with the appliance manufacturer's installation instructions is a fundamental requirement of all I-Codes and those instructions are an enforceable extension of the code. Federal, state, county or municipal laws might supercede part of the installation instructions or could be applied in addition to the requirements in the instructions.

**603.1.2 Approval.** The design, construction and installation of fuel-fired appliances shall be in accordance with the *International Fuel Gas Code* and the *International Mechanical Code*.

❖ The code relies on the IMC and the IFGC for the coverage of appliance installations and contains only a limited number of requirements that apply in addition to those of the IMC and IFGC.

**603.1.3 Electrical wiring and equipment.** Electrical wiring and equipment used in connection with oil-burning equip-

ment shall be installed and maintained in accordance with Section 605 and NFPA 70.

❖ Section 605 contains provisions intended to mitigate fire hazards and shock hazards associated with the use of existing appliances. NFPA 70 covers the installation of electrical appliances.

**603.1.4 Fuel oil.** The grade of fuel oil used in a burner shall be that for which the burner is *approved* and as stipulated by the burner manufacturer. Oil containing gasoline shall not be used. Waste crankcase oil shall be an acceptable fuel in Group F, M and S occupancies where utilized in equipment *listed* for use with waste oil and where such equipment is installed in accordance with the manufacturer's instructions and the terms of its listing.

❖ Different grades of fuel oil have different viscosities and chemical makeup. A burner and fuel mismatch could result in poor combustion, sooting and burner component failure. Oil burners are not designed to burn oil contaminated with chemicals of higher volatility. Appliances that consume used engine oil are allowed only in occupancies of low-occupant density (those without sleeping rooms) and where such appliances will likely be monitored and maintained by facility personnel. Used engine oil appliances use a specialized type of atomizing oil burner designed to burn dirty waste oil collected from internal combustion engine maintenance operations.

**603.1.5 Access.** The installation shall be readily accessible for cleaning hot surfaces; removing burners; replacing motors, controls, air filters, chimney connectors, draft regulators and other working parts; and for adjusting, cleaning and lubricating parts.

❖ The IMC and the IFGC require access for the initial installation as well as for the life of the appliance. Safe operation depends on observation and maintenance, which depend on adequate access to the appliances. In order for the installation to be considered readily accessible, personnel should be able to reach it without having to remove building elements or obstacles of any kind, or use climbing aids.

**603.1.6 Testing, diagrams and instructions.** After installation of the oil-burning equipment, operation and combustion performance tests shall be conducted to determine that the burner is in proper operating condition and that all accessory equipment, controls, and safety devices function properly.

❖ Testing of an appliance after installation is also required by the IMC and the appliance manufacturer's installation instructions.

**603.1.6.1 Diagrams.** Contractors installing industrial oil-burning systems shall furnish not less than two copies of diagrams showing the main oil lines and controlling valves, one copy of which shall be posted at the oil-burning equipment

and another at an *approved* location that will be accessible in case of emergency.

- ❖ For large systems, the piping and control valve layout may be complicated and extensive. In the event of an emergency, facility personnel or fire fighters might need access to control valves to protect piping and to limit the fire hazard.

**603.1.6.2 Instructions.** After completing the installation, the installer shall instruct the *owner* or operator in the proper operation of the equipment. The installer shall furnish the *owner* or operator with the name and telephone number of persons to contact for technical information or assistance and routine or emergency services.

- ❖ Appliances are more likely to be properly (safely) operated and maintained if the owner or operator is instructed in the operation of the equipment and given the necessary means to obtain technical and emergency services.

**603.1.7 Clearances.** Working clearances between oil-fired appliances and electrical panelboards and equipment shall be in accordance with NFPA 70. Clearances between oil-fired equipment and oil supply tanks shall be in accordance with NFPA 31.

- ❖ NFPA 70 requires working clearances around electrical equipment for protection of personnel. NFPA 31 requires clearances between appliances and oil-supply tanks to protect the oil tank from excessive heat and to lessen the fire hazard from any oil leakage.

**603.2 Chimneys.** Masonry chimneys shall be constructed in accordance with the *International Building Code*. Factory-built chimneys shall be installed in accordance with the *International Mechanical Code*. Metal chimneys shall be constructed and installed in accordance with NFPA 211.

- ❖ The *International Building Code*<sup>®</sup> (IBC<sup>®</sup>) regulates masonry chimney construction in Chapter 21. Factory-built chimneys are regulated by Section 805 of the IMC. Metal chimneys are distinct from factory-built chimneys, are industrial occupancy related (e.g., smokestacks) and are regulated by NFPA 211 (see IMC commentary, Section 806.1).

**603.3 Fuel oil storage systems.** Fuel oil storage systems shall be installed in accordance with this code. Fuel-oil piping systems shall be installed in accordance with the *International Mechanical Code*.

- ❖ The code regulates the storage of fuel oil. The IMC regulates installation of the fuel oil distribution piping system.

**603.3.1 Fuel oil storage in outside, above-ground tanks.** Where connected to a fuel-oil piping system, the maximum amount of fuel oil storage allowed outside above ground without additional protection shall be 660 gallons (2498 L). The storage of fuel oil above ground in quantities exceeding 660 gallons (2498 L) shall comply with NFPA 31.

- ❖ To limit the potential fire hazard resulting from oil spillage, the code sets a quantity limitation on unpro-

TECTED storage. NFPA 31 requires protection, such as spill containment, for storage in excess of 660 gallons (2498 L). The storage of 660 gallons (2498 L) is allowed to be in any configuration of containers that does not exceed a total of 660 gallons (2498 L).

**603.3.2 Fuel oil storage inside buildings.** Fuel oil storage inside buildings shall comply with Sections 603.3.2.1 through 603.3.2.5 or Chapter 57.

- ❖ This section introduces Sections 603.3.2.1 through 603.3.2.5, which contain requirements for controlling the hazards associated with the storage of fuel oil inside of buildings. Fuel oil is defined in the IMC as “Kerosene or any hydrocarbon oil having a flash point not less than 100°F (38°C).” This would include Number 2 diesel fuel, which is classified as either a Class II or IIIA combustible liquid, depending on the refiner and the region where the fuel will be used. Number 2 diesel fuel is commonly used as a fuel source for diesel-driven electric generators.

The indicated sections have been revised to allow larger amounts of fuel oil in storage inside of buildings in response to increased fuel oil storage requirements for switch and data centers and similar telecommunications facilities. Such facilities are constructed to house large numbers of computers to serve as remote data centers for the protection of computer data or data switches for internet providers. To increase the likelihood that the data is always available, design professionals place a great deal of emphasis on the building’s electrical power supply. These types of uses consume large amounts of electrical power. Accordingly, large generators are installed to ensure that service is not disrupted. These generators have fairly demanding fuel requirements. Consider, for example, that a single 2-megawatt (2 million watt) generator can have a fuel consumption rate of 3-4 gallons/minute under full electrical load conditions. As a result, these facilities require a large volume of fuel. The fuel storage is commonly located inside of a building because many of these facilities are located in commercial or other densely populated areas of a community.

**603.3.2.1 Quantity limits.** One or more fuel oil storage tanks containing Class II or III *combustible liquid* shall be permitted in a building. The aggregate capacity of all such tanks shall not exceed 660 gallons (2498 L).

**Exception:** The aggregate capacity limit shall be permitted to be increased to 3,000 gallons (11 356 L) of Class II or III liquid for storage in protected above-ground tanks complying with Section 5704.2.9.7, where all of the following conditions are met:

1. The entire 3,000-gallon (11 356 L) quantity shall be stored in protected above-ground tanks.
2. The 3,000-gallon (11 356 L) capacity shall be permitted to be stored in a single tank or multiple smaller tanks.

3. The tanks shall be located in a room protected by an *automatic sprinkler system* complying with Section 903.3.1.1.

❖ This section correlates with Table 5003.1.1(1), Note i and Section 5701.2, Item 4, of the code and Table 307.1(1), Note i, of the IBC. Further, this section contains a specific exception to the maximum special quantity of 660-gallon (2498 L) inside storage of combustible liquids, where connected to a closed fuel oil piping system. This would apply to most oil-fired stationary equipment in industrial, commercial and residential occupancies. Note that this provision applies only to the aggregate storage of fuel oil and does not include the capacity of the piping system.

Where the need for an aggregate indoor storage quantity of fuel oil connected to a closed fuel oil piping system exceeds the special amount of 660 gallons (2498 L), the exception may be applied. The exception allows an almost five-fold increase in the quantity of fuel oil stored by recognizing the increased level of safety provided by protected above-ground tanks listed in accordance with UL 2085. These tanks have extensive regulations in Chapter 57, and the listing requirements further document their safety. Included in the design requirements for these tanks are the ability to survive a 2-hour pool fire test conducted in accordance with the UL 1709 fire exposure protocol; a limitation that all penetrations must be made through the top of the tank (to avoid the risk of a gravity-fed leak that might be associated with a connection below liquid level); and that piping connected to the tank must be provided with anti-siphon controls where needed to prevent a siphon risk, among others. The safety level, which allows increased storage, is further enhanced by requiring the room in which the tank is installed to be equipped with an automatic sprinkler system. See the commentary to the Section 202 definition of “Tank, protected above ground” and Section 5704.2.9.7.

**603.3.2.2 Restricted use and connection.** Tanks installed in accordance with Section 603.3.2 shall be used only to supply fuel oil to fuel-burning or generator equipment installed in accordance with Section 603.3.2.4. Connections between tanks and equipment supplied by such tanks shall be made using closed piping systems.

❖ This section makes it clear that the fuel oil storage quantity limits in Section 603.3.2 are applicable only to fuel oil supplies for oil-burning equipment and generators and then only when connected to a fuel oil piping system supplying such equipment. Fuel oil piping systems are regulated by Chapter 13 of the IMC.

**603.3.2.3 Applicability of maximum allowable quantity and control area requirements.** The quantity of *combustible liquid* stored in tanks complying with Section 603.3.2 shall

not be counted towards the maximum allowable quantity set forth in Table 5003.1.1(1), and such tanks shall not be required to be located in a *control area*.

❖ This section clearly states that the fuel oil quantity in Section 603.3.2 is a “special quantity” that is outside the scope of the maximum allowable quantity per control area (MAQ) provisions of Chapter 50, including any requirement to install the tank in a control area in accordance with Section 5003.8.3. Table 5003.1.1(1), Note i, is also correlated with these provisions and indicates that the MAQ provisions of the table do not apply to fuel oil storage complying with Section 603.3.2.

The origins of the “special quantity” were in an ad-hoc hazardous materials committee constituted by one of the legacy model code groups. As the committee developed updated regulations pertaining to flammable and combustible liquids, it concluded that a closed fuel oil storage and piping system feeding oil-fired building service equipment should not be penalized for providing sufficient fuel oil on-site for long-term operation of such systems. Accordingly, the ad-hoc committee, using NFPA 31 as a guide, created the original provisions of Section 603.3 and its subsections to provide that relief.

**603.3.2.4 Installation.** Tanks and piping systems shall be installed and separated from other uses in accordance with Section 915 and Chapter 13, both of the *International Mechanical Code*, as applicable.

**Exception:** Protected above-ground tanks complying with Section 5704.2.9.7 shall not be required to be separated from surrounding areas.

❖ Section 915 of the IMC addresses liquid-fueled internal combustion engines and turbines and permanently installed equipment and appliances powered by internal combustion engines and turbines. Engine-driven electrical generators for private use are becoming more popular, as are engine-driven cooling appliances and heat pumps. Such equipment is also used to power fire pumps, generators, water pumps, refrigeration machines and other stationary equipment. Section 915 of the IMC also references NFPA 37, which addresses the fire safety of this kind of equipment including requirements for enclosures, controls, fuel supplies, exhaust systems, cooling systems and combustion air.

Chapter 13 of the IMC complements the code’s fuel oil storage provisions and regulates the design and installation of fuel oil piping systems. The regulations reference construction standards for above-ground and underground storage tanks, material standards for piping systems (both above ground and underground) and extensive requirements for the proper assembly of system piping and components.

The exception here, as in Section 603.3.2.1, recog-

nizes the increased safety provided by protected above-ground tanks. See the commentary to Section 603.3.2.1 for a discussion of those tanks and their enhanced safety.

**603.3.2.5 Tanks in basements.** Tanks in *basements* shall be located not more than two stories below grade plane.

- ❖ This section prohibits tank installations more than two stories below grade because the further an incident is below grade, the greater challenge for the fire department to mitigate it. This is consistent with the control area approach in Table 5003.8.3.2, which also limits control areas to two levels below grade.

**603.3.3 Underground storage of fuel oil.** The storage of fuel oil in underground storage tanks shall comply with NFPA 31.

- ❖ Section 603.3 does not require that fuel oil tanks be installed underground; however, there may be circumstances under which such an installation is either desirable or advisable. The code user is directed to NFPA 31 for specific requirements applicable to the installation of underground combustible liquid storage tanks.

**603.4 Portable unvented heaters.** Portable unvented fuel-fired heating equipment shall be prohibited in occupancies in Groups A, E, I, R-1, R-2, R-3 and R-4.

**Exceptions:**

1. *Listed* and *approved* unvented fuel-fired heaters, including portable outdoor gas-fired heating appliances, in one- and two-family *dwelling*s.
  2. Portable outdoor gas-fired heating appliances shall be allowed in accordance with Section 603.4.2.
- ❖ Portable unvented fuel-fired heating equipment refers to portable space heaters, such as LP-gas fired or kerosene-fueled appliances. This section would also apply to movable gas-fired appliances that connect to gas convenience outlets with gas hose connectors. This section does not apply to permanently installed appliances. Portable space-heating appliances are moved around at will by the occupants and might be placed too close to combustibles or where they are susceptible to being hit, tipped over, etc. Because of potential misuse, such appliances are considered an unacceptable risk in the listed, higher life hazard occupancies. Exception 1 is based on the assumption that, in one- and two-family dwellings, the occupants will take greater care in the use of such appliances. Exception 2 is based on the provisions of Section 603.4.2 and its subsections, which provide strict regulation of portable outdoor gas-fired heating appliances in all occupancies.

**603.4.1 Prohibited locations.** Unvented fuel-fired heating equipment shall not be located in, or obtain combustion air from, any of the following rooms or spaces: sleeping rooms, bathrooms, toilet rooms or storage closets.

- ❖ The intent of this section is to prevent fuel-fired appliances from being installed in rooms and spaces where the combustion process could pose a threat to

occupants. Potential threats include depleted oxygen levels; elevated levels of carbon dioxide, nitrous oxides, carbon monoxide, and other combustion gases; ignition of combustibles; and elevated levels of flammable gases.

In small rooms, such as bedrooms and bathrooms, the doors are typically closed when the room is occupied, which could allow combustion gases to build up to life-threatening levels. In bedrooms, sleeping occupants would not be alert to or aware of impending danger. This section is parallel in its intent with Section 303.3 of both the IMC and the IFGC. Note that, as a subsection of Section 603.4, this section is addressing portable appliances in Groups A, E, I and R (see also IFGC commentary, Section 303.3).

**603.4.2 Portable outdoor gas-fired heating appliances.**

Portable gas-fired heating appliances located outdoors shall be in accordance with Sections 603.4.2.1 through 603.4.2.3.4.

- ❖ This section introduces Sections 603.4.2.1 through 603.4.2.3.4, which contain requirements for controlling the hazards associated with portable gas-fired heating appliances located outdoors. In many jurisdictions, LP-gas-fired portable heaters, also called patio heaters, are being utilized in outdoor areas of restaurants, sidewalk cafes, hotel dining areas, outdoor smoking areas and retail sites in increasing numbers. These heaters are also readily available to consumers at local home and building supply locations. These sections provide regulations to allow for the conditional use of outdoor patio heaters and establishes general safety requirements for the storage and use of such heaters (see Commentary Figure 603.4.2).

**603.4.2.1 Location.** Portable outdoor gas-fired heating appliances shall be located in accordance with Sections 603.4.2.1.1 through 603.4.2.1.4.

- ❖ This section introduces Sections 603.4.2.1.1 through 603.4.2.1.4, which contain requirements for controlling the location hazards associated with portable outdoor gas-fired heating appliances, sometimes called “patio heaters.”

**603.4.2.1.1 Prohibited locations.** The storage or use of portable outdoor gas-fired heating appliances is prohibited in any of the following locations:

1. Inside of any occupancy where connected to the fuel gas container.
2. Inside of tents, canopies and membrane structures.
3. On exterior balconies.

**Exception:** As allowed in Section 6.20 of NFPA 58.

- ❖ These “patio heaters” are not designed or listed for indoor use because they are unvented appliances. The potential fire and life safety hazard of LP-gas warrants their prohibition inside of occupied buildings and structures, making this section consistent with the prohibitions of containers inside of buildings in NFPA 58.



**Figure 603.4.2**  
**PORTABLE OUTDOOR GAS-FIRED**  
**HEATING APPLIANCE/PATIO HEATER**  
 (Photo courtesy of Infrared Dynamics, Yorba Linda, CA)

**603.4.2.1.2 Clearance to buildings.** Portable outdoor gas-fired heating appliances shall be located not less than 5 feet (1524 mm) from buildings.

- ❖ The 5-foot (1524 mm) separation reduces the likelihood that operating portable outdoor gas-fired heating appliances will come in contact with heat-damageable building surfaces or material that is easily ignited.

**603.4.2.1.3 Clearance to combustible materials.** Portable outdoor gas-fired heating appliances shall not be located beneath, or closer than 5 feet (1524 mm) to combustible decorations and combustible overhangs, awnings, sunshades or similar combustible attachments to buildings.

- ❖ The 5-foot (1524 mm) separation reduces the likelihood that operating portable outdoor gas-fired heating appliances will come in contact with combustible construction or material that is easily ignited.

**603.4.2.1.4 Proximity to exits.** Portable outdoor gas-fired heating appliances shall not be located within 5 feet (1524 mm) of *exits* or *exit discharges*.

- ❖ In order to not compromise the means of egress in a potential fire or other emergency evacuation scenario

and to prevent LP-gas from entering the building and finding an ignition source in case of a leak, portable outdoor gas-fired heating appliances must be kept a minimum of 5 feet (1524 mm) from any exit or exit discharge.

**603.4.2.2 Installation and operation.** Portable outdoor gas-fired heating appliances shall be installed and operated in accordance with Sections 603.4.2.2.1 through 603.4.2.2.4.

- ❖ This section introduces Sections 603.4.2.2.1 through 603.4.2.2.4, which contain requirements for controlling the installation and operation hazards associated with portable outdoor gas-fired heating appliances.

**603.4.2.2.1 Listing and approval.** Only *listed* and *approved* portable outdoor gas-fired heating appliances utilizing a fuel gas container that is integral to the appliance shall be used.

- ❖ Even though portable outdoor gas-fired heating appliances can be listed under the standard ANSI Z83.26/CSA 2.37 for natural gas or LP-gas (propane) use, this section makes it clear that only appliances employing an integral LP-gas container can be used. The safety feature here is that the gas hoses used to connect natural gas-fired appliances to an external fuel source are eliminated, thus eliminating the hazard of wear-and-tear effects on the hose and the possibility of persons tripping over the hoses, the latter reducing the risk of personal injury or heaters tipping over. Another safety feature required by the ANSI standard is the connection between the LP-gas cylinder and the hose supplying the appliance's burner. The standard requires the hose connected to the appliance to be equipped with a Compressed Gas Association (CGA) 790 fitting as described in CGA V-1. A CGA 790 fitting provides three separate safety features. First, the fitting has a thermal link that is designed to activate at temperatures of 200°F to 250°F (93°C – 121°C), thus stopping the flow of LP-gas in the event of a fire. Second, the fitting requires a positive connection to the cylinder before LP-gas can flow into the appliance. Finally, the fitting is equipped with an internal excess flow control valve, which is designed to stop the flow of a gas or liquid in the event of hose or pipe rupture.

**603.4.2.2.2 Installation and maintenance.** Portable outdoor gas-fired heating appliances shall be installed and maintained in accordance with the manufacturer's instructions.

- ❖ Compliance with the appliance manufacturer's installation and maintenance instructions is a fundamental requirement of all I-Codes and those instructions are an enforceable extension of the code because they are typically an integral part of the appliances, listing, as required by Section 603.4.2.2.1. Federal, state, county or municipal laws might supercede part of the installation instructions or could be applied in addition to the requirements in the instructions.

**603.4.2.2.3 Tip-over switch.** Portable outdoor gas-fired heating appliances shall be equipped with a tilt or tip-over switch that automatically shuts off the flow of gas if the appliance is tilted more than 15 degrees (0.26 rad) from the vertical.

- ❖ For safety, listed commercial heaters feature a safety switch that immediately shuts the unit off if it senses that the heater is tilted more than 15 degrees (0.26 rad) from vertical. This is especially important given these heaters can be over 7 feet (2137 mm) tall and weigh over 80 pounds (36 kg), depending on the design or manufacturer. This safety feature reduces the likelihood of personal injury and the heating element coming into contact with combustible material.

**603.4.2.2.4 Guard against contact.** The heating element or combustion chamber of portable outdoor gas-fired heating appliances shall be permanently guarded so as to prevent accidental contact by persons or material.

- ❖ This safety feature reduces the likelihood of personal injury and the heating element coming into direct contact with persons or combustible material.

**603.4.2.3 Gas containers.** Fuel gas containers for portable outdoor gas-fired heating appliances shall comply with Sections 603.4.2.3.1 through 603.4.2.3.4.

- ❖ This section introduces Sections 603.4.2.3.1 through 603.4.2.3.4, which contain requirements for controlling the hazards associated with fuel gas containers for portable outdoor gas-fired heating appliances.

**603.4.2.3.1 Approved containers.** Only *approved* DOTn or ASME gas containers shall be used.

- ❖ This section is consistent with Chapter 61 and the provisions of NFPA 58, which is the LP-gas referenced standard in that chapter of the code. Using only DOTn and ASME containers increases the likelihood of the appliance being safe because the containers are built to exacting standards.

**603.4.2.3.2 Container replacement.** Replacement of fuel gas containers in portable outdoor gas-fired heating appliances shall not be conducted while the public is present.

- ❖ In order to avoid exposing the public to the potential for a gas leak during cylinder replacement, the portable outdoor gas-fired heating appliance being serviced must either be removed to a nonpublic area or the area in which it is being used must be cleared of patrons while the container exchange is in progress.

**603.4.2.3.3 Container capacity.** The maximum individual capacity of gas containers used in connection with portable outdoor gas-fired heating appliances shall not exceed 20 pounds (9 kg).

- ❖ The maximum size of the gas container to be used in portable outdoor gas-fired heating appliances is the same as those typically used in gas grills and is dictated by the listing standard.

**603.4.2.3.4 Indoor storage prohibited.** Gas containers shall not be stored inside of buildings except in accordance with Section 6109.9.

- ❖ Requirements for the storage of idle replacement containers of LP-gas are specified in this section. Indoor storage of 20-pound (9 kg) LP-gas cylinders in a building that is accessible to the public is a violation of Section 6109.9. Both ANSI Z83.26/CSA 2.37 and Section 603.4.2.3.3 limit the volume of the LP-gas containers to 20 pounds (9 kg). Containers must also be qualified to be filled in accordance with the requirements in NFPA 58. Section 6109 provides regulations for the storage of containers awaiting use, which is applicable to replacement containers for portable outdoor gas-fired heating appliances.

**603.5 Heating appliances.** Heating appliances shall be *listed* and shall comply with Sections 603.5.1 and 603.5.2.

- ❖ The IMC and the IFGC require that all space-heating appliances be listed and labeled.

**603.5.1 Guard against contact.** The heating element or combustion chamber shall be permanently guarded so as to prevent accidental contact by persons or material.

- ❖ The injury and ignition protection feature required by this section is typically designed into the appliance.

**603.5.2 Heating appliance installation and maintenance.** Heating appliances shall be installed and maintained in accordance with the manufacturer's instructions, the *International Building Code*, the *International Mechanical Code*, the *International Fuel Gas Code* and NFPA 70.

- ❖ Depending upon the type of fuel utilized, appliance installation and maintenance can be subject to the requirements of multiple codes, including the IBC, the IMC, the IFGC, and NFPA 70 in addition to the appliance manufacturer's instructions.

**603.6 Chimneys and appliances.** Chimneys, incinerators, smokestacks or similar devices for conveying smoke or hot gases to the outer air and the stoves, furnaces, fireboxes or boilers to which such devices are connected, shall be maintained so as not to create a fire hazard.

- ❖ A primary function of the code is to reduce or eliminate fire hazards through proper maintenance of appliances and systems that are potential fire and life safety hazards.

**603.6.1 Masonry chimneys.** Masonry chimneys that, upon inspection, are found to be without a flue liner and that have open mortar joints which will permit smoke or gases to be discharged into the building, or which are cracked as to be dangerous, shall be repaired or relined with a *listed* chimney liner system installed in accordance with the manufacturer's instructions or a flue lining system installed in accordance with the requirements of the *International Building Code* and appropriate for the intended class of chimney service.

- ❖ See Section 2113 of the IBC, Section 801.16 of the IMC and Sections 501.12, 501.13 and 503.5 of the IFGC for information on masonry chimney liners and masonry chimneys.

**603.6.2 Metal chimneys.** Metal chimneys which are corroded or improperly supported shall be repaired or replaced.

- ❖ See the commentary to Section 603.2.

**603.6.3 Decorative shrouds.** Decorative shrouds installed at the termination of factory-built chimneys shall be removed except where such shrouds are *listed* and *labeled* for use with the specific factory-built chimney system and are installed in accordance with the chimney manufacturer's instructions.

❖ This section is retroactive in that it requires removal of a previously installed trim item. Section 805.6 of the IMC and Section 503.5.4 of the IFGC prohibit the installation of decorative shrouds not meeting the listing criteria. The code addresses those noncomplying shrouds that were illegally installed (see IMC commentary, Section 805.6, and IFGC commentary, Section 503.5.4).

**603.6.4 Factory-built chimneys.** Existing factory-built chimneys that are damaged, corroded or improperly supported shall be repaired or replaced.

❖ Defective or inadequately supported chimneys could leak flue gas and could fail structurally, resulting in separation, collapse, a fire hazard and a life safety hazard. This section is consistent with the maintenance focus of the code.

**603.6.5 Connectors.** Existing chimney and vent connectors that are damaged, corroded or improperly supported shall be repaired or replaced.

❖ See the commentary to Section 603.6.4.

**603.7 Discontinuing operation of unsafe heating appliances.** The *fire code official* is authorized to order that measures be taken to prevent the operation of any existing stove, oven, furnace, incinerator, boiler or any other heat-producing device or appliance found to be defective or in violation of code requirements for existing appliances after giving notice to this effect to any person, *owner*, firm or agent or operator in charge of the same. The *fire code official* is authorized to take measures to prevent the operation of any device or appliance without notice when inspection shows the existence of an immediate fire hazard or when imperiling human life. The defective device shall remain withdrawn from service until all necessary repairs or *alterations* have been made.

❖ When a heat-producing appliance or system is determined to be unsafe, the fire code official is required to notify the owner or agent of the building as the first step in correcting the difficulty. This notice may describe the repairs and improvements necessary to correct the deficiency and keep the system in operation or require the unsafe equipment or system to be removed or replaced. The notice must specify a time frame in which the corrective actions must occur. Additionally, the notice should require the immediate response of the owner or agent.

If the owner or agent is not available, public notice of the declaration would be enough to comply with this section. The fire code official may also determine that the system must be disconnected to correct an unsafe condition and must give written notice to that effect; however, an immediate disconnection can be

ordered if it is essential for protection of public health and safety.

**603.7.1 Unauthorized operation.** It shall be a violation of this code for any person, user, firm or agent to continue the utilization of any device or appliance (the operation of which has been discontinued or ordered discontinued in accordance with Section 603.7) unless written authority to resume operation is given by the *fire code official*. Removing or breaking the means by which operation of the device is prevented shall be a violation of this code.

❖ Appliances or systems removed from service in accordance with Section 603.7 may be sealed or otherwise secured in a manner approved by the fire code official and may only be returned to service upon written authorization of the fire code official.

**603.8 Incinerators.** Commercial, industrial and residential-type incinerators and chimneys shall be constructed in accordance with the *International Building Code*, the *International Fuel Gas Code* and the *International Mechanical Code*.

❖ See the commentary to Section 907.1 of the IMC, Section 606.1 of the IFGC and Section 2113 of the IBC.

**603.8.1 Residential incinerators.** Residential incinerators shall be of an *approved* type.

❖ Residential incinerators have gone out of use today but may still be found in older homes and in rural areas.

**603.8.2 Spark arrestor.** Incinerators shall be equipped with an effective means for arresting sparks.

❖ Spark arrestor chimney caps are designed with a screened outlet that prevents the escape of burning embers and particles.

**603.8.3 Restrictions.** Where the *fire code official* determines that burning in incinerators located within 500 feet (152 m) of mountainous, brush or grass-covered areas will create an undue fire hazard because of atmospheric conditions, such burning shall be prohibited.

❖ The fire code official must determine whether incinerator use would present an unacceptable risk of wild fires in timber, brush and grass-covered areas. For wildland-urban interface areas, see the *International Wildland-Urban Interface Code*<sup>®</sup> (IWUIC<sup>®</sup>). The local air-quality agency may also have restrictions.

**603.8.4 Time of burning.** Burning shall take place only during *approved* hours.

❖ The jurisdiction must determine the periods that would be safe for burning and those that would be unsafe. Consideration must be given to daylight, prevailing winds, ambient temperatures, impact on air quality, moisture levels and presence of observers and supervisory personnel.

**603.8.5 Discontinuance.** The *fire code official* is authorized to require incinerator use to be discontinued immediately if

the *fire code official* determines that smoke emissions are offensive to occupants of surrounding property or if the use of incinerators is determined by the *fire code official* to constitute a hazardous condition.

- ❖ The fire code official can prohibit incinerator use if it would be a nuisance or a health or fire hazard. Coordination with the local air-quality agency may also be necessary.

**603.8.6 Flue-fed incinerators in Group I-2.** In Group I-2 occupancies, the continued use of existing flue-fed incinerators is prohibited.

- ❖ This type of incinerator is hazardous and would not comply with current code requirements. This section is simply making sure that such incinerators are no longer used.

**603.8.7 Incinerator inspections in Group I-2.** Incinerators in Group I-2 occupancies shall be inspected not less than annually in accordance with the manufacturer's instructions. Inspection records shall be maintained on the premises and made available to the *fire code official* upon request

- ❖ Incinerators pose a hazard to the building and its occupants if not properly maintained. This is more of a concern in Group I-2 occupancies where the residents are at particular risk from such hazards.

**603.9 Gas meters.** Above-ground gas meters, regulators and piping subject to damage shall be protected by a barrier complying with Section 312 or otherwise protected in an *approved* manner.

- ❖ Vehicle impact protection is necessary to prevent gas leakage resulting from impact damage to gas service equipment. Protection can be accomplished by location alone or by the construction of barriers as prescribed by Section 312. Barriers would be required only where the gas service equipment is located where vehicle impact is likely to occur.

## SECTION 604

### EMERGENCY AND STANDBY POWER SYSTEMS

**604.1 General.** Emergency power systems and standby power systems required by this code or the *International Building Code* shall comply with Sections 604.1.1 through 604.1.8.

- ❖ This section simply states that all required emergency and standby power comply with various subsections. These subsections provide more detailed direction on how such systems are required to be installed. These provisions are consistent with the standards referenced by the code and provide the basic information to the code official.

**604.1.1 Stationary generators.** Stationary emergency and standby power generators required by this code shall be *listed* in accordance with UL 2200.

- ❖ The provisions of this section apply only to generator sets that are chosen and permanently installed for the purpose of providing an emergency or standby power

supply for the required, fixed building facilities indicated in Section 604.2. Section 2.37 of UL 2200 defines a stationary unit as "An engine generator that is intended to be hard wired and/or permanently installed." The section would not apply to mobile units such as truck-, trailer- or skid-mounted or other non-fixed, nonpermanent units. Such nonpermanently installed units would not be approved for purposes of complying with the requirements of Section 604. Similarly, stationary generator sets that are installed for purposes other than to supply emergency or standby power required by the code would not be required to be listed to UL 2200.

**604.1.2 Installation.** Emergency power systems and standby power systems shall be installed in accordance with the *International Building Code*, NFPA 70, NFPA 110 and NFPA 111.

- ❖ Emergency power systems are intended to provide electrical power for life safety systems, such as egress illumination, emergency communications and processes involving the handling and use of hazardous materials. In other words, emergency power is required where the loss of normal power would endanger occupants. Such systems are covered in Article 700 of NFPA 70 and one of their key features is the required response time of 10 seconds or less. The time between loss of normal power and the provision of emergency power must be kept very short to prevent putting occupants at risk. This is especially important during an emergency event, such as a building fire, but is important at all times to prevent occupant panic, which could happen if a crowded building is suddenly plunged into darkness.

Standby power systems are covered in Article 701 of NFPA 70 and are intended to provide electrical power for loads not as critical in terms of transfer time as those requiring emergency power. Standby power loads include smoke control systems; certain elevators; certain hazardous material operations; smoke-proof enclosure systems; illumination; heating, ventilating and air-conditioning (HVAC) systems; refrigeration and sewage pumps. Standby power systems must provide power within 60 seconds of failure of primary power.

Sources of power for emergency power systems (NFPA 70, Section 701-11) include storage batteries, generators, uninterruptible power supplies and separate services. Sources of power for standby systems include those allowed for emergency systems plus a source that is taken from a point of connection ahead of the normal service disconnecting means.

NFPA 110 addresses the performance criteria and "nuts and bolts" of emergency and standby power systems and separates them into types, classes and levels relative to maximum response time, minimum required operation time and life safety importance factor, respectively. NFPA 111 addresses stored emergency power supply systems and is similar in coverage to NFPA 110. Stored energy systems typically rely on batteries that store chemical energy.

**604.1.3 Load transfer.** Emergency power systems shall automatically provide secondary power within 10 seconds after primary power is lost, unless specified otherwise in this code. Standby power systems shall automatically provide secondary power within 60 seconds after primary power is lost unless specified otherwise in this code.

❖ These provisions are consistent with NFPA 70 and provide clarity to the code official regarding one of the key differences between standby and emergency power. This was discussed in more detail in the commentary to Section 604.1.2.

**604.1.4 Load duration.** Emergency power systems and standby power systems shall be designed to provide the required power for a minimum duration of 2 hours without being refueled or recharged, unless specified otherwise in this code.

❖ In order to properly design emergency and standby power systems, the minimum load duration must be known. This section provides a default minimum 2-hour duration for systems unless another load duration is specified. For instance, emergency responder radio coverage systems are required to provide standby power for 24 hours.

**604.1.5 Uninterruptable power source.** An uninterrupted source of power shall be provided for equipment where required by the manufacturer's instructions, the listing, this code or applicable referenced standards.

❖ In some cases an uninterruptable power supply is required. Uninterruptible power supplies are different from emergency and standby power supplies in that there is no transfer time allowed. This is necessary for equipment with volatile memories or that are generally sensitive to any loss of power. An uninterruptible power source must be provided if required by the equipment manufacturer's instructions; the listing of the equipment; the code; or applicable referenced standards, such as NFPA 72.

**604.1.6 Interchangeability.** Emergency power systems shall be an acceptable alternative for installations that require standby power systems.

❖ An emergency power system, given its more rapid transfer time, is an acceptable substitute for a standby power system. It will simply result in a faster-reacting system, which will only improve performance.

**604.1.7 Group I-2 occupancies.** In Group I-2 occupancies, where an essential electrical system is located in flood hazard areas established in Section 1612.3 of the *International Building Code* and where new or replacement essential electrical system generators are installed, the system shall be located and installed in accordance with ASCE 24.

❖ This provision provides a necessary link to ASCE 24 *Flood Resistant Design and Construction* for Group I-2 essential electrical systems. There have been losses of such systems due to flooding where the standard was not properly addressed. These types of facilities, such as hospitals and nursing homes, need

to have continued operation during flood events. Hurricane Katrina was a good example of such power being lost during flooding. This provision will ensure that new Group I-2 occupancies installing such systems and those replacing systems that have been substantially damaged by a flood will be installed correctly.

ASCE 24 provides the designer with the minimum requirements and expected performance for the design and construction of buildings and structures in flood hazard areas. It is not a restatement of all of the National Flood Insurance Program regulations, but offers additional specificity, some additional requirements, and some limitations. Buildings designed according to ASCE 24 are better able to resist flood loads and flood damage. See the commentary to Section 1612.3 of the IBC for additional information on this topic.

**604.1.8 Maintenance.** Existing installations shall be maintained in accordance with the original approval and Section 604.4.

❖ In order for existing generators to continue to serve the purpose for which they were installed, they must be properly maintained. This section simply provides the mechanism to ensure this maintenance. The maintenance level is linked to the original installation approval. Section 604.4 provides detailed maintenance requirements.

**604.2 Where required.** Emergency and standby power systems shall be provided where required by Sections 604.2.1 through 604.2.16.

❖ Fires or natural events can cause the loss of utility power as a result of either damage to equipment and wiring or fire-fighter action to shut off power to eliminate sources of ignition and danger to personnel.

Sections 604.2.1 through 604.2.16 list locations throughout buildings and facilities where emergency or standby power is required. In some cases, the requirements are occupancy- or use-specific and in others the requirements are system- or equipment-specific. Generally, the requirements are related to life safety-oriented systems within buildings, such as a fire alarm system or elevators used for egress for those with disabilities. Recall that emergency and standby power systems have different characteristics, and subsequent sections will require one or the other (see commentary, Section 604.1.2).

**604.2.1 Elevators and platform lifts.** Standby power shall be provided for elevators and platform lifts as required in Sections 607.2, 1009.4, and 1009.5.

❖ Elevators can be a component of an accessible means of egress in accordance with Section 1009.4 and must, therefore, be dependable at all times. Without backup power, an elevator could be a dead end for someone with physical disabilities who is trying to egress a building (see commentary, Section 1009.4).

Platform lifts are allowed to be used as part of an accessible means of egress only when they are

allowed as part of an accessible route, in accordance with Section 1109.8, Items 1 through 10, of the IBC. When this is the case, the platform lift could be a dead end for someone with physical disabilities if power to the platform lift were to be lost; therefore, standby power is required, in accordance with Section 604 or ASME A18.1.

The reference to Section 607.2 addresses how standby power is to be provided to elevators where required elsewhere. These requirements are the same as those found in Section 3003 of the IBC. Primarily, these requirements apply to high-rise buildings (see commentary, IBC Section 403.4.8.3). Also note that the IBC has specific standby power requirements in Sections 3007.8 and 3008.8 for fire service access elevators and occupant evacuation elevators, respectively. These requirements are more restrictive than those found in Section 607.2 of the code and Section 3003 of the IBC. See commentary for Section 607.2.

**604.2.2 Emergency alarm systems.** Emergency power shall be provided for emergency alarm systems as required by Section 414 of the *International Building Code*.

❖ Emergency alarm systems required by Section 908 of the code and Section 908 of the IBC are systems that provide warning of dangerous conditions involving hazardous materials. Emergency alarm systems must be available at all times and therefore require the use of an emergency power system. See commentary for Section 908 of the code and Sections 414.5.2 and 908 of the IBC.

**604.2.3 Emergency responder radio coverage systems.** Standby power shall be provided for emergency responder radio coverage systems as required in Section 510.4.2.3. The standby power supply shall be capable of operating the emergency responder radio coverage system for a duration of not less than 24 hours.

❖ Loss of power during an emergency situation is likely and emergency responders will require the use of their radios for an extended period of time in many cases. This section and Section 510.4.2.3 require that standby power be available for 24 hours.

**604.2.4 Emergency voice/alarm communication systems.** Emergency power shall be provided for emergency voice/alarm communication systems as required in Section 907.5.2.2.5. The system shall be capable of powering the required load for a duration of not less than 24 hours, as required in NFPA 72.

❖ Emergency voice/alarm communication systems are required by Section 907.5.2.2.5 to include an emergency power source. Certain Group A occupancies and covered malls are two of the many occupancies and building types that require emergency voice/alarm communication systems.

**604.2.5 Exit signs.** Emergency power shall be provided for *exit* signs as required in Section 1013.6.3. The system shall be

capable of powering the required load for a duration of not less than 90 minutes.

❖ Emergency power is warranted for exit signage illumination since guiding occupants to the exits is certainly a life safety function (see commentary, Section 1013.6.3). Note that this section specifies a time duration of not less than 90 minutes for exit sign illumination. This specific duration would take precedence over the general 2-hour duration specified in Section 604.1.4.

**604.2.6 Group I-2 occupancies.** Essential electrical systems for Group I-2 occupancies shall be in accordance with Section 407.10 of the *International Building Code*.

❖ Emergency power systems are required to comply with NFPA 99 by the Center for Medicare/Medicaid Services (CMS) in order for a federally licensed healthcare facility to receive federal reimbursement funds. Section 407.10 of the IBC provides a direct reference to NFPA 99 for the design and construction of emergency power systems in Group I-2. See the commentary to Section 407.10 of the IBC.

**604.2.7 Group I-3 occupancies.** Power-operated sliding doors or power-operated locks for swinging doors in Group I-3 occupancies shall be operable by a manual release mechanism at the door. Emergency power shall be provided for the doors and locks in accordance with Section 604.

Exceptions:

1. Emergency power is not required in facilities where provisions for remote locking and unlocking of occupied rooms in Occupancy Condition 4 are not required as set forth in the *International Building Code*.
2. Emergency power is not required where remote mechanical operating releases are provided.

❖ In an emergency situation involving power loss, occupants in detention and correctional facilities are at the mercy of door-locking mechanisms and those who control such locks; thus, emergency power is warranted. For a discussion of Exception 1, see the commentary to Sections 408.4.1 and 408.4.2 of the IBC. Exception 2 recognizes the use of mechanical operating releases controlled remotely as eliminating the need for emergency power.

**604.2.8 Hazardous materials.** Emergency and standby power shall be provided in occupancies with hazardous materials as required in the following sections:

1. Sections 5004.7 and 5005.1.5 for hazardous materials.
2. Sections 6004.2.2.8 and 6004.3.4.2 for highly toxic and toxic gases.
3. Section 6204.1.11 for organic peroxides.

❖ Where hazardous materials and processes are housed, occupant safety could be dependent on one or more ventilation, treatment, temperature control,

alarm or detection system. Thus, emergency or standby power is required, depending upon the nature of the material hazard presented (see commentary to code sections referenced in Items 1 through 3).

**604.2.9 High-rise buildings.** Standby power and emergency power shall be provided for high-rise buildings as required in Section 403 of the *International Building Code*, and shall be in accordance with Section 604.

- ❖ Occupants of high-rise buildings are at greater risk due to longer egress travel times, difficult fire-fighter access and the danger of vertical spread of fire and smoke. In accordance with this chapter and Sections 403.4.8, some loads in a high-rise building will require standby power and some will require emergency power (see commentary for Section 403.4.8 of the IBC).

**604.2.10 Horizontal sliding doors.** Standby power shall be provided for horizontal sliding doors as required in Section 1010.1.4.3. The standby power supply shall have a capacity to operate not fewer than 50 closing cycles of the door.

- ❖ Power-operated doors could be an obstruction to egress if the primary power supply fails; therefore, standby power is required to maintain door operation (see commentary, Section 1010.1.4.3).

**604.2.11 Hydrogen fuel gas rooms.** Standby power shall be provided for hydrogen fuel gas rooms as required by Section 5808.7.

- ❖ Ventilation and gas detection are critical to the ongoing safe operation of a hydrogen fuel gas room. Therefore, both ventilation and gas detection systems are required by Section 5808.7 to be provided with standby power. See the commentary to Section 5808.7.

**604.2.12 Means of egress illumination.** Emergency power shall be provided for *means of egress* illumination in accordance with Sections 1008.3 and 1104.5.1.

- ❖ The path of travel to all exits must be illuminated to guide occupants and allow for safe egress; therefore, emergency power for illumination is necessary (see commentary, Section 1008.3).

**604.2.13 Membrane structures.** Standby power shall be provided for auxiliary inflation systems in permanent membrane structures in accordance with Section 2702 of the *International Building Code*. Auxiliary inflation systems shall be provided in temporary air-supported and air-inflated membrane structures in accordance with Section 3103.10.4.

- ❖ Air-supported and air-inflated structures would collapse on the occupants if the inflation systems were to fail. Section 3102.8.1.1 of the IBC requires redundant inflation equipment that would be as worthless as the primary system in the event of power failure; therefore, standby power is required. Emergency power is required for all exit signs in temporary tents and membrane structures (see commentary, IBC Section 3102.8.2). Note that temporary air-supported

and air-inflated membrane structures require auxiliary power. However, the auxiliary power is not specifically standby power in accordance with Section 604.1. Section 3103.10.4 sets out specific criteria as to how this is to be provided. The time it takes to provide this power is 60 seconds, which is the same transfer time required for standby power in Section 604.1.3.

**604.2.14 Semiconductor fabrication facilities.** Emergency power shall be provided for semiconductor fabrication facilities as required in Section 2703.15.

- ❖ Where hazardous materials are utilized in Group H-5 hazardous production materials (HPM) facilities, many systems are depended on to protect the occupants from exposure to hazardous materials, including exhaust/ventilation systems, gas cabinet exhaust systems, gas detection systems, alarm systems and suppression systems. Loss of power would endanger the occupants; thus, emergency power is essential for these occupancies. For the complete list of required systems, see Section 2703.15 and its commentary.

**604.2.15 Smoke control systems.** Standby power shall be provided for smoke control systems as required in Section 909.11.

- ❖ Smoke control systems are intended to maintain a tenable environment in certain buildings to allow the occupants ample time to evacuate or relocate to protected areas. As such, smoke control systems are life safety systems and must be dependable (see commentary, Section 909.11). Such systems are more likely to be needed during a power loss than typical building systems such as HVAC.

**604.2.16 Underground buildings.** Emergency and standby power shall be provided in underground buildings as required in Section 405 of the *International Building Code* and shall be in accordance with Section 604.

- ❖ In the event of power failure, occupants could be underground without light, ventilation and numerous required life safety systems. These structures are analogous to inverted high-rise buildings. See Sections 405.8.1 and 405.8.2 of the IBC, which require standby power and emergency power for specified loads, respectively.

**604.3 Critical circuits.** Cables used for survivability of required critical circuits shall be listed in accordance with UL 2196. Electrical circuit protective systems shall be installed in accordance with their listing requirements.

- ❖ The standard referenced, UL 2196, is the ANSI-approved standard for tests of fire-resistive cables. NFPA 20 (fire pumps) and NFPA 72 (fire alarm) include selective survivability requirements to assure integrity of certain critical circuits. NFPA 70 does not specify the applicable standard within the mandatory provisions of the code, but recognizes electrical circuit protective systems as alternatives to listed cables. An electrical circuit protective system is a field

assembly of components that must be installed according to the listing requirements and manufacturer's instructions in order to maintain the listing for the system. There are more than two dozen electrical circuit protective systems listed in the UL Fire Resistance Directory.

**604.4 Maintenance.** Emergency and standby power systems shall be maintained in accordance with NFPA 110 and NFPA 111 such that the system is capable of supplying service within the time specified for the type and duration required.

❖ This section introduces requirements for maintenance of all elements of emergency and standby power systems. The two standards referenced are for emergency and standby power systems and stored electrical energy emergency and standby power systems, respectively. NFPA 110 is geared toward power sources, such as diesel-driven generators, while NFPA 111 is geared toward power supplies, such as stationary lead-acid battery systems. See also Section 604.1.8, which requires the same system maintenance as was originally approved.

**604.4.1 Schedule.** Inspection, testing and maintenance of emergency and standby power systems shall be in accordance with an approved schedule established upon completion and approval of the system installation.

❖ Standby power and emergency power are useful only if they continue to work over the life of both the building and its associated equipment; therefore, this section specifically focuses on the maintenance of such systems. The primary specifications of these secondary power supplies are that they be able to supply power within the specified length of time.

This section requires that a specific schedule be created at the completion of the installation of the system to encourage regular maintenance of the power systems.

**604.4.2 Records.** Records of the inspection, testing and maintenance of emergency and standby power systems shall include the date of service, name of the servicing technician, a summary of conditions noted and a detailed description of any conditions requiring correction and what corrective action was taken. Such records shall be maintained.

❖ Documentation of maintenance is key, in that it highlights what specifically was inspected and tested and where potential problems exist. Also, the information about the inspector and inspection agency in the document allows for further reference in the future. This provides a level of accountability. These documents must be made available to the fire code official upon request.

As a result of a review of Recommendation 2(c) of the National Institute of Standards and Technology (NIST) Charleston, South Carolina Sofa Superstore Fire Report, changes were made to Sections 107.2 and 107.3, along with 49 other sections (including this section), to comprehensively address recordkeeping requirements. Section 107.3 provides standardized

recordkeeping requirements for periodic inspection, testing, servicing and other operational and maintenance requirements of the code and makes it clear that records must be maintained on the premises or another approved location and that copies of records must be provided to the fire code official upon request. Section 107.3 also makes it clear that records must be maintained for a period of not less than 3 years unless a different time interval is specified in the code or a referenced standard, and that the fire code official is authorized to prescribe the form and format of such records. See the commentaries to Sections 107.2 and 107.3.

**604.4.3 Switch maintenance.** Emergency and standby power system transfer switches shall be included in the inspection, testing and maintenance schedule required by Section 604.4.1. Transfer switches shall be maintained free from accumulated dust and dirt. Inspection shall include examination of the transfer switch contacts for evidence of deterioration. When evidence of contact deterioration is detected, the contacts shall be replaced in accordance with the transfer switch manufacturer's instructions.

❖ One of the most important elements of emergency and standby power systems is the ability for the primary power to be switched to the secondary power supply within the specified time; therefore, this section pays specific attention to the long-term reliability of the transfer switches. This includes inspection for cleanliness and signs of deterioration.

**604.5 Operational inspection and testing.** Emergency power systems, including all appurtenant components, shall be inspected and tested under load in accordance with NFPA 110 and NFPA 111.

**Exception:** Where the emergency power system is used for standby power or peak load shaving, such use shall be recorded and shall be allowed to be substituted for scheduled testing of the generator set, provided that appropriate records are maintained.

❖ This section requires that emergency power systems be tested and inspected as specified in NFPA 110 and 111. There is an exception to testing emergency power when the emergency power system is either used for peak power periods or for standby power. The use during peak hours means that on a fairly regular basis the power supply will be tested. In terms of the use of emergency power for standby power, the capacity of both types of secondary power systems is the same. The two differ on when they will activate; therefore, testing the system as a standby power supply is adequate when the emergency power system is used as standby power.

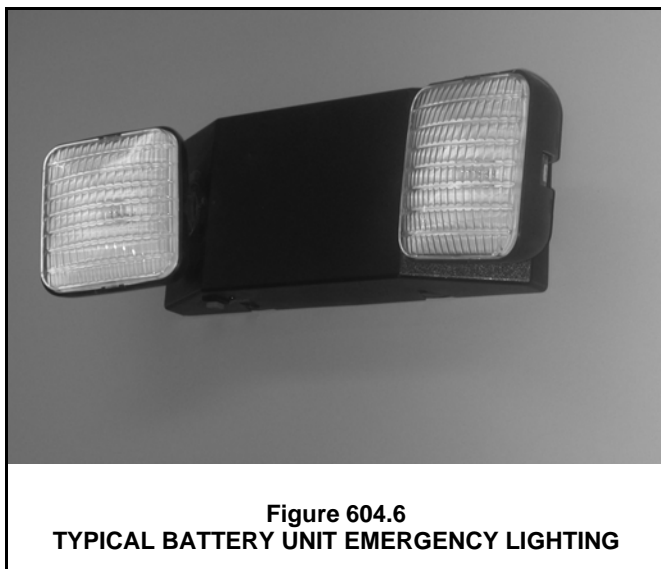
**604.5.1 Transfer switch test.** The test of the transfer switch shall consist of electrically operating the transfer switch from the normal position to the alternate position and then return to the normal position.

❖ This section specifically prescribes the sequence of events for testing transfer switches. The switch must

move from the normal position to the alternate position and back again. As noted earlier in this commentary, emergency power must be available within a maximum of 10 seconds upon the loss of primary power, whereas standby power is to be available within 60 seconds. The transfer switches, therefore, must work within the specified time.

**604.6 Emergency lighting equipment.** Emergency lighting shall be inspected and tested in accordance with Sections 604.6.1 through 604.6.2.1.

❖ This section introduces the requirements for regular testing of emergency lighting equipment installed in accordance with Section 1008. While Section 604.4 requires that emergency power systems be inspected and tested in accordance with the referenced standards, NFPA 111 Section 1.1.4.1, Item 4, specifically exempts battery unit equipment from being covered by the maintenance provisions of that standard and NFPA 110 does not apply. These sections will fill that gap in maintenance coverage by providing for the testing of the most common type of emergency lighting found in smaller buildings, i.e., battery unit emergency lighting equipment (see Commentary Figure 604.6).



**604.6.1 Activation test.** An activation test of the emergency lighting equipment shall be completed monthly. The activation test shall ensure the emergency lighting activates automatically upon normal electrical disconnect and stays sufficiently illuminated for not less than 30 seconds.

❖ This section requires a monthly 30-second function test of battery unit emergency lighting equipment to verify that the unit is holding a charge, that all connected bulbs or luminaires are operational and that the transfer switch functions properly. This test must be conducted by turning off the normal power supply circuit that serves the unit, not by simply pressing the “test” button on the unit. It is important to note that since NFPA 70 typically requires a lock-on device to

be provided on branch circuit breakers powering unit equipment, those lock-ons must be reinstalled upon completion of the test.

**604.6.1.1 Activation test record.** Records of tests shall be maintained. The record shall include the location of the emergency lighting tested, whether the unit passed or failed, the date of the test and the person completing the test.

❖ Accurate, up-to-date records are required to document the history of equipment inspection, testing and maintenance. Record keeping is not intended simply to prove to the fire code official that required inspection, testing and maintenance are being performed, but to assist the owner or his or her agent in performing these functions. A well-kept log helps an owner or technician determine how the equipment is performing over time and assists the building owner in understanding the responsibilities associated with having this equipment installed in the building. These records must be kept on the premises of the affected building. Where a complex of buildings exists, a centralized location for record storage will aid the owner and the fire code official. Similarly, buildings, such as warehouses, that are typically unoccupied but are located adjacent to an occupied building, such as an office, can have their records maintained in the office building so that they are protected and secured.

As a result of a review of Recommendation 2(c) of the NIST Charleston, South Carolina Sofa Superstore Fire Report, changes were made to Sections 107.2 and 107.3, along with 49 other sections (including this section), to comprehensively address recordkeeping requirements. Section 107.3 provides standardized recordkeeping requirements for periodic inspection, testing, servicing and other operational and maintenance requirements of the code and makes it clear that records must be maintained on the premises or another approved location and that copies of records must be provided to the fire code official upon request. Section 107.3 also makes it clear that records must be maintained for a period of not less than 3 years unless a different time interval is specified in the code or a referenced standard, and that the fire code official is authorized to prescribe the form and format of such records. See the commentaries to Sections 107.2 and 107.3.

**604.6.2 Power test.** For battery-powered emergency lighting, a power test of the emergency lighting equipment shall be completed annually. The power test shall operate the emergency lighting for not less than 90 minutes and shall remain sufficiently illuminated for the duration of the test.

❖ Section 1008.3.4 requires that emergency lighting for means of egress have a duration of 90 minutes. This section complements that requirement by requiring a 90-minute operational test of battery units annually to verify the condition of the battery, unit-powered bulbs or luminaires and unit circuitry. As with the activation test in Section 604.6.1, this test should be conducted by turning off the normal power supply to the unit. The determination of whether the unit remains “suffi-

ciently illuminated” for the full 90-minute test should be based on the performance requirements for emergency lighting for means of egress established in Section 1008.3.5.

**604.6.2.1 Power test record.** Records of tests shall be maintained. The record shall include the location of the emergency lighting tested, whether the unit passed or failed, the date of the test and the person completing the test.

❖ See the commentary to Section 604.6.1.1.

**604.7 Supervision of maintenance and testing.** Routine maintenance, inspection and operational testing shall be overseen by a properly instructed individual.

❖ This section requires a minimum level of qualifications for the testing of emergency and standby power systems. Only trained personnel should do the testing and maintenance of these systems. This is consistent with Section 107.4. See the commentary to that section.

**SECTION 605**

**ELECTRICAL EQUIPMENT, WIRING AND HAZARDS**

**605.1 Abatement of electrical hazards.** Identified electrical hazards shall be abated. Identified hazardous electrical conditions in permanent wiring shall be brought to the attention of the responsible code official. Electrical wiring, devices, appliances and other equipment that is modified or damaged and constitutes an electrical shock or fire hazard shall not be used.

❖ Maintenance of electrical systems and services to achieve compliance with the requirements of NFPA 70 is required. The leading causes of electrical fires include inadequate or improper maintenance; non-conforming modifications to existing installations; failure to maintain clearances around electrical equipment and devices; and improper use of electrical equipment and devices. A detailed analysis of the causes of residential electrical fires by the U.S. Consumer Products Safety Commission suggests that misuse and improper modifications to conforming electrical systems are the leading causes of these fires.

**605.2 Illumination.** Illumination shall be provided for service equipment areas, motor control centers and electrical panelboards.

❖ Adequate lighting in electrical service distribution equipment areas is required to facilitate the location of the electrical service shutoff during a fire or other emergency and to minimize potential hazards during maintenance or repair work. Although not required, this lighting should be connected to an emergency or standby power source to permit continued illumination when power to service equipment is interrupted during maintenance repair activities or emergencies.

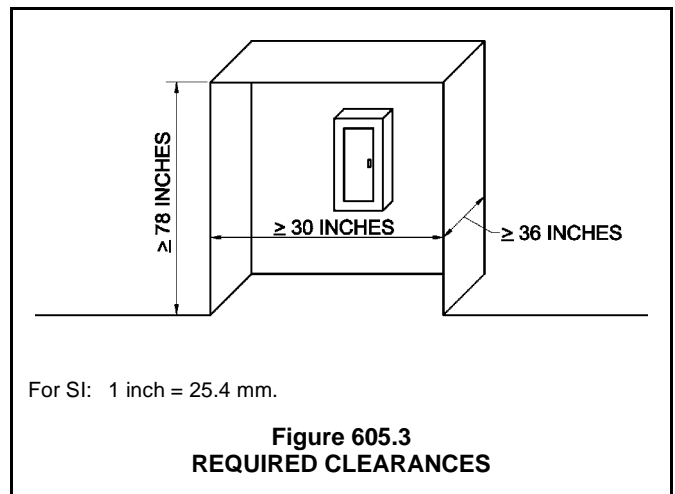
**605.3 Working space and clearance.** A working space of not less than 30 inches (762 mm) in width, 36 inches (914 mm) in depth and 78 inches (1981 mm) in height shall be provided

in front of electrical service equipment. Where the electrical service equipment is wider than 30 inches (762 mm), the working space shall be not less than the width of the equipment. Storage of materials shall not be located within the designated working space.

**Exceptions:**

1. Where other dimensions are required or allowed by NFPA 70.
2. Access openings into attics or under-floor areas which provide a minimum clear opening of 22 inches (559 mm) by 30 inches (762 mm).

❖ Adequate clearance serves two important purposes: physical separation of combustibles from heat-producing electrical devices and equipment to minimize the possibility of ignition, and providing adequate work space to perform maintenance and repair work safely (see Commentary Figure 605.3). The exceptions note that NFPA 70 may allow different dimensions than those prescribed in this section. Additionally, the lack of space in areas such as attics and underfloor areas is recognized by also allowing a smaller opening width.



**605.3.1 Labeling.** Doors into electrical control panel rooms shall be marked with a plainly visible and legible sign stating ELECTRICAL ROOM or similar approved wording. The disconnecting means for each service, feeder or branch circuit originating on a switchboard or panelboard shall be legibly and durably marked to indicate its purpose unless such purpose is clearly evident.

❖ In addition to the illumination required in Section 605.2, additional labeling is required for the electrical equipment to assist emergency responders in identifying and then shutting down electrical service controls during a fire or other emergency.

**605.4 Multiplug adapters.** Multiplug adapters, such as cube adapters, unfused plug strips or any other device not complying with NFPA 70 shall be prohibited.

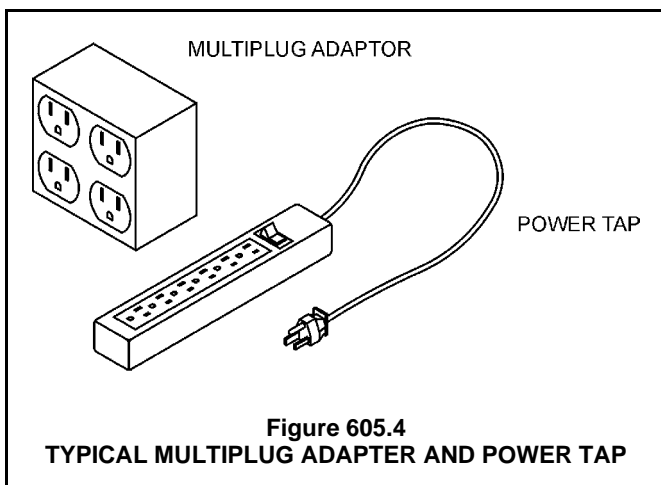
❖ The intent of this section is to prohibit conditions that could lead to the overloading of building electrical cir-

cuits that, in turn, could result in a fire. The devices intended to be regulated by this section are referred to as a “multiplug adapter” but are more correctly identified as a “current tap.” Underwriters Laboratories, Inc. (UL), in its Guide Information for the listing category EMDV, defines “current tap” as follows: “A male and female contact device that, when connected to an outlet receptacle or cord set, provides multiple outlets or outlet configurations. An outlet configuration may consist of a slot configuration, or provision for the connection of flexible cord.” An adapter, on the other hand, is defined there as “a device that adapts one blade or slot configuration to another (including a grounding adapter for a non-grounding receptacle).” The term “cube adapter” (more correctly “cube tap”) refers to the shape of the device, i.e., cube-shaped. They can also be known as “octopus taps.”

Overcurrent protection interrupts power to an outlet only when connected loads exceed the current rating of the overcurrent device for a specified amount of time. When multiplug adaptors are used for several appliances, such devices may produce enough heat to ignite nearby combustibles in the time it takes to trip the overcurrent protection device. Simultaneous operation of many small loads may cause dangerous localized resistance heating without tripping the overcurrent protection device. Additionally, these devices may result in loose electrical connections because of the weight of the cords pulling on them.

The use of these devices may also indicate that the building’s electrical wiring is inadequate for the connected loads or occupancy demands. These devices are intended for temporary use only, not at a fixed location or in place of wiring complying with NFPA 70.

The code does allow for the use of listed, relocatable power taps complying with specific criteria mentioned in Sections 605.4.1 through 605.4.3. Commentary Figure 605.4 shows the difference between a multiplug adapter and a power tap.



**605.4.1 Power tap design.** Relocatable power taps shall be of the polarized or grounded type, equipped with overcurrent protection, and shall be *listed* in accordance with UL 1363.

❖ This section sets out the basic requirements for relocatable power taps (RPTs). The testing requirements of UL 1363 are applied to relocatable, cord-connected power taps rated at 250 volts AC or less and 20 amps or less. These devices are intended only for indoor use as a temporary extension of a branch circuit for general use to supply home workshop tools, computers, audio and video equipment, etc. They consist of an attachment plug and a length of flexible cord terminating in an enclosure containing one or more receptacles and may also be provided with fuses or other supplemental overcurrent protection, switches, line surge suppressors or indicator lights. The flexible cord length is dependent on the listing of the particular device, but power taps have been listed for lengths up to 25 feet (7620 mm). The scope of UL 1363 indicates that RPTs are neither intended to be connected in series nor used with medical equipment.

**605.4.2 Power supply.** Relocatable power taps shall be directly connected to a permanently installed receptacle.

❖ The restrictions on power taps are similar to those on extension cords. Power taps should not be used as a substitute for building wiring. Relocatable power taps are intended to be plugged directly into a permanently installed receptacle and are not intended to be connected in series or connected to other power taps or extension cords. They are also not intended for use outdoors, at construction sites and similar hard-use locations.

**605.4.3 Installation.** Relocatable power tap cords shall not extend through walls, ceilings, floors, under doors or floor coverings, or be subject to environmental or physical damage.

❖ To prevent use as a substitute for permanent wiring, power taps cannot be placed in locations such as within or through walls, under doors or on building surfaces, furnishings, cabinets or similar structures where they would be subject to physical damage. This section would prohibit relocatable power taps from being plugged into a receptacle in one room to power a device in another room.

**605.5 Extension cords.** Extension cords and flexible cords shall not be a substitute for permanent wiring. Extension cords and flexible cords shall not be affixed to structures, extended through walls, ceilings or floors, or under doors or floor coverings, nor shall such cords be subject to environmental damage or physical impact. Extension cords shall be used only with portable appliances.

❖ Frequent or improper use of extension cords in place of permanent fixed wiring is another indication of inadequate electrical wiring capacity or incompatible

demands (see Commentary Figure 605.5). Physical damage to extension cords caused by concealment or inadequate maintenance may result in localized resistance heating, shorts or ground faults.

The amount of electrical current that any extension cord can safely conduct is limited by the size of its conductor, its insulation type and its environment. This principle is often not understood by the general public. As a result, extension cords are commonly overloaded by connecting appliances and other loads in excess of the cord's capacity.

Overloading of extension cords causes an increase in the conductor's temperature. This increase in temperature can exceed the temperature rating of the conductor insulation, causing it to melt, decompose or burn. The burning insulation can ignite other combustible materials. The resulting loss of conductor insulation can also cause a short circuit or ground fault that can act as a source of ignition. The buildup of heat in an extension cord is often made worse by excessive cord length and by the insulating effect of rugs that often cover extension cords. Extension cords are much more susceptible to physical damage than permanent wiring. Damage to extension cords increases the likelihood of shorts and poor connections, both of which can cause a fire.

In addition to the fire hazard, extension cords pose a tripping hazard to occupants and, when damaged, can pose an electrical shock hazard. Securing flexible cords to a wall baseboard, door jambs, etc., with nails, staples or other fasteners to eliminate tripping hazards can create another dangerous condition by pinching or piercing the cord and causing shorts or faults that could lead to ignition.

Additionally, as a way of limiting the use of extension cords, their use is restricted to portable appliances. The reference to "portable" primarily denotes smaller, often-relocated appliances, such as a fan or a power tool. Extension cords must not be used with major appliances or equipment, such as refrigerators,

which are obviously not portable. See the definitions for "Portable equipment" and "Portable appliance" in NFPA 70 Sections 520.2 and 550.2, respectively.

**605.5.1 Power supply.** Extension cords shall be plugged directly into an *approved* receptacle, power tap or multiplug adapter and, except for *approved* multiplug extension cords, shall serve only one portable appliance.

❖ This restriction means that multiple extension cords must not be connected to one another. Additionally, extension cords are limited to one appliance unless they are specifically approved multiplug extension cords.

**605.5.2 Ampacity.** The ampacity of the extension cords shall be not less than the rated capacity of the portable appliance supplied by the cord.

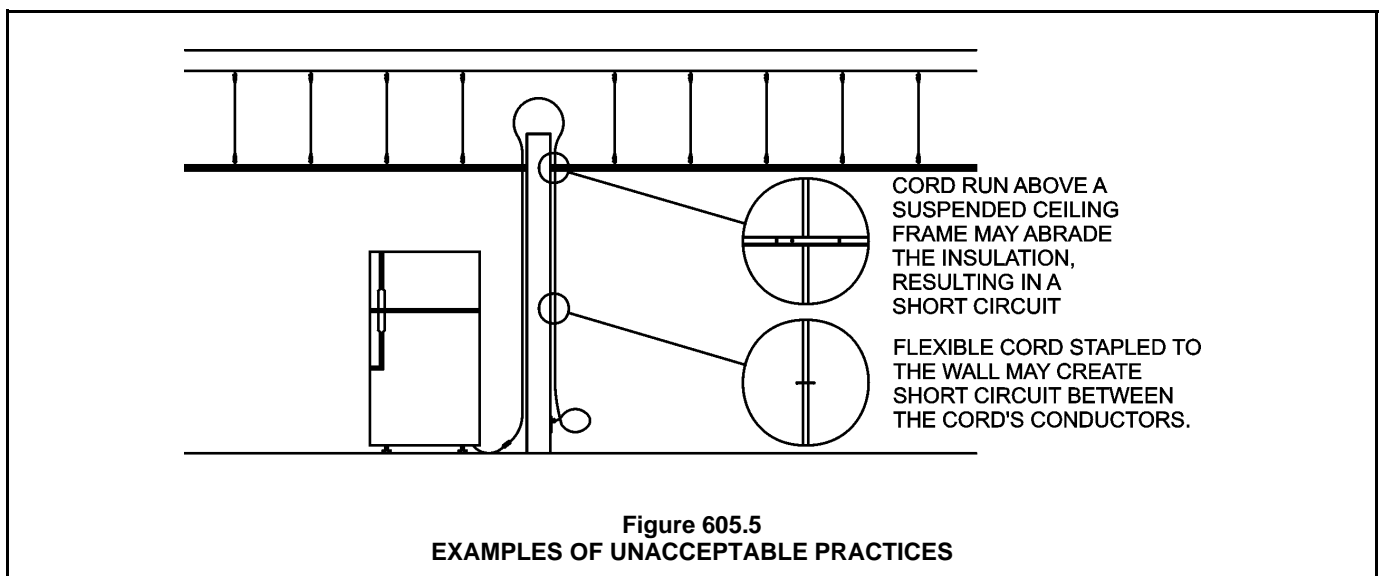
❖ Although most building occupants may have difficulty understanding ampacity, which is the amount of electrical current that a particular conductor is capable of handling without exceeding its temperature limits, it is extremely important. If an appliance demands a higher electrical current than the extension cord is intended to handle, the extension cord will be overloaded causing overheating and a potential fire. Familiarity with the types of extension cords available for sale and the general relationships to common appliances will help with the enforcement of this section.

**605.5.3 Maintenance.** Extension cords shall be maintained in good condition without splices, deterioration or damage.

❖ When extension cords are damaged, they become potential shock hazards and a source of ignition.

**605.5.4 Grounding.** Extension cords shall be grounded where serving grounded portable appliances.

❖ If an extension cord serves an appliance that requires a grounding conductor to avoid potential shock, that cord must provide a grounding conductor.



**605.6 Unapproved conditions.** Open junction boxes and open-wiring splices shall be prohibited. *Approved* covers shall be provided for all switch and electrical outlet boxes.

❖ Without covers, connections made in junction boxes may be subject to physical damage. Such damage may loosen electrical connections, resulting in high-resistance arcing. Switches and outlet boxes are subject to arcing from loose connections and reduced clearances between contacts as they age. Accumulation of dirt and debris in open electrical boxes creates an ignitable fuel concentration. Fires in open electrical boxes may spread to wire or cable insulation or other fuels in electrical and mechanical concealed spaces. Furthermore, unprotected electrical connections are electrical shock hazards to personnel working in concealed spaces.

**605.7 Appliances.** Electrical appliances and fixtures shall be tested and *listed* in published reports of inspected electrical equipment by an *approved* agency and installed and maintained in accordance with all instructions included as part of such listing.

❖ The fire code official should look for the listing mark of an approved testing or inspection agency on the appliance and may request the agency's published report showing the listing to verify that the appliance meets an applicable standard for electrical safety. Fire code officials experiencing difficulties interpreting the marking or listing of an agency, as in the case of a laboratory not located within the United States, should consult representatives of the agency or the U.S. Consumer Products Safety Commission (CPSC) for assistance.

**605.8 Electrical motors.** Electrical motors shall be maintained free from excessive accumulations of oil, dirt, waste and debris.

❖ Internal heating is commonly associated with the operation of electrical motors. Excessive accumulations of dust, oil, grease, dirt or other debris may be easily ignited by the internal frictional heating of electrical motor components.

**605.9 Temporary wiring.** Temporary wiring for electrical power and lighting installations is allowed for a period not to exceed 90 days. Temporary wiring methods shall meet the applicable provisions of NFPA 70.

**Exception:** Temporary wiring for electrical power and lighting installations is allowed during periods of construction, remodeling, repair or demolition of buildings, structures, equipment or similar activities.

❖ In some cases, because of a specific need and the temporary nature of the need, temporary wiring is allowed for a period of not more than 90 days. This allowance is primarily aimed at needs such as for holiday lighting. The exception allows temporary wiring to exceed 90 days for certain activities, such as remodeling or general construction of a building. Section 590 of NFPA 70 contains specific requirements for temporary wiring.

The term "temporary wiring" is not referring here to the use of power taps or extension cords (see commentary, Sections 605.4 and 605.5). The requirements for temporary wiring are less restrictive than those for permanent wiring but are much more rigorous than the requirements for the use of power taps and extension cords.

**605.9.1 Attachment to structures.** Temporary wiring attached to a structure shall be attached in an *approved* manner.

❖ When wiring is specifically attached to a structure, care must be taken to make sure that the attachment will not damage the wiring in a way that would cause resistance heating in localized areas of the wiring (see commentary, Section 605.5).

**605.10 Portable, electric space heaters.** Where not prohibited by other sections of this code, portable, electric space heaters shall be permitted to be used in all occupancies other than Group I-2 and in accordance with Sections 605.10.1 through 605.10.4.

**Exception:** The use of portable, electric space heaters in which the heating element cannot exceed a temperature of 212°F (100°C) shall be permitted in nonsleeping staff and employee areas in Group I-2 occupancies.

❖ Portable, electric space heaters are a readily available, commonly used source of supplementary heat for homes or workplaces, but should not be relied on to replace a building's fixed heating system. Because a portable, electric space heater's heating element operates at high temperatures, improper use of the heater creates a fire risk. This section provides minimum safety requirements for the use of portable, electric space heaters that have historically been carelessly or incorrectly installed or used. However, because Group I-2 occupancies have a higher life hazard that results in a longer evacuation time, the use of these devices in such occupancies is prohibited. These provisions also correlate the code with federal regulations for these facilities. The exception recognizes the reduced life hazard in nonpatient staff areas of Group I-2 occupancies; limiting the portable heater temperature will reduce the incidence of fire from these devices.

**605.10.1 Listed and labeled.** Only *listed* and *labeled* portable, electric space heaters shall be used.

❖ Using only tested, listed and labeled portable, electric space heaters provides both the consumer and the fire code official with an increased level of confidence that the heater has been thoroughly and carefully examined by an independent agency concerned with public safety. An important part of the product listing is the manufacturer's use and care booklet that should be read and carefully followed before using a portable, electric space heater for the first time and periodically thereafter. An appropriate standard that could be used to examine and list these heaters would be UL 1278.

**605.10.2 Power supply.** Portable, electric space heaters shall be plugged directly into an *approved* receptacle.

❖ Because of the amount of current required for an electric space heater, its listing will limit the length of the power supply cord provided with the unit to prevent overheating of the conductors. Using an extension cord or other temporary wiring device defeats the purpose of the limited-length cord and can lead to conductor overheating or damage to the heater itself. The heater's power supply cord should be kept away from high traffic areas to prevent the cord from being damaged or tripped over. Power supply cords should also not be run under rugs or furniture where they could be walked on or have heavy objects set on them. This could cause a damaged cord to overheat and cause a fire.

**605.10.3 Extension cords.** Portable, electric space heaters shall not be plugged into extension cords.

❖ See the commentaries to Sections 605.10.2 and 605.5.

**605.10.4 Prohibited areas.** Portable, electric space heaters shall not be operated within 3 feet (914 mm) of any combustible materials. Portable, electric space heaters shall be operated only in locations for which they are *listed*.

❖ Because portable electric space heaters have hot and arcing or sparking parts inside of them, adequate clearance from combustible materials must be maintained to avoid ignition of the combustibles. Likewise, flammable liquid vapors could be liberated during liquid transfer or in the event of a spill during travel to the heater where the arcing or sparking components could cause ignition.

**605.11 Solar photovoltaic power systems.** Solar photovoltaic power systems shall be installed in accordance with Sections 605.11.1 through 605.11.2, the *International Building Code* or *International Residential Code*, and NFPA 70.

❖ Among the most popular alternative energy sources are solar photovoltaic (PV) power systems. A number of United States electric utility power suppliers offer incentives for the installation of PV systems on buildings because such systems offer the property owners the ability to generate their own electricity and, in many cases, sell excess electricity back to the utility provider. Such an arrangement is a benefit to the utility provider because it reduces the provider's power generation demand, which in turn can control the rates that commercial and residential customers pay.

According to the U.S. Energy Information Administration, approximately 21,200 PV cells and modules were shipped domestically in 1999; by 2008, the number shipped was over 524,200. As the number of PV power systems increases, economy of scale will continue to reduce the systems costs, making them more common on commercial and residential buildings (see Commentary Figure 605.11).

PV systems are designed to convert light energy

into direct current (DC) electricity. They have no moving parts and do not contain fluids. The light-to-electricity conversion begins at the PV cell, which is commonly a semiconductor device that generates electricity when exposed to light. To be effective, PV cells are assembled into PV modules, which are then assembled into PV panels. The panels are assembled onto a frame or a flexible substrate, which then can be affixed to the roof of buildings to create a PV array. The PV array and its modules are wired together and generally operate as a series electrical circuit. PV array are required by NFPA 70 to have a fuse or other means of branch-circuit protection to prevent them from being overloaded. While not required, a PV array is commonly equipped with a blocking diode. A blocking diode is analogous to a check valve in a piping system because it limits the direction the electrons can travel. The blocking diode prevents electrical current from one power supply from finding entry into another. In PV systems, the blocking diode protects each individual PV panel if other panels fail and prevents the withdrawal of electricity from the system during the nighttime (see Commentary Figure 605.11).

The ever-increasing demand for alternative power sources brings with it hazards to confront emergency responders. The greatest danger facing emergency responders operating in proximity to solar energy collection systems is the lack of knowledge needed to operate safely around these systems. Some of the potential hazards associated with PV systems are tripping hazards and falls for fire fighters operating on the roof, earlier roof collapse due to the added dead load and electric shock. The provisions of Sections 605.11 through 605.11.2 were developed to provide for the proper installation of PV systems and to address the potential hazards to fire fighters. This section requires compliance with the IBC or *International Residential Code*<sup>®</sup> (IRC<sup>®</sup>), as applicable, and NFPA 70.

Relevant provisions of the IBC and IRC are IBC Sections 1505, 1512 and 3111 and IRC Sections R324, R902, R905 and R907, as applicable.

The reference to NFPA 70 would require compliance with Section 690 of NFPA 70, which addresses requirements such as marking of equipment and the type of materials that are permitted. Section 605.11 focuses primarily on creating pathways where fire fighters can perform manual ventilation operations on roofs.

**605.11.1 Access and pathways.** Roof access, pathways, and spacing requirements shall be provided in accordance with Sections 605.11.1.1 through 605.11.1.3.3.

#### Exceptions:

1. Detached, nonhabitable Group U structures including, but not limited to, parking shade structures, carports, solar trellises and similar structures.

2. Roof access, pathways and spacing requirements need not be provided where the fire chief has determined that rooftop operations will not be employed.

❖ This section introduces a major element of PV system design: the requirement to provide access and paths so fire fighters can perform the important task of manual ventilation by cutting one or more holes in a building roof. The provisions in Sections 605.11.1.1 through 605.11.1.3.3 address the placement of PV arrays on building roofs. It should be noted that these requirements do not apply to buildings regulated by the IRC. See the commentary to Section 102.5 for a discussion of the relationship between the code and the IRC.

Exception 1 to this section recognizes that the installation of PV systems on detached Group U occupancy structures will not require ventilation and therefore does not need to be regulated by this section.

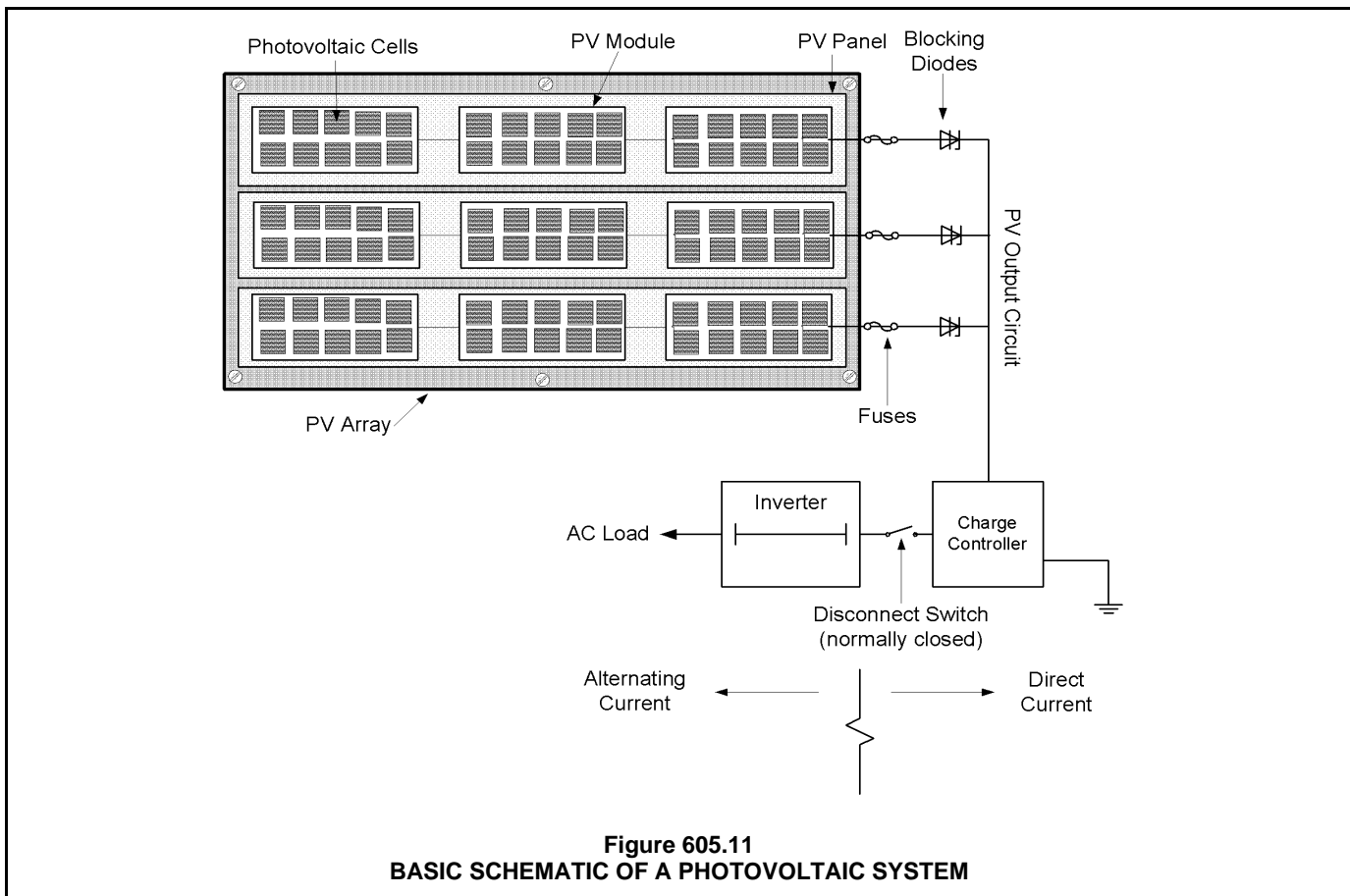
Exception 2 exempts PV arrays from the spacing requirements when the fire chief indicates that vertical manual ventilation practices will not be employed. Conditions that could be considered under this exception include, but are not limited to, proximity and type of adjacent exposures; alternative access opportunities (as from adjoining roofs); adequate ventilation opportunities beneath solar arrays that are sufficiently elevated, spaced or set back from other

rooftop equipment; installation of automatic ventilation devices or new technology, methods, or other innovations that ensure adequate fire department access, pathways and ventilation opportunities. Note that a construction permit in accordance with Section 105.7.15 would still be required.

**605.11.1.1 Roof access points.** Roof access points shall be located in areas that do not require the placement of ground ladders over openings such as windows or doors, and located at strong points of building construction in locations where the access point does not conflict with overhead obstructions such as tree limbs, wires or signs.

❖ Roof access points are areas where ladder placement would not be over openings so as to obstruct ingress or egress of personnel, interfere with the use of openings for ventilation or expose the ground ladder and its users to heat, smoke or fire erupting from openings. Ladder placement must also be located at strong points of building construction so that there is less risk of collapse while fighting a fire. Overhead obstructions must also be taken into account. Having PV panels and modules limits the locations where fire fighters can place ladders, therefore it is more important that these factors be addressed as part of the installation process.

Although specific emphasis is not provided within this section, the fire code official should be involved in the determination of access points.



**Figure 605.11**  
**BASIC SCHEMATIC OF A PHOTOVOLTAIC SYSTEM**

**605.11.1.2 Solar photovoltaic systems for Group R-3 buildings.** Solar photovoltaic systems for Group R-3 buildings shall comply with Sections 605.11.1.2.1 through 605.11.1.2.5.

**Exception:** These requirements shall not apply to structures designed and constructed in accordance with the *International Residential Code*.

❖ This section introduces the PV system access requirements for residential buildings (see Commentary Figure 605.11.1.2). Note that the Group R-3 buildings focused on are typically one- and two-family dwellings that fall outside the scope of the IRC. As noted in Section 605.11, the IRC addresses one- and two-family dwellings that fall within the scope of that code. The requirements in Section R324 are very similar to those found in Sections 605.11.1.2 through 605.11.1.2.5.



**Figure 605.11.1.2  
INSTALLATION OF A PV ARRAY  
ON AN R-3 OCCUPANCY**

**605.11.1.2.1 Size of solar photovoltaic array.** Each photovoltaic array shall be limited to 150 feet (45 720 mm) by 150 feet (45 720 mm). Multiple arrays shall be separated by a 3-foot-wide (914 mm) clear access pathway.

❖ This section establishes a maximum size of the solar array. This provides a manageable size for fire fighters. Multiple arrays are permitted but must be separated by 3 feet between so that there is access between each array.

**605.11.1.2.2 Hip roof layouts.** Panels and modules installed on Group R-3 buildings with hip roof layouts shall be located

in a manner that provides a 3-foot-wide (914 mm) clear access pathway from the eave to the ridge on each roof slope where panels and modules are located. The access pathway shall be at a location on the building capable of supporting the fire fighters accessing the roof.

**Exception:** These requirements shall not apply to roofs with slopes of two units vertical in 12 units horizontal (2:12) or less.

❖ Where PV arrays are installed on the roofs of Group R-3 buildings, a minimum 3-foot (914 mm) access pathway must be left from the eave to the roof ridge so fire fighters have an unobstructed area in which to cut ventilation openings. The exception exempts low-slope roofs (i.e., a slope that is 2:12 or less) because of the reduced hazards of such flatter roofs.

**605.11.1.2.3 Single-ridge roofs.** Panels and modules installed on Group R-3 buildings with a single ridge shall be located in a manner that provides two, 3-foot-wide (914 mm) access pathways from the eave to the ridge on each roof slope where panels and modules are located.

**Exception:** This requirement shall not apply to roofs with slopes of two units vertical in 12 units horizontal (2:12) or less.

❖ Where PV arrays are installed on the roofs of Group R-3 buildings, a minimum of two 3-foot (914 mm) access pathways must be left from the eave to the roof ridge so fire fighters have an unobstructed area in which to cut ventilation openings. The exception exempts low-slope roofs (i.e., a slope that is 2:12 or less) due to the reduced hazards of such flatter roofs.

**605.11.1.2.4 Roofs with hips and valleys.** Panels and modules installed on Group R-3 buildings with roof hips and valleys shall not be located closer than 18 inches (457 mm) to a hip or a valley where panels/modules are to be placed on both sides of a hip or valley. Where panels are to be located on only one side of a hip or valley that is of equal length, the panels shall be permitted to be placed directly adjacent to the hip or valley.

**Exception:** These requirements shall not apply to roofs with slopes of two units vertical in 12 units horizontal (2:12) or less.

❖ Where installed on both sides of a roof hip or valley, PV arrays on the roofs of Group R-3 buildings must be located so they create a minimum 3-foot (914 mm) clearance between the PV arrays on opposing sides of the roof hip or valley so fire fighters have an unobstructed area in which to cut ventilation openings. The exception exempts low-slope roofs (i.e., a slope that is 2:12 or less) because of the reduced hazards of such flatter roofs.

**605.11.1.2.5 Allowance for smoke ventilation operations.** Panels and modules installed on Group R-3 buildings shall be located not less than 3 feet (914 mm) from the ridge in order to allow for fire department smoke ventilation operations.

**Exception:** Panels and modules shall be permitted to be located up to the roof ridge where an alternative ventilation method *approved* by the fire chief has been provided or where the fire chief has determined vertical ventilation techniques will not be employed.

❖ Manual ventilation is most effective when accomplished at the highest portion of the roof above the fire. This section establishes an obstruction-free zone within 3 feet (914 mm) of the roof ridge in order to optimize the area available for effective ventilation, allowing for a 2-foot (609.6 mm) trench cut.

The exception addresses the fact that in some cases vertical ventilation techniques or alternative techniques will not be used. This allows the panels and modules to be located higher up on the roof. Note that Exception 2 to Section 605.11.1 makes a similar allowance.

**605.11.1.3 Other than Group R-3 buildings.** Access to systems for buildings, other than those containing Group R-3 occupancies, shall be provided in accordance with Sections 605.11.1.3.1 through 605.11.1.3.3.

**Exception:** Where it is determined by the fire code official that the roof configuration is similar to that of a Group R-3 occupancy, the residential access and ventilation requirements in Sections 605.11.1.2.1 through 605.11.1.2.5 shall be permitted to be used.

❖ This section introduces PV system access requirements for other than Group R-3 buildings. The exception recognizes that nonresidential buildings are often constructed in a residential configuration and authorizes the fire code official to allow the provisions for Group R-3 construction styles to be used. The access and ventilation requirements are not occupancy specific but are affected most by the construction configuration.

**605.11.1.3.1 Access.** There shall be a minimum 6-foot-wide (1829 mm) clear perimeter around the edges of the roof.

**Exception:** Where either axis of the building is 250 feet (76 200 mm) or less, the clear perimeter around the edges of the roof shall be permitted to be reduced to a minimum 4 foot wide (1290 mm).

❖ PV arrays installed on the roofs of nonresidential buildings must be located so they create a minimum 6-foot (1829 mm) clearance between the PV array and roof edge so fire fighters have an unobstructed area in which to move and operate when cutting ventilation openings. The exception provides some flexibility for smaller buildings where less access to the roof is needed, therefore a reduced width of 4 feet is acceptable. Nongravity-operated smoke and heat vents require more access by the fire department to provide ventilation and require a 4-foot width around the vent.

**605.11.1.3.2 Pathways.** The solar installation shall be designed to provide designated pathways. The pathways shall meet the following requirements:

1. The pathway shall be over areas capable of supporting fire fighters accessing the roof.
2. The centerline axis pathways shall be provided in both axes of the roof. Centerline axis pathways shall run where the roof structure is capable of supporting fire fighters accessing the roof.
3. Pathways shall be a straight line not less than 4 feet (1290 mm) clear to roof standpipes or ventilation hatches.
4. Pathways shall provide not less than 4 feet (1290 mm) clear around roof access hatch with not less than one singular pathway not less than 4 feet (1290 mm) clear to a parapet or roof edge.

❖ Pathways must be established in the design of the solar installation and meet the requirements listed in this section. Placing the pathways over or adjacent to structural elements of the building provides a stable walking platform for personnel who will likely be carrying additional heavy equipment up to the roof. Straight pathways with a 4-foot (1290 mm) clearance to tripping and other hazards help provide a safe working environment for personnel assigned to roof-top operations.

**605.11.1.3.3 Smoke ventilation.** The solar installation shall be designed to meet the following requirements:

1. Arrays shall be not greater than 150 feet (45 720 mm) by 150 feet (45 720 mm) in distance in either axis in order to create opportunities for fire department smoke ventilation operations.
2. Smoke ventilation options between array sections shall be one of the following:
  - 2.1. A pathway 8 feet (2438 mm) or greater in width.
  - 2.2. A 4-foot (1290 mm) or greater in width pathway and bordering roof skylights or gravity-operated dropout smoke and heat vents on not less than one side.
  - 2.3. A 4-foot (1290 mm) or greater in width pathway and bordering all sides of nongravity-operated dropout smoke and heat vents.
  - 2.4. A 4-foot (1290 mm) or greater in width pathway and bordering 4-foot by 8-foot (1290 mm by 2438 mm) “venting cutouts” every 20 feet (6096 mm) on alternating sides of the pathway.

❖ This section establishes design options for providing adequate space among and around the PV arrays for safe fire department ventilation operations. Note that skylights and gravity-operated smoke and heat vents are only required to provide access on one side. Skylights are not intended to serve a ventilation purpose. In addition, gravity-operated smoke and heat vents will automatically provide ventilation if needed. Non-

gravity-operated smoke and heat vents will require more intervention from the fire department, therefore more access to those vents will be needed.

**605.11.2 Ground-mounted photovoltaic arrays.** Ground-mounted photovoltaic arrays shall comply with Section 605.11 and this section. Setback requirements shall not apply to ground-mounted, free-standing photovoltaic arrays. A clear, brush-free area of 10 feet (3048 mm) shall be required for ground-mounted photovoltaic arrays.

❖ This section applies all requirements for rooftop PV systems to ground-mounted PV systems except for the access, pathway and smoke ventilation clearance requirements since the physical hazards of a ground-mounted system are reduced. For visibility and service and emergency access, a clear zone around the arrays is required.

**605.12 Abandoned wiring in plenums.** Accessible portions of abandoned cables in air-handling plenums shall be removed. Cables that are unused and have not been tagged for future use shall be considered abandoned.

❖ This section introduces a concept that has long been in NFPA 70 and NFPA 90A—that plenums (see Chapter 2 commentary to the definition of “Plenum”) are intended specifically to be a part of the air distribution system. Plenums are also used legitimately for stringing communications and data cables as well as utility pipes, sprinkler pipes and similar items. However, such items often are not removed from the plenum when they become obsolete. For example, when an updated data system is installed in a facility (which can occur every 18 to 24 months), it is not unusual for old wires to be cut out of the system but left in place with a new wiring system added on top of them (see Commentary Figure 605.12).

The suspended ceiling tile systems that often enclose plenums are not intended to support any significant weight and can, therefore, easily be overwhelmed by the added weight of storage or abandoned materials such as cables (see commentary to IBC Section 808.1.1.1). Recently, a plenum space fuel load study showed how the safety of fire fighters is compromised by the weight of these abandoned cables. It pointed out that plenum space fuel loads and wiring issues are serious concerns for fire fighters during interior fire-fighting operations and its key recommendation was that abandoned wiring be removed.

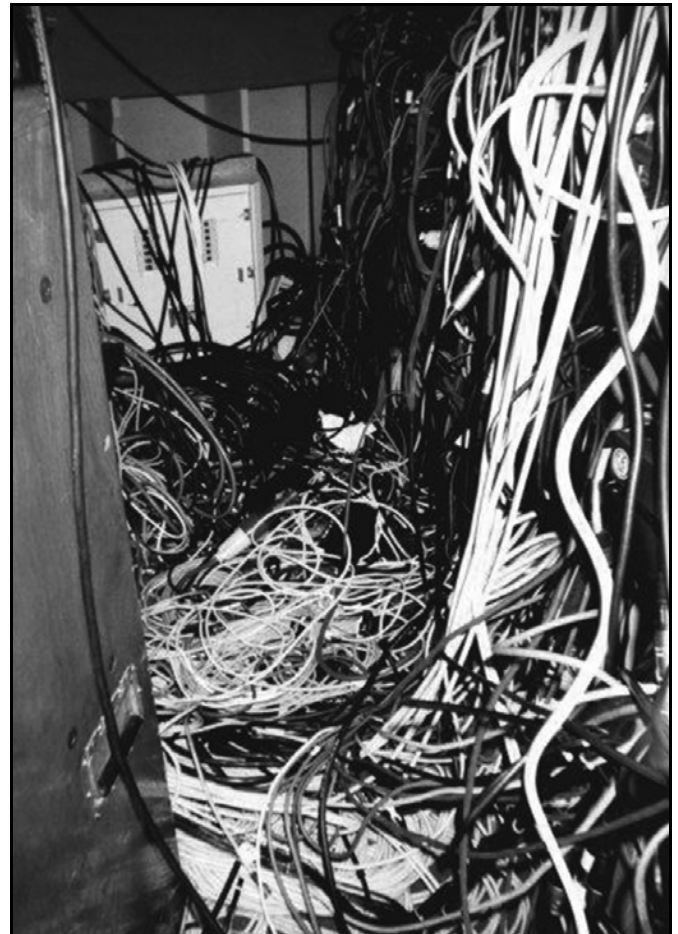
Although the primary reason to require the removal of abandoned materials in plenums is the elimination of unnecessary weight, fire safety considerations should also be taken into account, as should the practical consideration that the HVAC design airflow through the plenum could be adversely affected. Such a requirement was long believed not to be enforceable primarily because fire code inspectors would rarely spend their time looking into plenums in existing buildings. However, the danger presented by the fire load of storage or abandoned materials is well-documented. Thus, there should be no signifi-

cant difficulty in having inspectors identify the existence of abandoned products—especially abandoned cables—classify them as storage and require their removal. Note that only the “accessible portions” of abandoned cables must be removed because there is no intent to cause potential damage to the building or facility by attempting to remove cables or circuits that are strung through walls, floors or other building elements. Where some cables are left in place because they are intended to be reused at a future date, they must be clearly identified as such by affixing a tag. See also Section 315.6.

## SECTION 606 MECHANICAL REFRIGERATION

[M] **606.1 Scope.** Refrigeration systems shall be installed in accordance with the *International Mechanical Code*.

❖ Chapter 11 of the IMC, in conjunction with ASHRAE 15 and IAR 2 provides complete coverage for the design, installation and maintenance of refrigeration systems.



**Figure 605.12  
ABANDONED WIRING IN PLENUM**

**[M] 606.2 Refrigerants.** The use and purity of new, recovered and reclaimed refrigerants shall be in accordance with the *International Mechanical Code*.

❖ Refrigeration equipment is designed to operate with a specific type or types of refrigerant. Using the wrong refrigerant or a contaminated refrigerant could cause equipment damage or loss of operating efficiency. Refrigerant types differ in how they react with system lubricants, seals, gaskets and other components.

Existing equipment may have to be converted to a different type of refrigerant or charged with refrigerant recovered from it or another system; however, it would be an unnecessary risk to charge new equipment with any refrigerant other than that specified by the equipment manufacturer. See the commentary to Section 1102.2 of the IMC.

**[M] 606.3 Refrigerant classification.** Refrigerants shall be classified in accordance with the *International Mechanical Code*.

❖ The classification of refrigerants is based on ASHRAE 34, which numbers and classifies refrigerants in accordance with their potential hazards. In the IMC, refrigerants are identified by their number, which is preceded by the letter “R” (for example, R-22). Trademark names of manufacturers, such as “Freon,” are not used. The refrigerant number, name and chemical formula can be found in IMC Table 1103.1.

Each refrigerant is classified into a safety group that is based on two factors: flammability and toxicity. The safety group in which an individual refrigerant is classified relates to the potential hazard to building occupants and fire fighters and is one of the factors used to determine the maximum quantities of refrigerants allowed by the IMC. See the commentary to Section 1103.1 of the IMC.

**[M] 606.4 Change in refrigerant type.** A change in the type of refrigerant in a refrigeration system shall be in accordance with the *International Mechanical Code*.

❖ The intent of this section is to keep the local fire code official up-to-date on the status of large refrigeration systems and systems containing toxic and/or flammable refrigerants. See the commentary to Section 1101.8 of the IMC.

**606.5 Access.** Refrigeration systems having a refrigerant circuit containing more than 220 pounds (100 kg) of Group A1 or 30 pounds (14 kg) of any other group refrigerant shall be accessible to the fire department at all times as required by the *fire code official*.

❖ Where any one or more refrigeration circuits contain more than the specified quantity limits, the room or building housing the system or systems must be constructed with fire department access for emergency response, inspection and hazard assessment. Refrigerants of other than Group A1 tend to be more flammable or toxic. This section could require that the fire

department be given keys to refrigeration machinery rooms and buildings.

**606.6 Testing of equipment.** Refrigeration equipment and systems having a refrigerant circuit containing more than 220 pounds (100 kg) of Group A1 or 30 pounds (14 kg) of any other group refrigerant shall be subject to periodic testing in accordance with Section 606.6.1. Records of tests shall be maintained. Tests of emergency devices or systems required by this chapter shall be conducted by persons trained and qualified in refrigeration systems.

❖ This section sets forth which refrigeration systems are subject to periodic testing and states that records of such testing must be maintained. Minimum qualifications are also required for testing personnel.

As a result of a review of Recommendation 2(c) of the NIST Charleston, South Carolina Sofa Superstore Fire Report, changes were made to Sections 107.2 and 107.3, along with 49 other sections (including this section), to comprehensively address recordkeeping requirements. Section 107.3 provides standardized recordkeeping requirements for periodic inspection, testing, servicing and other operational and maintenance requirements of the code and makes it clear that records must be maintained on the premises or another approved location and that copies of records must be provided to the fire code official upon request. Section 107.3 also makes it clear that records must be maintained for a period of not less than 3 years unless a different time interval is specified in the code or a referenced standard, and that the fire code official is authorized to prescribe the form and format of such records. See the commentaries to Sections 107.2, 107.3, 107.4 and 606.6.1.

**606.6.1 Periodic testing.** The following emergency devices or systems shall be periodically tested in accordance with the manufacturer’s instructions and as required by the *fire code official*.

1. Treatment and flaring systems.
2. Valves and appurtenances necessary to the operation of emergency refrigeration control boxes.
3. Fans and associated equipment intended to operate emergency ventilation systems.
4. Detection and alarm systems.

❖ The devices and systems listed in this section are critical life safety and fire protection elements; therefore, it is imperative that they be tested periodically to assess their condition and dependability. Failure of the safety systems could lead to deadly consequences for building occupants and fire personnel entering the building in an emergency situation. See also the commentary to Section 1109.1 of the IMC.

**606.7 Emergency signs.** Refrigeration units or systems having a refrigerant circuit containing more than 220 pounds (100 kg) of Group A1 or 30 pounds (14 kg) of any other group refrigerant shall be provided with *approved* emergency

signs, charts and labels in accordance with NFPA 704. Hazard signs shall be in accordance with the *International Mechanical Code* for the classification of refrigerants listed therein.

- ❖ Signs, charts and labels are necessary to assist emergency response personnel in carrying out their duties to protect building occupants and protect themselves from the hazards associated with refrigerant chemicals (see IMC Table 1103.1).

**606.8 Refrigerant detector.** Machinery rooms shall contain a refrigerant detector with an audible and visual alarm. The detector, or a sampling tube that draws air to the detector, shall be located in an area where refrigerant from a leak will concentrate. The alarm shall be actuated at a value not greater than the corresponding TLV-TWA values shown in the *International Mechanical Code* for the refrigerant classification. Detectors and alarms shall be placed in *approved* locations. The detector shall transmit a signal to an *approved* location.

- ❖ Section 1105.3 of the IMC refers to the code for refrigerant detector requirements. Refrigerant detectors provide early warning of refrigerant leakage. Such leakage could result in a significant fire or health hazard if not discovered and stopped or if occupants are not evacuated from the building. Machinery rooms are required by the IMC where refrigerant quantities exceed specified limits.

Detector location is critical to early leakage warning and should comply with the detector manufacturer's instructions. The required detectors must be designed for application with the refrigerant or refrigerants used in the machinery room. Because machinery rooms are unattended most of the time, once the refrigerant gas is detected at the levels noted in this section, a local alarm must be initiated and a signal must be transmitted to an approved location remote from the machinery room, such as a security room or fire command center, or possibly to an on-duty, on-site technician via pager or cell phone. The alarm is intended to alert those both inside the area of detection and in the immediate vicinity to prevent harm to those outside the area of refrigerant gas release. The notification to an approved location provides timely information to those who must take a role in emergency response, whereas the local alarm is a warning for those in the vicinity of the release. As a first step in the mitigation of the hazards of fugitive refrigerant gas, the required detectors have the additional important role of activating the emergency ventilation/exhaust systems in the machinery rooms required by Sections 1105.6.3 and 1106.3 of the IMC (see the definition of "Machinery room" and Table 1103.1, both in the IMC).

**606.9 Remote controls.** Where flammable refrigerants are used and compliance with Section 1106 of the *International Mechanical Code* is required, remote control of the mechanical equipment and appliances located in the machinery room as required by Sections 606.9.1 and 606.9.2 shall be provided

at an approved location immediately outside the machinery room and adjacent to its principal entrance.

- ❖ Emergency controls located outside of the machinery room enclosure will allow shutdown of the compressors and related equipment without requiring someone to enter the room and risk being exposed to refrigerant or fire. This arrangement would also permit equipment shutdown by fire-fighting personnel without the risk of fire spreading into or out of the fire-resistance-rated enclosure. The controls must be located near the entrance to the machinery room so that their location is conspicuous. The controls should be labeled and color coded so that their purpose is obvious. Such controls are customarily painted red to make them readily identifiable as emergency devices.

**606.9.1 Refrigeration system emergency shutoff.** A clearly identified switch of the break-glass type or with an *approved* tamper-resistant cover shall provide off-only control of refrigerant compressors, refrigerant pumps and normally closed automatic refrigerant valves located in the machinery room. Additionally, this equipment shall be automatically shut off when the refrigerant vapor concentration in the machinery room exceeds the vapor detector's upper detection limit or 25 percent of the LEL, whichever is lower.

- ❖ The intent of this section of the code is to provide a safe environment for emergency response personnel when responding to an incident in a refrigeration room. Shutting down compressors and related refrigeration equipment could be necessary to prevent a hazardous condition from worsening and to allow the room to be safely entered. The emergency "kill" switch must be a tamper-resistant type (similar to manual fire alarm boxes) that requires more than one action to actuate it. To prevent an accidental startup, the switch must be capable of only stopping the controlled machinery, not restarting it. The switch must not affect the operation of life safety systems, such as detectors and exhaust equipment, and must not affect room and egress lighting. In addition to the manual switch, the required refrigerant room detector must also shut down the same equipment when the vapor concentration exceeds the lesser of the detector's upper detection limit or 25 percent of the refrigerant's lower explosive limit (LEL).

**606.9.2 Ventilation system.** A clearly identified switch of the break-glass type or with an approved tamper-resistant cover shall provide on-only control of the machinery room ventilation fans.

- ❖ For the same reasoning stated in the commentary to Section 606.9.1, a remote switch is required that is not connected to the exhaust system. Although not specifically stated, the intent is for the remote control to activate the emergency mode of operation (see IMC commentary, Section 1106.5.2). To maximize the dependability of the exhaust systems, ASHRAE 15 requires that they be powered from independent dedicated electrical branch circuits.

**606.10 Emergency pressure control system.** Permanently installed refrigeration systems containing more than 6.6 pounds (3 kg) of flammable, toxic or highly toxic refrigerant or ammonia shall be provided with an emergency pressure control system in accordance with Sections 606.10.1 and 606.10.2.

❖ Technological advances in refrigeration system control equipment now make it possible to provide an automatic emergency control system to replace key functions of the traditional emergency control box. The automatic controls required by Sections 606.10.1 through 606.10.2.2 provide a means of mitigating an overpressure condition prior to operation of emergency pressure-relief vents and, most likely, prior to the arrival of emergency responders. The automatic valves also eliminate the need for emergency responders to decipher the condition of a system in an attempt to determine whether operation of manual crossover valves in an emergency control box would be of benefit in mitigating a system malfunction. The 6.6-pound (3 kg) threshold parallels existing provisions in Section 606.11. This section parallels Section 1105.9 of the IMC to increase the likelihood that designers don't miss this design requirement in the code. Note that these provisions are intended for permanently installed systems versus portable systems such as agricultural cooling trailers used in fields and at processing facilities. This is specifically clarified by the term "permanently installed."

Overall, these provisions add a requirement for a fully redundant safety control system in lieu of a manual system that has proven itself to be rarely, if ever, utilized by the fire service. This favorably resolves long-standing concerns regarding the potential for harm caused by an untrained person operating valves in an emergency control box. There is no condition where removal of refrigerant from a refrigeration system by the fire service is considered advisable. In contrast, automatic transfer of excess pressure to another zone of the system in conjunction with stopping the pressure source (i.e., the compressors) can safely mitigate an overpressure condition.

**606.10.1 Automatic crossover valves.** Each high- and intermediate-pressure zone in a refrigeration system shall be provided with a single automatic valve providing a crossover connection to a lower pressure zone. Automatic crossover valves shall comply with Sections 606.10.1.1 through 606.10.1.3.

❖ The requirement for a single crossover valve between systems is based on the traditional industry practice of providing a single manual crossover valve in the emergency control box. In the unlikely event that a fire causes an overpressure condition, allowing system zones to automatically interconnect creates a much larger heat sink to limit pressure buildup while safely containing refrigerant. If the exposure fire continues to grow, emergency relief vents can protect the refrigeration system and automatic reseating valves

can automatically limit the release of refrigerant to the amount necessary to maintain the system within design limits. In contrast, most emergency responders would not possess the expertise to properly cycle a manual valve in an emergency control box to limit the release of refrigerant to the minimum amount necessary for safety.

**606.10.1.1 Overpressure limit set point.** Automatic crossover valves shall be arranged to automatically relieve excess system pressure to a lower pressure zone if the pressure in a high- or intermediate-pressure zone rises to within 90 percent of the set point for emergency pressure relief devices.

❖ This section provides a safety buffer between activation of the emergency pressure control system (EPCS) and operation of a relief valve. Because of variances in operational tolerances among relief valves and because some relief valves may begin to seep at 90 percent of their rated operating pressure, it is appropriate to have the EPCS shut down a system if system pressure rises to 90 percent of the relief valve set pressure. This further reduces the potential for any release from a system that has malfunctioned and overpressurized.

**606.10.1.2 Manual operation.** Where required by the *fire code official*, automatic crossover valves shall be capable of manual operation.

❖ This section authorizes the local fire code official to require manual control capabilities for the crossover valve. Although this provision is not regarded as necessary by the industry, it is recognized that some fire departments will prefer to have the manual control capability for backup.

**606.10.1.3 System design pressure.** Refrigeration system zones that are connected to a higher pressure zone by an automatic crossover valve shall be designed to safely contain the maximum pressure that can be achieved by interconnection of the two zones.

❖ This provision requires lower pressure zones to be capable of handling additional pressure added by a crossover condition without overpressurizing or operating the emergency relief vents on the lower zone. The legacy codes did not address this concern, given the assumption that someone operating a manual bypass valve in the emergency control box would be knowledgeable with regard to system limitations; however, this may or may not be true. Nevertheless, the legacy codes never required the low pressure side of the system to handle the high-side pressure, and as a result, some systems with emergency control boxes present the potential for an emergency responder to overpressurize a system zone by fully opening a manual crossover valve too quickly. The resulting overpressure condition could cause operation of a relief vent or even a failure in the piping system.

**606.10.2 Automatic emergency stop.** An automatic emergency stop feature shall be provided in accordance with Sections 606.10.2.1 and 606.10.2.2.

❖ This establishes applicability of the requirements for the additional safety feature of an emergency stop feature in refrigeration systems.

**606.10.2.1 Operation of an automatic crossover valve.** Operation of an automatic crossover valve shall cause all compressors on the affected system to immediately stop. Dedicated pressure-sensing devices located immediately adjacent to crossover valves shall be permitted as a means for determining operation of a valve. To ensure that the automatic crossover valve system provides a redundant means of stopping compressors in an overpressure condition, high-pressure cutout sensors associated with compressors shall not be used as a basis for determining operation of a crossover valve.

❖ The intent of this section is for the automatic crossover system to have a fully redundant means of stopping compressors. Compressors are ordinarily provided with automatic high-pressure cutout controls, but this section requires that these controls not be used to satisfy the requirement. An additional set of controls can be required to serve as a backup means of preventing a severe overpressure condition that could cause operation of an emergency relief vent.

**606.10.2.2 Overpressure in low-pressure zone.** The lowest pressure zone in a refrigeration system shall be provided with a dedicated means of determining a rise in system pressure to within 90 percent of the set point for emergency pressure relief devices. Activation of the overpressure sensing device shall cause all compressors on the affected system to immediately stop.

❖ The lowest pressure zone of a system cannot be arranged to bleed pressure to another system zone since crossing the lowest pressure zone to a higher pressure zone would most likely result in reverse flow. However, by providing a redundant emergency stop control, which would disengage the compressor, an overpressure condition should be automatically mitigated. Overpressure on a low-pressure zone would most likely result from a defrost line from the high side that is stuck in the open position, and stopping the compressor will disengage the pressure source for the defrost system. Note that compressors will only cut out if an overpressure condition occurs. If the emergency condition involves a leak on the low side, compressors will continue to operate, which is beneficial in pumping down the low side for this type of event.

**606.11 Storage, use and handling.** Flammable and combustible materials shall not be stored in machinery rooms for refrigeration systems having a refrigerant circuit containing more than 220 pounds (100 kg) of Group A1 or 30 pounds

(14 kg) of any other group refrigerant. Storage, use or handling of extra refrigerant or refrigerant oils shall be as required by Chapters 50, 53, 55 and 57.

**Exception:** This provision shall not apply to spare parts, tools and incidental materials necessary for the safe and proper operation and maintenance of the system.

❖ Storage of materials could introduce additional hazards in rooms already considered to be hazardous because of large quantities of refrigerants in the system circuits and machines.

**606.12 Discharge and termination of pressure relief and purge systems.** Pressure relief devices, fusible plugs and purge systems discharging to the atmosphere from refrigeration systems containing flammable, toxic or highly toxic refrigerants or ammonia shall comply with Sections 606.12.3 through 606.12.5.

❖ Discharge systems are intended to treat, incinerate or absorb flammable or toxic refrigerants that would otherwise be released unaltered into the atmosphere. Release would result from the operation of pressure relief devices or intentional dumping of refrigerant in an emergency. Specific requirements are found in the subsections for each type of refrigeration system.

**606.12.1 Standards.** Refrigeration systems and the buildings in which such systems are installed shall be in accordance with ASHRAE 15.

❖ This section is simply making sure that all ammonia refrigeration systems comply with ASHRAE 15 in addition to the requirements of Section 606.12. This section parallels Section 1105.8 of the IMC, which also references ASHRAE 15.

**606.12.1.1 Ammonia refrigeration.** Refrigeration systems using ammonia refrigerant and the buildings in which such systems are installed shall comply with IAR-2 for system design and installation and IAR-7 for operating procedures.

❖ This reference provides appropriate referenced standards for refrigeration system design and installation and for operating procedures. These standards are considered essential for facilities with ammonia refrigeration systems as a basis of providing for the safety of these facilities, as well as surrounding communities.

**606.12.2 Fusible plugs and rupture members.** Discharge piping and devices connected to the discharge side of a fusible plug or rupture member shall have provisions to prevent plugging the pipe in the event the fusible plug or rupture member functions.

❖ This section is intended to ensure that, through the use of discharge piping and devices, the emergency pressure relief system will not become obstructed in the event that a fusible plug or rupture member operates and causes debris to be ejected into the relief system.

**606.12.3 Flammable refrigerants.** Systems containing more than 6.6 pounds (3 kg) of flammable refrigerants having a density equal to or greater than the density of air shall discharge vapor to the atmosphere only through an *approved* treatment system in accordance with Section 606.12.6 or a flaring system in accordance with Section 606.12.7. Systems containing more than 6.6 pounds (3 kg) of flammable refrigerants having a density less than the density of air shall be permitted to discharge vapor to the atmosphere provided that the point of discharge is located outside of the structure at not less than 15 feet (4572 mm) above the adjoining grade level and not less than 20 feet (6096 mm) from any window, ventilation opening or *exit*.

❖ Where they have a density greater than air (i.e., are heavier than air) and pose the hazard of collecting in low points, which could bring them into contact with ignition sources, flammable refrigerants (A2, B2, A3, B3) must be incinerated in a flaring system (see Section 6004.2.2.7.1). The second sentence of the provision is derived from ANSI/ASHRAE 15 and recognizes the reduced hazard of lighter-than-air flammable refrigerants by allowing them to discharge to the atmosphere without incineration or treatment since they would either dissipate into the air or flare at the point of discharge. Because of their flammability hazard, however, the point of discharge must be located out of reach from grade and well away from building openings. Note that these provisions apply only to systems that contain more than 6.6 pounds (3 kg) of refrigerant because systems containing smaller quantities are considered “small systems” and their relative hazard is considered insignificant.

**606.12.4 Toxic and highly toxic refrigerants.** Systems containing more than 6.6 pounds (3 kg) of toxic or highly toxic refrigerants shall discharge vapor to the atmosphere only through an *approved* treatment system in accordance with Section 606.12.6 or a flaring system in accordance with Section 606.12.7.

❖ Toxic refrigerants, like flammable refrigerants, must be treated to reduce their toxicity or be destroyed by incineration (see Section 6004.2.2.7.1).

**606.12.5 Ammonia refrigerant.** Systems containing more than 6.6 pounds (3 kg) of ammonia refrigerant shall discharge vapor to the atmosphere in accordance with one of the following methods:

1. Directly to atmosphere where the *fire code official* determines, on review of an engineering analysis prepared in accordance with Section 104.7.2, that a fire, health or environmental hazard would not result from atmospheric discharge of ammonia.
2. Through an *approved* treatment system in accordance with Section 606.12.6.
3. Through a flaring system in accordance with Section 606.12.7.
4. Through an *approved* ammonia diffusion system in accordance with Section 606.12.8.

5. By other *approved* means.

**Exception:** Ammonia/water absorption systems containing less than 22 pounds (10 kg) of ammonia and for which the ammonia circuit is located entirely outdoors.

❖ This section is more restrictive than ASHRAE 15 in that it requires the discharge to be treated in one of the listed methods. Item 1 recognizes that there are some cases, such as at remote facilities, where atmospheric discharge of ammonia would pose no danger to people or property. Further, it provides a basis in the code for permitting relief lines on ammonia refrigeration systems to discharge to the atmosphere when an appropriate analysis, accepted by the fire code official, has shown that such discharge can be accomplished safely. In such cases, a flaring or water diffusion system would serve no beneficial purpose, since ammonia is naturally biodegradable. Items 2 through 4 allow the use of one of three methods, including treatment systems, flaring system or an ammonia diffusion system.

Item 5 recognizes that engineered designs can be used to activate an alarm and automatically stop the leak rather than relying on manual means to stop the leak and a water tank to treat whatever release may occur before manual intervention can be accomplished.

The exception recognizes the reduced hazard in smaller systems where the ammonia circuit is completely outdoors.

**606.12.6 Treatment systems.** Treatment systems shall be designed to reduce the allowable discharge concentration of the refrigerant gas to not more than 50 percent of the IDLH at the point of exhaust. Treatment systems shall be in accordance with Chapter 60.

❖ See the commentary to Section 6004.2.2.7. “Immediately Dangerous to Life and Health (IDLH)” is defined in Section 202.

**606.12.7 Flaring systems.** Flaring systems for incineration of flammable refrigerants shall be designed to incinerate the entire discharge. The products of refrigerant incineration shall not pose health or environmental hazards. Incineration shall be automatic upon initiation of discharge, shall be designed to prevent blowback and shall not expose structures or materials to threat of fire. Standby fuel, such as LP-gas, and standby power shall have the capacity to operate for one and one-half the required time for complete incineration of refrigerant in the system. Standby electrical power, where required to complete the incineration process, shall be in accordance with Section 604.

❖ Destruction of refrigerant by incineration is supposed to render the discharge harmless, so obviously the flames and the combustion byproducts do not pose a hazard themselves. Because most refrigerants would not support combustion unaided, a fuel source is necessary to sustain incineration.

**606.12.8 Ammonia diffusion systems.** Ammonia diffusion systems shall include a tank containing 1 gallon of water for

each pound of ammonia (8.3 L of water for each 1 kg of ammonia) that will be released in 1 hour from the largest relief device connected to the discharge pipe. The water shall be prevented from freezing. The discharge pipe from the pressure relief device shall distribute ammonia in the bottom of the tank, but not lower than 33 feet (10 058 mm) below the maximum liquid level. The tank shall contain the volume of water and ammonia without overflowing.

❖ Ammonia is readily absorbed by water; therefore, an ammonia discharge into a water tank would be chemically held in the tank. The water tank may have to be heated to prevent it from freezing, which would block the discharge pipe and make the water useless for absorbing ammonia. The deeper the discharge pipe extends below the water surface, the greater the pressure the discharge would have to overcome to escape from the pipe. A 33-foot (10 058 mm) depth of water would exert a pressure approximately equal to sea level atmospheric pressure [14.7 psi (101 kPa)].

**606.13 Discharge location for refrigeration machinery room ventilation.** Exhaust from mechanical ventilation systems serving refrigeration machinery rooms containing flammable, toxic or highly toxic refrigerants, other than ammonia, capable of exceeding 25 percent of the LFL or 50 percent of the IDLH shall be equipped with *approved* treatment systems to reduce the discharge concentrations to those values or lower.

❖ In previous editions of the code, this section required the discharge of mechanical ventilation systems serving refrigeration machinery rooms utilizing anhydrous ammonia to be directed to a treatment system to reduce the toxicity to 50 percent of its IDLH value, the same as the more hazardous refrigerants. This section now permits the mechanical ventilation system to exhaust directly to the atmosphere when anhydrous ammonia is the refrigerant. Anhydrous ammonia is classified by Table 1103.1 of the IMC as a corrosive liquefied compressed gas. It is not a toxic or highly toxic gas, as defined in Section 202 of the code, nor does it meet the definition of a flammable gas. It has a vapor density of 0.597, making it lighter than air, and is extremely hygroscopic (a Latin word literally meaning “water seeking”), thus it aggressively absorbs water. Anhydrous ammonia’s water-absorbing abilities can be of benefit to fire fighters, who can use hose or master streams to control anhydrous ammonia if it is leaking.

Exclusion of anhydrous ammonia from the requirement of this section also provides correlation with Section 1105.8 of the IMC, which addresses pressure relief systems for refrigeration systems. The IMC requires pressure relief devices be terminated in accordance with the requirements of American Society of Refrigeration and Air Conditioning Engineers (ASHRAE) Standard 15, Safety Standard for Refrigeration Systems. ASHRAE 15 requires pressure relief devices serving ammonia refrigeration equipment to be terminated outside of buildings and permits these devices to discharge to the atmosphere.

**606.14 Notification of refrigerant discharges.** The *fire code official* shall be notified immediately when a discharge becomes reportable under state, federal or local regulations in accordance with Section 5003.3.1.

❖ Emergency personnel must be informed of a discharge so that they can respond appropriately. The refrigerant discharge notification requirements of this section parallel those required for all hazardous materials in Section 5003.3.1. There is no reason for different requirements for refrigerants than for other hazardous materials.

**606.15 Records.** A record of refrigerant quantities brought into and removed from the premises shall be maintained.

❖ Emergency personnel must be able to maintain accurate assessments of the dangers they may face and the hazards the public may face in and around buildings housing refrigeration systems.

As a result of a review of Recommendation 2(c) of the NIST Charleston, South Carolina Sofa Superstore Fire Report, changes were made to Sections 107.2 and 107.3, along with 49 other sections (including this section), to comprehensively address recordkeeping requirements. Section 107.3 provides standardized recordkeeping requirements for periodic inspection, testing, servicing and other operational and maintenance requirements of the code and makes it clear that records must be maintained on the premises or another approved location and that copies of records must be provided to the fire code official upon request. Section 107.3 also makes it clear that records must be maintained for a period of not less than 3 years unless a different time interval is specified in the code or a referenced standard, and that the fire code official is authorized to prescribe the form and format of such records. See the commentaries to Sections 107.2 and 107.3.

**606.16 Electrical equipment.** Where refrigerants of Groups A2, A3, B2 and B3, as defined in the *International Mechanical Code*, are used, refrigeration machinery rooms shall conform to the Class I, Division 2 hazardous location classification requirements of NFPA 70.

**Exception:** Ammonia machinery rooms that are provided with ventilation in accordance with Section 1106.3 of the *International Mechanical Code*.

❖ This section mirrors the text of Section 1106.4 of the IMC and is included in the code because, in some jurisdictions, the fire code official is designated to inspect classified electrical equipment. A reference to classified electrical requirements here is consistent with the approach taken in Chapters 50 and 57 for other hazardous materials and flammable liquids, and it provides the fire code official with the provisions that are to be enforced.

The exception for ammonia refrigerant is consistent with requirements of NFPA 70 and is included here to avoid possible confusion regarding the need for classified electrical equipment in ammonia machinery rooms. Because ammonia can combust within a lim-

ited range of concentrations in the air, the fire code official might be led to believe that classified electrical equipment should be provided in ammonia storage and use areas; however, when such areas are ventilated to maintain ammonia vapor in a concentration that is outside of the flammable range, there is no need for classified electrical equipment.

**SECTION 607  
ELEVATOR OPERATION,  
MAINTENANCE AND FIRE SERVICE KEYS**

**607.1 Emergency operation.** Existing elevators with a travel distance of 25 feet (7620 mm) or more shall comply with the requirements in Chapter 11. New elevators shall be provided with Phase I emergency recall operation and Phase II emergency in-car operation in accordance with ASME A17.1.

❖ Elevators are often used as a tool by emergency personnel when responding to fires and other emergencies. Due to these needs, the elevators must be capable of providing certain functions such as recall and emergency operation.

This section establishes requirements for both new and existing elevators. Existing elevators that travel 25 feet (635 mm) or more above or below the main level must, as a minimum, be equipped with emergency operation capabilities that comply with ASME A17.3 as required by Section 1103.3.2. New elevator installations are held to more restrictive guidelines for increased cost effectiveness and must have both emergency recall (Phase I) and emergency in-car operation (Phase II) to comply with ASME A17.1 for any amount of travel distance. The ASME standards are safety codes for elevators and escalators: ASME A17.3 is for existing elevators and ASME A17.1 for new elevator installations.

**607.2 Standby power.** In buildings and structures where standby power is required or furnished to operate an elevator, standby power shall be provided in accordance with Section 604. Operation of the system shall be in accordance with Sections 607.2.1 through 607.2.4.

❖ This section states how standby power is to be supplied to elevators when required by other sections, such as Section 604.2.17. The requirements from this section are the same as those located in Chapter 30 of the IBC.

**607.2.1 Manual transfer.** Standby power shall be manually transferable to all elevators in each bank.

❖ This section requires that whenever necessary, all elevators in each bank of elevators must be equipped for manual transfer to standby power. All elevators, however, would not need to operate on standby power at the same time; they would have to have manual transfer capability.

**607.2.2 One elevator.** Where only one elevator is installed, the elevator shall automatically transfer to standby power within 60 seconds after failure of normal power.

❖ When a building has a single elevator, it must be automatically transferred to standby power within 60 seconds. The 60 seconds is a reflection of the NFPA 70 requirements for standby power.

**607.2.3 Two or more elevators.** Where two or more elevators are controlled by a common operating system, all elevators shall automatically transfer to standby power within 60 seconds after failure of normal power where the standby power source is of sufficient capacity to operate all elevators at the same time. Where the standby power source is not of sufficient capacity to operate all elevators at the same time, all elevators shall transfer to standby power in sequence, return to the designated landing and disconnect from the standby power source. After all elevators have been returned to the designated level, not less than one elevator shall remain operable from the standby power source.

❖ When there is more than one elevator operating off of a common system, the elevators must all be transferred to standby power within 60 seconds. When only one elevator needs to be available during a loss of power, all elevators must still have the ability to run on standby power. Specifically, all elevators must initially connect to the standby power system and then, in sequence, return to the designated floor where all but one would be disconnected from the standby power.

**607.2.4 Machine room ventilation.** Where standby power is connected to elevators, the machine room ventilation or air conditioning shall be connected to the standby power source.

❖ This section reduces the likelihood that the equipment running the elevators will overheat during a loss of power because standby power is also required to power the ventilation or air conditioning for those areas. Note that this would also address machine spaces, control rooms and control spaces.

**[BE] 607.3 Emergency signs.** An *approved* pictorial sign of a standardized design shall be posted adjacent to each elevator call station on all floors instructing occupants to use the exit stairways and not to use the elevators in case of fire. The sign shall read: IN FIRE EMERGENCY, DO NOT USE ELEVATOR. USE EXIT STAIRS.

**Exceptions:**

1. The emergency sign shall not be required for elevators that are part of an accessible *means of egress* complying with Section 1009.4.
2. The emergency sign shall not be required for elevators that are used for occupant self-evacuation in accordance with Section 3008 of the *International Building Code*.

❖ Because of the needs of fire fighters and the possible risks posed by the use of elevators during a fire, sig-

nage is required that prohibits the use of elevators by building occupants during a fire emergency. The need to evacuate all occupants regardless of their physical abilities is becoming a more important issue and, in some cases, elevators are specifically used for such purposes. Elevators used as part of the means of egress must comply with Section 1009.4.

**607.4 Fire service access elevator lobbies.** Where fire service access elevators are required by Section 3007 of the *International Building Code*, fire service access elevator lobbies shall be maintained free of storage and furniture.

❖ The fire service access elevator in high-rise buildings over 120 feet (3657 mm) in height above fire department vehicle access, as now required by Section 403.6.1 of the IBC, is a tool which enhances fire fighters' abilities to gain access to the fire floor and undertake necessary operational staging activities in a protected area. This section complements the provisions of the fire service access elevator provisions contained in Section 3007 of the IBC by requiring that fire service access elevator lobbies always be fully and immediately accessible by the fire service without impediment by storage or furniture and the fire load that some items might present. It is not unusual, especially in Group R-1 occupancies, to see tables, chairs, sofas or the like placed in areas opposite elevator entrances for aesthetic purposes in what may now be a required fire service access elevator lobby. This section would prohibit that practice. It should also be noted that the provisions of this section apply to noncombustible storage and furnishings, as well as combustible (see the IBC commentary, Sections 403.6.1 and 3007).

**607.5 Occupant evacuation elevator lobbies.** Where occupant evacuation elevators are provided in accordance with Section 3008 of the *International Building Code*, occupant evacuation elevator lobbies shall be maintained free of storage and furniture.

❖ This section is similar in intent to Section 607.4 for fire service access elevators except that the focus is providing adequate space for those awaiting evacuation via the elevators. If storage or furnishings are allowed, it takes away from that space and also will cause more people to wait outside the protected lobby. Placing combustibles within the lobby also creates potential fire hazards.

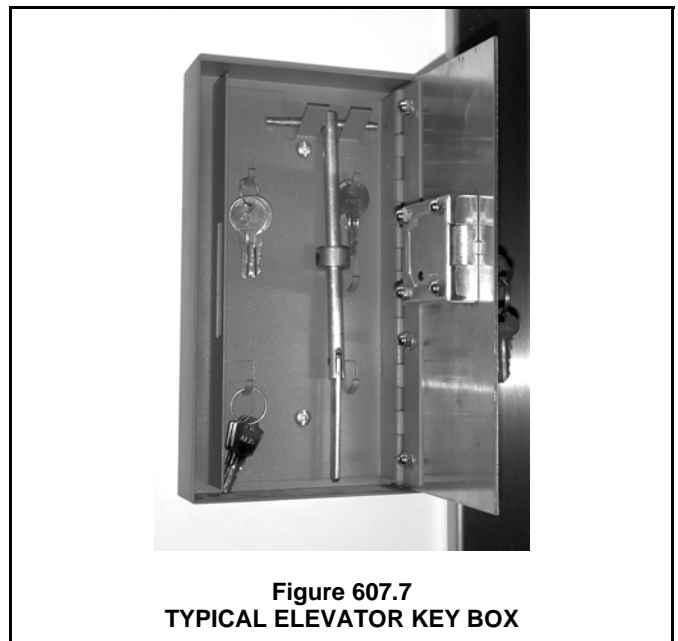
**607.6 Water protection of hoistway enclosures.** Methods to prevent water from infiltrating into a hoistway enclosure required by Section 3007.4 and Section 3008.4 of the *International Building Code* shall be maintained.

❖ Sections 3007.4 and 3008.4 of the IBC require that hoistway openings be protected from water originating from sprinklers activated outside of the elevator lobby. This is critical to extend the use of elevators during a fire. The methods used are not prescribed in the IBC but often will require some level of maintenance

to make sure they will be available during a fire. This section creates the maintenance mechanism.

**607.7 Elevator key location.** Keys for the elevator car doors and fire-fighter service keys shall be kept in an *approved* location for immediate use by the fire department.

❖ The fire service often responds to elevator emergencies and other emergencies that require the use or operation of the elevators and associated components. Most elevators will have at least five or six key-switched functions, including those for standby power transfer, Phase I emergency elevator recall (hall switch located in the elevator lobby at the designated level), Phase II in-cab emergency operation, inspection function, normal lighting and fan operation. Ready access to elevator keys is an important factor in the timely and efficient response to emergency situations. Because experience has shown that this important safety element is often overlooked, this section requires that elevator keys be kept in a location approved by the fire code official to ensure immediate access. Many elevator installers will provide, as part of their package, an elevator key box (see Commentary Figure 607.7), which will accommodate all of the required operating keys, plus an appropriate hoistway access key or tool for fire department use in accessing the hoistway in case of an elevator emergency. Elevator inspection reports should note the presence and locations of the keys. Inspectors may verify the availability of the keys during periodic fire safety inspections and prefire planning surveys.



**Figure 607.7**  
**TYPICAL ELEVATOR KEY BOX**

**607.8 Standardized fire service elevator keys.** Buildings with elevators equipped with Phase I emergency recall, Phase II emergency in-car operation, or a fire service access eleva-

tor shall be equipped to operate with a standardized fire service elevator key approved by the *fire code official*.

**Exception:** The owner shall be permitted to place the building's nonstandardized fire service elevator keys in a key box installed in accordance with Section 506.1.2.

❖ When fire departments and other emergency response agencies respond to emergencies, their ability to quickly access the location of the emergency can be the deciding factor of a successful response. Elevators are increasingly being relied upon for emergency operations and their importance has been highlighted by adding Section 3007 to the IBC requiring the installation of fire service access elevators and providing requirements for the installation of occupant evacuation elevators. One of the difficulties the fire service and other emergency response agencies have when accessing facilities and attempting to use elevators is the number of nonstandardized keys that may not be available at the time of response. Even when emergency responders are provided the necessary keys in case of response, the correct key may have to be identified from a large collection of keys for any one building. In larger jurisdictions, the sheer number of keys makes possession of them unwieldy for the emergency responders. An elevator key is an important tool to fire fighters. The key allows fire fighters to access the interior of the shaft housing an elevator cabin to initiate rescue in case of a malfunction or the loss of building power. More often, an elevator key is used to capture and control an elevator in emergencies. This section establishes new requirements for elevator keys used by the fire service that will only apply to those buildings that have elevators with Phase I or Phase II emergency service or to those buildings equipped with a fire service access elevator.

The exception recognizes that many jurisdictions have elevators built prior to the introduction of a standard elevator key and, as a result, each building with an elevator requires its own elevator key, and authorizes the jurisdiction to require the installation of a key box to house nonstandardized elevator keys (see commentary, Section 506.1.2).

**607.8.1 Requirements for standardized fire service elevator keys.** Standardized fire service elevator keys shall comply with all of the following:

1. All fire service elevator keys within the jurisdiction shall be uniform and specific for the jurisdiction. Keys shall be cut to a uniform key code.
2. Fire service elevator keys shall be of a patent-protected design to prevent unauthorized duplication.
3. Fire service elevator keys shall be factory restricted by the manufacturer to prevent the unauthorized distribution of key blanks. Uncut key blanks shall not be permitted to leave the factory.

4. Fire service elevator keys subject to these rules shall be engraved with the words "DO NOT DUPLICATE."

❖ This section requires that keys for any new elevators installed in the jurisdiction use a unique but standard format, regardless of elevator manufacturer or model. Standardizing the type of elevator key creates a consistent arrangement for fire fighters who utilize the elevators for EMS incidents or for the deployment of personnel and equipment in a multiple-story fire fighting operation. The keys must be manufactured to prevent unauthorized duplication.

**607.8.2 Access to standardized fire service keys.** Access to standardized fire service elevator keys shall be restricted to the following:

1. Elevator owners or their authorized agents.
2. Elevator contractors.
3. Elevator inspectors of the jurisdiction.
4. *Fire code officials* of the jurisdiction.
5. The fire department and other emergency response agencies designated by the *fire code official*.

❖ Access to or possession of a key that can take control of an elevator in a building is an area of vulnerability for buildings that was not previously addressed with simple key designs being utilized. In addition to the limitations placed on the unauthorized duplication and distribution of standardized elevator keys in Section 607.8.3, this section specifies exactly to whom the keys will be accessible. This list includes only those persons who have a vested interest in the building, the elevator equipment or the protection of the building.

**607.8.3 Duplication or distribution of keys.** A person shall not duplicate a standardized fire service elevator key or issue, give, or sell a duplicated key unless in accordance with this code.

❖ This section provides for a level of security for the standardized key by prohibiting its unauthorized duplication and distribution. Note that Section 607.8.1 requires that keys be stamped or embossed with a duplication prohibition warning.

**607.8.4 Responsibility to provide keys.** The building owner shall provide up to three standardized fire service elevator keys where required by the *fire code official*, upon installation of a standardized fire service key switch or switches in the building.

❖ This section establishes the responsibility of the building owner to provide at least three keys of the same standard design when an elevator is equipped with Phase I and II fire-fighter service or is a fire service access elevator. Multiple keys allow fire companies to use multiple elevators to carry personnel and equipment to the fire floor or swiftly remove multiple injured or otherwise incapacitated persons from upper or lower floors.

**SECTION 608  
STATIONARY STORAGE BATTERY SYSTEMS**

**608.1 Scope.** Stationary storage battery systems having an electrolyte capacity of more than 50 gallons (189 L) for flooded lead-acid, nickel cadmium (Ni-Cd) and valve-regulated lead-acid (VRLA), or more than 1,000 pounds (454 kg) for lithium-ion and lithium metal polymer, used for facility standby power, emergency power or uninterruptible power supplies shall comply with this section and Table 608.1.

❖ This section applies to certain sizes of stationary storage battery systems that are used for standby power, emergency power or uninterruptible power systems. It does not apply to individual stationary storage batteries such as are used in vehicles or other similar applications. The requirements apply to flooded lead-acid batteries having an electrolyte capacity of more than 50 gallons (189 L) and to VRLA, and to lithium-ion and lithium metal polymer batteries having an electrolyte capacity of more than 1,000 pounds (454 kg).

These requirements were developed in response to the concern that applying the generic hazardous materials requirements of the code to battery systems was inappropriate and unnecessary. Stationary storage batteries generally contain sulfuric acid, which is considered a corrosive liquid. In most cases, the battery system electrolyte would exceed the MAQs established in Chapter 50, which would lead to battery rooms being classified as a Group H occupancy. Generally, these types of systems have had a good safety record and, if the guidelines set out in Section 608 are followed, pose a very low hazard to the building, its occupants and emergency respond-

ers. In many cases, such systems are found in buildings with very low occupant loads, such as telephone company exchanges.

There are some very specific differences in the two types of batteries, recombinant and nonrecombinant, that should be understood in applying the requirements of Section 608. First, recombinant batteries are designed so that if punctured or damaged, they would not spill because the electrolyte is immobilized in an absorptive glass mat or by a gelling agent. Second, recombinant batteries do not routinely emit hydrogen gas to the atmosphere, as do nonrecombinant stationary storage batteries. Recombinant batteries vent hydrogen only when the internal pressure exceeds the ambient pressure; therefore, hydrogen release is still an issue and ventilation is still required.

Nonrecombinant (flooded) stationary storage batteries, on the other hand, are more likely to have a spill but routinely emit hydrogen to the atmosphere and thus are not as highly subject to pressure buildup. Also, recombinant batteries are often used in locations where the flooded types have not traditionally been used, such as in cabinets in a business occupancy. Nonrecombinant batteries are more typically used in locations such as a phone company exchange with a low occupant load.

Table 608.1 provides a convenient summary of battery requirements contained in this section.

**608.2 Safety caps.** Safety caps for stationary storage battery systems shall comply with Sections 608.2.1 and 608.2.2.

❖ See the commentary to Sections 608.2.1 and 608.2.2 for discussion of these essential safety devices for batteries.

**TABLE 608.1  
BATTERY REQUIREMENTS**

REQUIREMENT	NONRECOMBINANT BATTERIES		RECOMBINANT BATTERIES		OTHER BATTERIES
	Vented (Flooded) Lead Acid Batteries	Vented (Flooded) Nickel-Cadmium (Ni-Cd) Batteries	Valve Regulated Lead-Acid (VRLA) Cells	Lithium-Ion Cells	Lithium Metal Cells
Safety caps	Venting caps (608.2.1)	Venting caps (608.2.1)	Self-sealing flame-arresting caps (608.2.2)	No caps	No caps
Thermal runaway management	Not required	Not required	Required (608.3)	Not required	Required (608.3)
Spill control	Required (608.5)	Required (608.5)	Not required	Not required	Not required
Neutralization	Required (608.5.1)	Required (608.5.1)	Required (608.5.2)	Not required	Not required
Ventilation	Required (608.6.1; 608.6.2)	Required (608.6.1; 608.6.2)	Required (608.6.1; 608.6.2)	Not required	Not required
Signage	Required (608.7)	Required (608.7)	Required (608.7)	Required (608.7)	Required (608.7)
Seismic protection	Required (608.8)	Required (608.8)	Required (608.8)	Required (608.8)	Required (608.8)
Smoke detection	Required (608.9)	Required (608.9)	Required (608.9)	Required (608.9)	Required (608.9)

**608.2.1 Nonrecombinant batteries.** Vented lead-acid, nickel-cadmium or other types of nonrecombinant batteries shall be provided with safety venting caps.

❖ Pressures can build up within batteries as a result of the creation of hydrogen and oxygen, making a method of pressure relief necessary. The types of batteries regulated by this section vent hydrogen and oxygen to the atmosphere. Flooded batteries vent regularly whereas valve-regulated battery systems vent when the internal pressure exceeds ambient pressures. Because of this potential for pressure buildup, safety-venting caps are required. For additional information on nonrecombinant batteries, see the commentary to the definition of that term.

**608.2.2 Recombinant batteries.** VRLA batteries shall be equipped with self-resealing flame-arresting safety vents.

❖ Self-resealing vents are an integral part of the design of VRLA batteries. Flame-arresting vents are needed to prevent a static spark (or other flame source) outside the battery from propagating to the interior of the battery where oxygen or hydrogen may have accumulated during normal operation of the battery. For additional information on recombinant batteries, see the commentary to the definition of that term.

**608.3 Thermal runaway.** VRLA and lithium metal polymer battery systems shall be provided with a *listed* device or other *approved* method to preclude, detect and control thermal runaway.

❖ Under certain extreme conditions of high ambient temperature or charging rate, VRLA and lithium metal polymer batteries may experience a phenomenon known as “thermal runaway.” This is a condition that occurs in a battery (especially valve-regulated types) when charging energy results in heat generation within the battery greater than the heat dissipated, causing an uncontrolled rise in battery temperature. Under these conditions, a battery may generate excessive heat that can cause failure through cell dry-out or, in rare cases, rupture or melting of the battery.

Lithium metal polymer batteries are constructed with an internal means of thermal runaway management. Each battery is equipped with an internal heating system that is located within the electrochemical stack of anodes and cathodes. This heating element ensures that the battery temperature limits are not exceeded when the battery is being charged or discharged. The thermal runaway management system and batteries are commonly listed in accordance with UL 1642 and UL 1989.

**608.4 Room design and construction.** Enclosure of stationary battery systems shall comply with the *International Building Code*. Battery systems shall be allowed to be in the same room with the equipment they support.

❖ This section requires that battery rooms meet the basic construction requirements of the IBC. Section and Table 509 of the IBC treat rooms housing stationary storage battery systems as incidental use areas

based on the electrolyte capacity of the system. In that case, though no different occupancy group is assigned to it, the battery room’s fire-resistance rating must be 1 or 2 hours, depending upon the occupancy group or groups from which it must be separated in the building in which it is located. The construction of the battery room must also comply with the material requirements of the IBC for the type of construction required for the building. Additionally, there is no requirement for separating the equipment that the battery system supports from the battery system itself.

**608.4.1 Separate rooms.** Where stationary batteries are installed in a separate equipment room accessible only to authorized personnel, they shall be permitted to be installed on an open rack for ease of maintenance.

❖ Ease of access to the battery system components is important for the safety of maintenance personnel. Where access to battery rooms is restricted to only authorized personnel, exposure to the public or building occupants is reduced, thus eliminating the need for any out-of-the-ordinary public safety arrangements of the system components.

**608.4.2 Occupied work centers.** Where a system of VRLA, lithium-ion, or other type of sealed, nonventing batteries is situated in an occupied work center, it shall be allowed to be housed in a noncombustible cabinet or other enclosure to prevent access by unauthorized personnel.

❖ In order to prevent tampering or accidental contact with the battery system when installed in an occupied work area, this section requires enclosure of the battery system in a cabinet. VRLA battery systems are often listed under UL 1778, which places similar design and construction requirements on cabinetized systems.

**608.4.3 Cabinets.** Where stationary batteries are contained in cabinets in occupied work centers, the cabinet enclosures shall be located within 10 feet (3048 mm) of the equipment that they support.

❖ Placing battery system cabinets within 10 feet (3048 mm) of the equipment served by the system will limit the number of devices that can be powered by the system due to the voltage drop associated with longer or multiple conductor runs. Having a substantial clearance between the battery cabinet and powered equipment also reduces the likelihood of an ignition in the event that battery gassing has occurred within the cabinet, which could result in an explosive mixture when air is introduced upon opening the cabinet for maintenance. The clearance required by this section will also enhance the safety of personnel who may have to secure and work on equipment served by the battery system by placing the secondary power supply near enough to the powered equipment to ensure line-of-sight supervision of the secured battery system during equipment repair or maintenance.

**608.5 Spill control and neutralization.** An *approved* method and materials for the control and neutralization of a

spill of electrolyte shall be provided in areas containing lead-acid, nickel-cadmium or other types of batteries with free-flowing liquid electrolyte. For purposes of this paragraph, a “spill” is defined as any unintentional release of electrolyte.

**Exception:** VRLA, lithium-ion, lithium metal polymer or other types of batteries with immobilized electrolyte shall not require spill control.

- ❖ Batteries that contain a free-flowing liquid electrolyte pose the same containment problems as any other corrosive liquid hazardous material, but the containment and neutralization provisions in this section are performance based and neither specifically require spill control in the form of containment nor a specific method of neutralization. The quantity of neutralization material required to be available would be greater for these less-viscous electrolytes, however, because of their mobility and the rapidity with which they can spread and the potential scope of the spread. See the commentary to Section 5004.2.1 for further discussion of spill control strategies. The exception recognizes the reduced spill control hazard of sealed batteries that contain a higher-viscosity electrolyte.

**608.5.1 Nonrecombinant battery neutralization.** For battery systems containing lead acid, nickel cadmium or other types of batteries with free-flowing electrolyte, the method and materials shall be capable of neutralizing a spill of the total capacity from the largest cell or block to a pH between 5.0 and 9.0.

- ❖ This section is fairly performance-based and neither specifically requires spill control in the form of containment, nor a specific method of neutralization. Instead, it states that a capability to control and neutralize a spill equal to the liquid content of the largest single battery cell or block (not the whole battery) to a pH between 5.0 and 9.0 must be available. In the case of flooded lead-acid batteries, this may require initial containment followed by neutralization.

**608.5.2 Recombinant battery neutralization.** For VRLA or other types of batteries with immobilized electrolyte, the method and material shall be capable of neutralizing a spill of 3.0 percent of the capacity of the largest cell or block in the room to a pH between 5.0 and 9.0.

**Exception:** Lithium-ion and lithium metal polymer batteries shall not require neutralization.

- ❖ This section is fairly performance-based and neither specifically requires spill control in the form of containment, nor a specific method of neutralization. Instead, it states that a capability to control and neutralize a spill equal to the 3 percent of the liquid content of the largest single battery cell or block (not the whole battery) housed in the battery room to a pH between 5.0 and 9.0 must be available. Typically, either sodium-bicarbonate powder or a liquid buffering solution is provided within the room where the battery system is located for use by trained personnel.

The electrolyte in VRLA batteries is immobilized by either the addition of a gelling agent or by being absorbed in a fiberglass mat (i.e., a sponge). This immobilization creates a situation where a spill of the electrolyte is highly unlikely. A typical accident where a VRLA battery case is broken results in a slight drip or a slow ooze of material out of the battery that cannot be characterized as a spill. Accordingly, spill control, as prescribed in Section 608.5, for flooded lead-acid batteries is not necessary. The exception recognizes the reduced spill control hazard and accompanying neutralization needs of sealed batteries that contain a higher-viscosity electrolyte.

**608.6 Ventilation.** Ventilation of stationary storage battery systems shall comply with Sections 608.6.1 and 608.6.2.

- ❖ With good air circulation around a battery, hydrogen accumulation is normally not a problem. The gas mixture is explosive when hydrogen in air exceeds 4 percent by volume; however, if relatively large batteries are confined in small rooms, exhaust fans must be installed to vent the room constantly or to be turned on automatically when hydrogen accumulation exceeds a certain level. Battery cabinets must also be vented to the atmosphere. Sparks or flames can ignite these hydrogen mixtures above the LEL, so ignition sources must be carefully managed. See the commentary to Sections 608.6.1 and 608.6.2 for discussion of the ventilation requirements for battery rooms and cabinets.

**608.6.1 Room ventilation.** Ventilation shall be provided in accordance with the *International Mechanical Code* and the following:

1. For flooded lead-acid, flooded Ni-Cd and VRLA batteries, the ventilation system shall be designed to limit the maximum concentration of hydrogen to 1.0 percent of the total volume of the room; or
2. Continuous ventilation shall be provided at a rate of not less than 1 cubic foot per minute per square foot (1 ft<sup>3</sup>/min/ft<sup>2</sup>) [0.0051 m<sup>3</sup>/s · m<sup>2</sup>] of floor area of the room.

**Exception:** Lithium-ion and lithium metal polymer batteries shall not require additional ventilation beyond that which would normally be required for human occupancy of the space in accordance with the *International Mechanical Code*.

- ❖ Basic battery room ventilation, as with any other building area, must comply with the requirements of the IMC. Generally, with lead-acid battery systems, the main concern is the production of hydrogen and oxygen within an enclosed space. Hydrogen has a wide flammability range and is the lightest element on the Periodic Table of Elements, having an atomic number of 1. The gas mixture is explosive when the amount of hydrogen in air exceeds 4 percent by volume. To address the concern of hydrogen generation and containment in small areas, a minimum ventilation criterion is set. This section provides two methods of compliance from which the designer may

choose. The first is performance based and states that the maximum concentration of hydrogen must be limited to 1.0 percent of the total volume of the room. This method requires an analysis of plausible failure scenarios to justify the ventilation rate ultimately chosen. The second method simply requires continuous ventilation at a rate no less than 1 cubic foot per minute per square foot [ $1 \text{ ft}^3/\text{min}/\text{ft}^2$  or  $0.0051 \text{ m}^3/(\text{s} \times \text{m}^2)$ ] of room area. The exception recognizes the reduced fugitive gas hazard of sealed batteries that contain a higher viscosity electrolyte.

**608.6.2 Cabinet ventilation.** Where VRLA batteries are installed inside a cabinet, the cabinet shall be *approved* for use in occupied spaces and shall be mechanically or naturally vented by one of the following methods:

1. The cabinet ventilation shall limit the maximum concentration of hydrogen to 1 percent of the total volume of the cabinet during the worst-case event of simultaneous “boost” charging of all the batteries in the cabinet.
2. Where calculations are not available to substantiate the ventilation rate, continuous ventilation shall be provided at a rate of not less than 1 cubic foot per minute per square foot [ $1 \text{ ft}^3/\text{min}/\text{ft}^2$  or  $0.0051 \text{ m}^3/(\text{s} \cdot \text{m}^2)$ ] of floor area covered by the cabinet. The room in which the cabinet is installed shall be ventilated as required in Section 608.6.1.

❖ This section addresses the increasingly common practice of placing VRLA battery systems in cabinets. Ventilation of VRLA battery cabinets is treated in the same manner as VRLA battery rooms in Section 608.6.1 (see commentary, Section 608.6.1).

**608.6.3 Supervision.** Mechanical ventilation systems where required by Sections 608.6.1 and 608.6.2 shall be supervised by an *approved* central, proprietary or remote station service or shall initiate an audible and visual signal at a constantly attended on-site location.

❖ The ventilation systems in Sections 608.6.1 and 608.6.2 are required and reduce the likelihood that the concentration of hydrogen will reach 1 percent or present an explosion hazard. Without a supervised system or a signal at a constantly attended location, the required ventilation system could fail without warning, allowing hydrogen concentrations to build to hazardous levels.

Monitoring natural ventilation, which is specifically allowed by Section 608.6.2, is extremely difficult (if not impossible in some cases), extremely expensive and would force a huge financial burden on battery cabinet manufacturers to add mechanical ventilation systems, hydrogen detectors or flow sensors, for little or no apparent improvement in safety. Accordingly, this section mandates the supervision of both the required room and cabinet ventilation only where mechanical systems are employed to provide adequate notification of a system failure.

**608.7 Signage.** Signs shall comply with Sections 608.7.1 and 608.7.2.

❖ See the commentaries to Sections 608.7.1 and 608.7.2 for discussion of the hazard warning sign requirements for battery rooms.

**608.7.1 Equipment room and building signage.** Doors into electrical equipment rooms or buildings containing stationary battery systems shall be provided with *approved* signs. The signs shall state that:

1. The room contains energized battery systems.
2. The room contains energized electrical circuits.
3. The battery electrolyte solutions, where present, are *corrosive* liquids.

❖ Because of the possible hazards associated with exposure to corrosive electrolytes, energized electrical circuits and the presence of hydrogen and oxygen, specific signage is needed to make building occupants and emergency responders aware of the potential dangers in the building or areas thereof.

**608.7.2 Cabinet signage.** Cabinets shall have exterior labels that identify the manufacturer and model number of the system and electrical rating (voltage and current) of the contained battery system. There shall be signs within the cabinet that indicate the relevant electrical, chemical and fire hazards.

❖ Battery cabinets must be marked with technical data about the system so that emergency responders may properly judge the degree of hazard presented by the system. Because of the possible hazards associated with exposure to corrosive liquids, energized electrical circuits and the presence of hydrogen and oxygen, specific signage is needed to make building occupants and emergency responders aware of the potential dangers that could exist in the cabinet.

**608.8 Seismic protection.** The battery systems shall be seismically braced in accordance with the *International Building Code*.

❖ Because battery systems pose hazards of corrosive liquid spills and because they are used for essential standby power, emergency power or uninterruptible power supplies, this section requires seismic bracing of the systems. Generally, these systems are located in racks that carry a fairly heavy load because of the liquid contained within the batteries. Chapter 16 of the IBC contains seismic protection requirements.

**608.9 Smoke detection.** An *approved* automatic smoke detection system shall be installed in accordance with Section 907.2 in rooms containing stationary battery systems.

❖ Except for a fire involving hydrogen, battery room fires are likely to be slow-growing and smoldering; therefore, a smoke detection system is required for early detection and warning in accordance with Section 907.2.23 where the system electrolyte capacity exceeds 50 gallons (189 L).

## SECTION 609 COMMERCIAL KITCHEN HOODS

**[M] 609.1 General.** Commercial kitchen exhaust hoods shall comply with the requirements of the *International Mechanical Code*.

❖ Rather than including detailed commercial hood requirements here, the code simply references the IMC for hood design (see IMC commentary, Section 507).

**[M] 609.2 Where required.** A Type I hood shall be installed at or above all commercial cooking appliances and domestic cooking appliances used for commercial purposes that produce grease vapors.

**Exception:** A Type I hood shall not be required for an electric cooking appliance where an approved testing agency provides documentation that the appliance effluent contains 5 mg/m<sup>3</sup> or less of grease when tested at an exhaust flow rate of 500 cfm (0.236 m<sup>3</sup>/s) in accordance with UL 710B.

❖ A Type I hood (see definition of “Hood, Type I” in Section 202) is required for all appliances used for commercial cooking as defined in Section 202. In addition to the specific cooking appliances identified in the definition, further examples of commercial cooking appliances that require a commercial kitchen exhaust system are griddles (flat or grooved); tilting skillets or woks; braising and frying pans; roasters; pastry ovens; pizza ovens; charbroilers; salamanders and upright broilers; infrared broilers and open-burner stoves; ranges; and barbecue equipment. Further, the definition of “Commercial cooking appliances” defines a food service establishment as “...any building or portion thereof used for the preparation and serving of food.”

The term “grease” refers to animal and vegetable fats and oils that are used to cook foods or that are a byproduct of cooking foods. Cooking appliances are used for commercial purposes when the appliance is primarily used for the preparation of food for compensation, trade or services rendered. When the nature of the cooking produces grease or smoke, a Type I hood is required. The intent is not to require a Type I hood where there is a possibility of food being burned and producing smoke. For example, smoke that is produced when toast is burned does not mean that a Type I hood is required over a toaster.

Section 609 does not require exhaust hoods for cooking equipment or appliances installed outdoors where the grease-laden vapors, etc., discharge directly to the outside atmosphere, nor is this chapter intended to regulate cooking appliances installed in vehicles or towed trailers (see definition of “Commercial cooking appliances”). Note that cooking appliances installed outdoors but located under a roof should be evaluated for installation under a Type I

hood just as if they were located inside a building having enclosing walls.

The exception recognizes the growing use of small electrical appliances used for cooking, such as in small sandwich shops and convenience stores, where little or no grease is produced. The installation of a Type I hood in these small establishments would create the expense of the hood and the energy costs of running the fan and tempering the makeup air where grease emissions are minimal or nonexistent. The grease emission threshold requirement is consistent with NFPA 96 and the testing procedure is done in accordance with Section 17 of UL 710B. In order for an appliance to qualify for use without a Type I hood it must be tested by an approved agency and shown that the effluent contains 5 mg/m<sup>3</sup> or less of grease when tested at an exhaust flow rate of 500 cfm. See also the IMC definitions of “Light-,” “Medium-,” “Heavy-” and “Extra-heavy duty cooking appliances” as well as IMC Section 507.2.

**609.3 Operations and maintenance.** Commercial cooking systems shall be operated and maintained in accordance with Sections 609.3.1 through 609.3.4.

❖ The provisions of this section introduce Sections 609.3.1 through 609.3.4, which contain requirements for controlling the hazards associated with the operation and maintenance of commercial cooking systems.

**609.3.1 Ventilation system.** The ventilation system in connection with hoods shall be operated at the required rate of air movement, and classified grease filters shall be in place when equipment under a kitchen grease hood is used.

❖ The hood must be designed to adequately collect and exhaust fumes, smoke and vapors from the area over which it is installed. To accomplish this, the hood must cause an airflow pattern that will sweep and direct the fumes, smoke and vapors from the cooking surfaces into the hood inlet.

The IMC specifies the minimum quantity of exhaust air necessary for effective removal of cooking vapors and the approximate amount of makeup air necessary for proper operation. The quantity of required exhaust is as much a function of the operational characteristics of the cooking equipment as it is a function of the size of the cooking surface or the exhaust hood opening area and the presence of walls and side panels. Manufacturer recommendations must be followed where applicable.

Approved grease filters prevent large amounts of grease from collecting in the hood, in exhaust ducts, on fan blades and at the exhaust system termination. The accumulation of grease can cause blockage in ducts, cause equipment failure and create a fire hazard. It therefore makes sense to have grease filters in place whenever commercial cooking equipment is used.

**609.3.2 Grease extractors.** Where grease extractors are installed, they shall be operated when the commercial-type cooking equipment is used.

❖ As noted in the commentary for Section 609.3.1, it is imperative that grease removal devices operate when commercial cooking equipment is used. Grease extractors and similar grease removal devices range from simple designs, such as a configuration of baffles, to elaborate hot water scrubbers and electrostatic precipitators. The devices must be installed to comply with the IMC and the manufacturer’s installation instructions.

**609.3.3 Cleaning.** Hoods, grease-removal devices, fans, ducts and other appurtenances shall be cleaned at intervals as required by Sections 609.3.3.1 through 609.3.3.3.

❖ The provisions of this section introduce Sections 609.3.3.1 through 609.3.3.3, which contain requirements for controlling the hazards associated with grease accumulation in commercial cooking systems. This includes appliances that produce grease-laden vapors, the hood, any grease extractors, the exhaust duct and the exhaust fan. The date of the cleaning and the extent of the work performed must be documented and be maintained on the premises.

**609.3.3.1 Inspection.** Hoods, grease-removal devices, fans, ducts and other appurtenances shall be inspected at intervals specified in Table 609.3.3.1 or as *approved* by the *fire code official*. Inspections shall be completed by qualified individuals.

❖ A regular inspection schedule must be maintained to prevent the accumulation of grease residue within the exhaust system. The hood, grease removal devices, ducts, fans, fire suppression system discharge nozzles and other components of the system must be cleaned regularly to prevent excessive accumulation of grease. The frequency of such cleaning can vary depending on the amount and type of usage; however, at a minimum, the equipment must be inspected at the intervals indicated in Table 609.3.3.1. Commercial cooking equipment exhaust systems may be viewed in some respects as a combustible material conveying system inasmuch as the grease carried within the duct is very combustible under the right conditions. As such, the inspection of the system should be entrusted only to persons trained and qualified in system inspection practices. While there are no identified nationally recognized criteria for gauging if an individual is or is not qualified to perform this work, several companies have developed their own certification programs for establishing requirements for individuals who supervise the cleaning of commercial cooking operations. In any case, the fire code official will make the final determination in accordance with Section 102.8.

**TABLE 609.3.3.1  
COMMERCIAL COOKING SYSTEM INSPECTION FREQUENCY**

TYPE OF COOKING OPERATIONS	FREQUENCY OF INSPECTION
High-volume cooking operations such as 24-hour cooking, charbroiling or wok cooking	3 months
Low-volume cooking operations such as places of religious worship, seasonal businesses and senior centers	12 months
Cooking operations utilizing solid fuel-burning cooking appliances	1 month
All other cooking operations	6 months

❖ Inspection frequencies are established in this table, which is based on the volume of cooking being performed, the type of cooking operation and the type of fuel used. The most restrictive requirement is for cooking operations using solid fuels, such as barbecue pits and meat smokers. When these or similar appliances use a solid fuel such as wood or charcoal, a minimum monthly inspection frequency is required. Cooking operations that use charbroilers or woks require a minimum 3-month inspection frequency, as do high volume cooking operations such as are found in 24-hour restaurants. The frequency of inspection is reduced to 12 months for lower intensity cooking activities including, but not limited to, seasonal businesses, places of worship and facilities for the care of senior citizens. All other cooking operations are subject to a 6-month inspection frequency. Depending on the nature of the commercial cooking activities, a single kitchen could have activities that require different inspection frequencies. For example, a restaurant that serves smoked meats would require that the appliance used for the preparation of the meat be inspected monthly, while other equipment would require inspection every 3 or 6 months, depending on the volume of cooking being performed.

**609.3.3.2 Grease accumulation.** If during the inspection it is found that hoods, grease-removal devices, fans, ducts or other appurtenances have an accumulation of grease, such components shall be cleaned in accordance with ANSI/KECA C 10.

❖ Frequent cleaning of exhaust systems is essential to the fire safety of cooking establishments to eliminate the potentially flammable and highly dangerous collection of grease within the exhaust system. The most common cleaning method is hand scraping, which requires that a person remove the hood filters and the access doors in the exhaust ductwork and physically scrape the accumulated grease from the interior surfaces of the exhaust system. Done properly, this method is effective but far from perfect. Regular inspection and diligence by the owner and the fire

code official are needed to achieve the desired level of cleanliness of the exhaust system.

A frequently asked question about grease accumulation is, "How much of an accumulation is enough to warrant a cleaning?" Grease buildup in a commercial cooking exhaust system and the frequency with which the system must be cleaned depend on several factors, including but not limited to: the types of appliances under the hood, the type of grease-removal devices in use, exhaust velocity within the system, number of joints in the ductwork, changes in direction of the duct run, temperature of the grease-laden air being exhausted, efficiency of the exhaust fan and whether the duct is insulated or exposed to the outdoors. Just as the frequency of inspection in Table 609.3.3.1 varies based on the intensity of the cooking operation, so does the rate of grease accumulation. The referenced standard, ANSI/KECA C-10, provides requirements to determine the frequency and necessity for commercial kitchen exhaust system cleaning through inspection procedures. In addition, the standard defines acceptable methods for cleaning exhaust systems and components and sets standards for acceptable cleanliness.

**609.3.3.3 Records.** Records for inspections shall state the individual and company performing the inspection, a description of the inspection and when the inspection took place. Records for cleanings shall state the individual and company performing the cleaning and when the cleaning took place. Such records shall be completed after each inspection or cleaning and maintained.

❖ Adequate records of inspections and cleanings not only provide documentation of the required inspections and the resulting cleanings but are also essential in establishing a workable cleaning schedule. A record of all cleaning must be maintained by the person or party responsible for the system. The records must indicate the method of cleaning and the time between cleanings as well as what components were cleaned.

As a result of a review of Recommendation 2(c) of the NIST Charleston, South Carolina Sofa Superstore Fire Report, changes were made to Sections 107.2 and 107.3, along with 49 other sections (including this section), to comprehensively address recordkeeping requirements. Section 107.3 provides standardized recordkeeping requirements for periodic inspection, testing, servicing and other operational and maintenance requirements of the code and makes it clear that records must be maintained on the premises or another approved location and that copies of records must be provided to the fire code official upon request. Section 107.3 also makes it clear that records must be maintained for a period of not less than 3 years unless a different time interval is specified in the code or a referenced standard, and that the fire code official is authorized to prescribe the form and format of such records. See the commentaries to Sections 107.2 and 107.3.

**609.3.3.3.1 Tags.** When a commercial kitchen hood or duct system is inspected, a tag containing the service provider name, address, telephone number and date of service shall be provided in a conspicuous location. Prior tags shall be covered or removed.

❖ This section details the markings required to visually confirm serviceability of commercial kitchen hood and duct systems. The text is consistent with the requirements set forth in ANSI/KECA C-10, as referenced in Section 609.3.3.2.

**609.3.4 Extinguishing system service.** Automatic fire-extinguishing systems protecting commercial cooking systems shall be serviced as required in Section 904.12.6.

❖ See commentary, Section 904.12.6.

**609.4 Appliance connection to building piping.** Gas-fired commercial cooking appliances installed on casters and appliances that are moved for cleaning and sanitation purposes shall be connected to the piping system with an appliance connector listed as complying with ANSI Z21.69. The commercial cooking appliance connector installation shall be configured in accordance with the manufacturer's installation instructions. Movement of appliances with casters shall be limited by a restraining device installed in accordance with the connector and appliance manufacturer's instructions.

❖ This requirement is intended to end the practice of replacing listed flexible piping with residential flexible piping. Residential flexible piping is more easily damaged when the cooking equipment is moved for cleaning, thus causing a fire/life safety problem with gas leaks and fires. This section also intends to limit the distance the appliances can be moved for cleaning to further protect the connection.

## SECTION 610 COMMERCIAL KITCHEN COOKING OIL STORAGE

**610.1 General.** Storage of cooking oil (grease) in commercial cooking operations utilizing above-ground tanks with a capacity greater than 60 gal (227 L) installed within a building shall comply with Sections 610.2 through 610.7 and NFPA 30. For purposes of this section, cooking oil shall be classified as a Class IIIB liquid unless otherwise determined by testing.

❖ In these times of increasing interest in alternative fuels, used cooking oil has benefits in that it can be recycled for commercial cooking operations. It can also be chemically modified into biodiesel and used as fuel for mobile or stationary equipment. Because it can be recycled and reused, many restaurants and similar businesses that perform commercial cooking operations have found that capturing used cooking oil reduces waste disposal costs. As a result, the food service industry is seeking options for the safe storage of waste cooking oils in buildings and, as such, there has arisen a large market for collecting and recycling used cooking oil (grease) from commercial

cooking operations. This is sometimes done using a system designed to store the used cooking oil on-site in an above-ground tank. These systems typically include wheeled recovery carts and hoses (see Commentary Figure 610.2) to assist in transferring the grease from the cooking appliance to the storage tank, and from the storage tank to a recovery truck. Some systems include heating elements that assist in keeping the grease in a form that is easily pumped to the recovery truck. This arrangement could create a problem if the system is not properly designed and installed. Without the requirements of Section 610 addressing the storage of cooking oils, many installations may not be installed with the safety features needed to protect employees and the public.

It should be noted that this section also addresses fresh cooking oil versus used, spent or inedible cooking oil. These oils need to be stored in tanks and related components that are food grade. That is why there are specific requirements for nonmetallic tanks. Most metallic tanks, as required by this section, could not meet these specifications.

This section also specifies that, for the application of these requirements, cooking oils are classified as Class IIIB liquids in accordance with the definition of “Combustible liquids” in Chapter 2 of the code. These liquids have a closed-cup-flash-point temperature greater than 200°F (93.33°C). Flash point and ignition temperatures for common cooking oils are shown in Commentary Figure 610.1 and the data confirms that this classification is correct.

Note that installation of the cooking oil storage tank and its piping will require a construction permit in accordance with Section 105.7.8.

**610.2 Metallic storage tanks.** Metallic cooking oil storage tanks shall be listed in accordance with UL 142 or UL 80, and shall be installed in accordance with the tank manufacturer’s instructions.

❖ This section requires storage tanks for cooking oil storage to be listed as complying with either UL 142 or UL 80. Both standards are limited to shop-fabricated above-ground storage tanks (ASTs) designed

to operate at atmospheric pressure. Both standards require tanks to be constructed of carbon steel meeting a certain specification and, before shipment, to be tested at the factory to confirm they are liquid tight. Tanks constructed to UL 80 have a maximum volume of 660 gallons (2271.25 L) versus UL 142, which does not limit the volume of ASTs. Installations of metallic ASTs for cooking oil storage also must comply with the manufacturer’s installation instructions (see Commentary Figure 610.2).



**Figure 610.2**  
**COOKING OIL STORAGE TANK AND RECOVERY CART**  
(Photo courtesy of Darling International Inc., Irving, TX)

COOKING OIL TYPE	FLASH POINT TEMPERATURE (°F)	IGNITION TEMPERATURE (°F)
Canola oil	450	626
Corn oil	490	740
Cotton seed oil	486	650
Palm oil	323	600
Peanut oil	540	833
Soybean oil	549	833
Sunflower seed oil	550	Undetermined

For SI: °C = (°F - 32)/1.8.

**Figure 610.1**  
**COOKING OIL FLASH POINT AND IGNITION TEMPERATURES**

**610.3 Nonmetallic storage tanks.** Nonmetallic cooking oil storage tanks shall be installed in accordance with the tank manufacturer's instructions and shall also comply with all of the following:

1. Tanks shall be listed for use with cooking oil, including maximum temperature to which the tank will be exposed during use.
  2. Tank capacity shall not exceed 200 gallons (757 L) per tank.
- ❖ As discussed in Section 610.1, cooking oil that has not been previously used needs to be stored in food grade tanks. Typically, nonmetallic tanks are more appropriate for nonused cooking oil. These provisions are not limited to fresh cooking oil and can be utilized for used, spent and inedible cooking oils. This section sets out the requirements for basic construction and capacity of such tanks. Essentially, a listing for use with cooking oil is required, as is making sure that the maximum temperature limits associated with the tank match the application in which the tank is used.
- The tanks are limited in size to 200 gallons. Metallic tanks have the potential for much larger capacities, as discussed in the commentary for Section 610.2.

**610.4 Cooking oil storage system components.** Cooking oil storage system components shall include but are not limited to piping, connections, fittings, valves, tubing, hose, pumps, vents and other related components used for the transfer of cooking oil, and are permitted to be of either metallic or non-metallic construction.

- ❖ This section simply describes what components make up a cooking oil storage system. Section 610.4.1 addresses the design and construction requirements for these components. This section also notes that these components are permitted to be either metallic or nonmetallic. The allowance for types of materials will depend on the requirements in Section 610.4.1.

**610.4.1 Design standards.** The design, fabrication and assembly of system components shall be suitable for the working pressures, temperatures and structural stresses to be encountered by the components.

- ❖ The performance-based language provided in this section requires that it be determined that the system's intended use is consistent with all the components of the system.

**610.4.2 Components in contact with heated oil.** System components that come in contact with heated cooking oil shall be rated for the maximum operating temperatures expected in the system.

- ❖ Cooking oil storage system components may be exposed to elevated temperatures, such as when draining spent oil from deep fat fryers. Manufacturers must document that components can withstand the highest temperature to be expected during normal operations to avoid component deterioration or failure from heat exposure.

**610.5 Tank venting.** Normal and emergency venting shall be provided for cooking oil storage tanks.

- ❖ This section and the UL tank standards referenced in Section 610.2 require ASTs to be equipped with a normal vent and an emergency vent.

**610.5.1 Normal vents.** Normal vents shall be located above the maximum normal liquid line, and shall have a minimum effective area not smaller than the largest filling or withdrawal connection. Normal vents shall be permitted to vent inside the building.

- ❖ Tanks are vented to maintain the internal tank pressure within the design operating range. Low pressure can increase the generation of vapors while high pressure can damage the tank or piping system. Any pressure outside of the design pressure range (which could be caused if the vent line were not located above the highest level of liquid) can have an adverse effect on the operation of the system as well as the piping and equipment. This section is also consistent with Section 21.4.3 of NFPA 30.

While this section establishes the size of the normal vent line as being the same as the largest inflow or outflow connection, it should be noted that Section 21.4.3.3 of NFPA 30 also states that the minimum vent size must be 1 $\frac{1}{4}$  inches inside diameter.

Recognizing the reduced hazard of Class IIIB liquids, this section does not require the normal vent for a cooking oil AST installed indoors to be terminated outside the building. Note, however, that Section 5704.2.7.3.3 of the code allows this condition only where the tank is equipped with a normally closed pressure/vacuum vent.

**610.5.2 Emergency vents.** Emergency relief vents shall be located above the maximum normal liquid line, and shall be in the form of a device or devices that will relieve excessive internal pressure caused by an exposure fire. For nonmetallic tanks, the emergency relief vent shall be allowed to be in the form of construction. Emergency vents shall be permitted to vent inside the building.

- ❖ All ASTs for cooking oil storage require an emergency vent that will relieve excessive internal pressure caused by exposure to fires in accordance with Section 5704.2.7.4 of the code; however, the emergency vents for ASTs storing Class IIIB liquids are generally permitted to discharge inside the building in accordance with that section.

**610.6 Heating of cooking oil.** Electrical equipment used for heating cooking oil in cooking oil storage systems shall be listed to UL 499 and shall comply with NFPA 70. Use of electrical immersion heaters shall be prohibited in nonmetallic tanks.

- ❖ Many cooking oil storage tank systems will contain internal heaters to keep the oil above its melting temperature so that it can be efficiently removed by a recovery vacuum truck. This section requires that the electrical equipment associated with the heating of cooking oil be listed and its design and installation must comply with NFPA 70. Note that this section

does not require any temperature controls to ensure the cooking oil is not heated above its flash point temperature. See the commentary to Section 5701.5 for a discussion of the impact of heating combustible liquids above their flash point.

**610.7 Electrical equipment.** Electrical equipment used for the operation of cooking oil storage systems shall comply with NFPA 70.

- ❖ The phrase “cooking oil storage system” as used in this section could lead to the incorrect assumption that it is listed as a complete assembly of components. Fire code officials will need to evaluate the electrical equipment separately for compliance with the code and NFPA 70.

### SECTION 611 HYPERBARIC FACILITIES

**611.1 General.** Hyperbaric facilities shall be inspected, tested and maintained in accordance with NFPA 99.

- ❖ Section 425 of the IBC requires that hyperbaric facilities, regardless of occupancy, comply with NFPA 99 for installation. This section provides the maintenance requirements so that such facilities continue to operate safely. The standard provides detailed responsibilities for testing and inspecting these facilities, such as requirements for an on-site hyperbaric safety director and for training.

**611.2 Records.** Records shall be maintained of all testing and repair conducted on the hyperbaric chamber and associated devices and equipment. Records shall be available to the *fire code official*.

- ❖ This section requires that records be kept to document compliance with the maintenance and testing requirements of NFPA 99 for the benefit of the facility owner and the fire code official.

As a result of a review of Recommendation 2(c) of the NIST Charleston, South Carolina Sofa Superstore Fire Report, changes were made to Sections 107.2 and 107.3, along with 49 other sections, to comprehensively address recordkeeping requirements. Section 107.3 provides standardized recordkeeping requirements for periodic inspection, testing, servicing and other operational and maintenance requirements of the code and makes it clear that records must be maintained on the premises or another approved location and that copies of records must be provided to the fire code official upon request. Section 107.3 also makes it clear that records must be maintained for a period of not less than 3 years unless a different time interval is specified in the code or a referenced standard, and that the fire code official is authorized to prescribe the form and format of such records. See the commentaries to Sections 107.2 and 107.3.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

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# Chapter 7: Fire and Smoke Protection Features

## General Comments

This chapter sets forth general fire safety precautions for existing buildings and structures. In general, these requirements are intended to maintain required fire-resistance ratings and limit fire spread.

Chapter 7 is divided into four sections. Section 701 gives the general scope of the chapter and provides the basis for enforcement of its provisions. Section 702 provides applicable definitions. Section 703 describes the required maintenance of fire-resistance-rated assemblies, opening protectives and fire doors. Section 704 defines the enclosure requirements for shafts in existing buildings.

## Purpose

The maintenance of assemblies required to be fire-resistance rated is a key component in a passive fire protection philosophy. This chapter reinforces this component and further regulates floor openings, which are a leading cause of fire spread and smoke migration through buildings.

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## SECTION 701 GENERAL

**701.1 Scope.** The provisions of this chapter shall govern maintenance of the materials, systems and assemblies used for structural fire resistance and fire-resistance-rated construction separation of adjacent spaces to safeguard against the spread of fire and smoke within a building and the spread of fire to or from buildings. New buildings shall comply with the *International Building Code*.

❖ This section establishes the scope of Chapter 7, introduces the requirements for maintaining the integrity of fire-resistance-rated assemblies (see Section 703) and prescribes the types of floor opening protection required in existing buildings (see Section 704). The provisions of Chapter 7 apply to the ongoing maintenance of the materials, assemblies and systems used to protect against the passage of fire and smoke within and between buildings. The assemblies outlined herein provide various degrees of protection. The required fire-resistance rating varies with the potential fire hazard associated with type of construction, occupancy, height and area of the building and degree of protection for different elements of the means of egress. The potential fire hazard associated with various occupancies is reflected in the *International Building Code*® (IBC®). Chapter 7 of the IBC provides the details and the extent of the protection (horizontal and vertical continuity); however, the actual fire-resistance-rated construction is mandated by provisions in Chapters 4, 5, 6, 7 and 10 of the IBC.

**701.2 Unsafe conditions.** Where any components in this chapter are not maintained and do not function as intended or do not have the *fire resistance* required by the code under which the building was constructed, remodeled or altered,

such component(s) or portion thereof shall be deemed an unsafe condition, in accordance with Section 110.1.1. Components or portions thereof determined to be unsafe shall be repaired or replaced to conform to that code under which the building was constructed, remodeled, altered or this chapter, as deemed appropriate by the *fire code official*.

Where the extent of the conditions of components is such that any building, structure or portion thereof presents an imminent danger to the occupants of the building, structure or portion thereof, the *fire code official* shall act in accordance with Section 110.2.

❖ This section is intended to clarify to code officials, designers, contractors and property owners that a building's fire-resistance-rated construction must be maintained at the original level of safety required by the codes that were applicable when the building was constructed or last remodeled. Failure to maintain fire-resistant components to that level of safety will result in the component being declared unsafe in accordance with Section 110.1.1 of the code and repair or restoration being required.

Code provisions, which require maintenance to a level of safety required by an often-unknown code or an unknown edition of a known code, are sometimes viewed as problematic and unenforceable. However, communities should have some record of when a building was constructed, and knowing the year of construction should make it relatively easy to determine an edition of the code that was published close to or prior to that year. In many communities, local architectural historical research can also be helpful in doing architectural historical research to determine the year of construction. These types of methods for determining the originally applicable code, if any, could be viewed

as haphazard and arbitrary, but they can be considered better than trying to make a building constructed 30, 50 or 100 years ago comply with today's requirements. In the event that no information of any kind can be found to shed light on an original construction date, this chapter provides for an acceptable level of safety and can be retroactively required where deemed appropriate by the fire code official.

This section also provides that where component conditions are so bad due to lack of maintenance as to constitute a clear and present threat to the safety of the occupants, the fire code official must take the steps required by Section 110.2.

**SECTION 702  
DEFINITIONS**

**702.1 Definitions.** The following terms are defined in Chapter 2:

**DRAFTSTOP.**

**FIRE-RESISTANT JOINT SYSTEM.**

**FIREBLOCKING.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

**SECTION 703**

**FIRE-RESISTANCE-RATED CONSTRUCTION**

**703.1 Maintenance.** The required *fire-resistance rating* of fire-resistance-rated construction, including, but not limited to, walls, firestops, shaft enclosures, partitions, *smoke barriers*, floors, fire-resistive coatings and sprayed fire-resistant materials applied to structural members and fire-resistant joint systems, shall be maintained. Such elements shall be visually inspected by the *owner* annually and properly repaired, restored or replaced where damaged, altered, breached or penetrated. Records of inspections and repairs shall be maintained. Where concealed, such elements shall not be required to be visually inspected by the *owner* unless the concealed space is accessible by the removal or movement of a panel, access door, ceiling tile or similar movable entry to the space. Openings made therein for the passage of pipes, electrical conduit, wires, ducts, air transfer openings and holes made for any reason shall be protected with *approved* methods capable of resisting the passage of smoke and fire. Openings through fire-resistance-rated assemblies shall be protected by self- or automatic-closing doors of *approved* construction meeting the fire protection requirements for the assembly.

❖ The code mandates that all equipment, systems, devices and safeguards required by the current and

previously adopted codes be maintained in good working order (see Section 102.1). This section reiterates that requirement specifically for fire-resistance-rated assemblies in existing buildings.

Once a building is occupied, its component parts are often damaged, altered or penetrated for installation of new piping, wiring and the like. These actions may reduce the effectiveness of assemblies that must be fire-resistance rated. This section requires the building owner, annually, to visually inspect non-concealed elements and that any damage to a fire-resistance-rated assembly be repaired in a manner that restores the original required performance characteristics. Concealed elements must be visually inspected if they may be accessed by a door, removable ceiling tile, access panel or the like. Similarly, if a fire-resistance-rated assembly is altered or penetrated, the alteration or penetration must comply with the applicable requirements of the IBC for the particular type of alteration or penetration.

This section also requires that written records of maintenance and repairs to rated assemblies must be kept and should indicate the date, time and the name of the person conducting the inspection or repair for each rated assembly. These records must be maintained by the owner and made available to the fire code official for review when requested. This requirement relieves the fire code official of the administrative burden of maintaining test records.

**703.1.1 Fireblocking and draftstopping.** Required *fireblocking* and draftstopping in combustible concealed spaces shall be maintained to provide continuity and integrity of the construction.

❖ Fireblocking and draftstopping (see the Chapter 2 commentary for the definitions “Fireblocking” and “Draftstop”) slow the spread of fire and the products of combustion through concealed spaces within a building. To fulfill their intended function, fireblocking and draftstopping must be properly maintained. Most frequently, damage or repairs to other building components, such as mechanical piping, results in fireblocking or draftstopping being removed and not properly replaced. This section specifically requires that when fireblocking and draftstopping required by the IBC are damaged, removed or otherwise altered, they must be replaced or restored.

**703.1.2 Smoke barriers and smoke partitions.** Required *smoke barriers* and smoke partitions shall be maintained to prevent the passage of smoke. Openings protected with *approved* smoke barrier doors or smoke dampers shall be maintained in accordance with NFPA 105.

❖ Smoke barriers divide areas of a building into separate smoke compartments to create an area of safety for occupants. A smoke barrier is designed and installed in accordance with IBC Section 709 to resist fire and smoke spread so that occupants can be evacuated or relocated to adjacent smoke compartments (see the commentary to the definitions of “Smoke barrier” and “Smoke compartment” in Chap-

ter 2). This concept has proven effective in Group I-2 and I-3 occupancies, and Sections 407.5 and 408.6 of the IBC identify where smoke barriers are required in those occupancies. Smoke barriers may also be utilized in other applications, such as part of a smoke control system (see Section 909.5 of the code), separation of accessible areas of refuge in accessible means of egress (see Section 1009.6.4 of the code), compartmentation of underground buildings (see Section 405.4.2 of the IBC) and elevator lobbies in underground buildings (see Section 405.4.3 of the IBC), FSAE lobbies (3007.6.2) and occupant evacuation elevator lobbies (3008.6.2) among others. Other than the wall itself, all of the elements in the smoke barrier that can potentially allow smoke travel through the smoke barrier are required to have a quantified resistance to leakage. This includes doors, joints, through penetrations and dampers. The maximum leakage limits are as established in the individual code sections referenced above for each element. A smoke barrier is not intended or expected to be exposed to fire for extended periods and is, therefore, not required to have a fire-resistance rating exceeding 1 hour. Also, the occupancies in which smoke barriers are required are generally required to be sprinklered by Section 903 of the code. Smoke barriers are to be continuous from outside wall to outside wall and from the top of the foundation or floor/ceiling assembly below to the underside of the floor or roof sheathing, deck or slab. The provisions require the barrier to be continuous through all concealed and interstitial spaces, including suspended ceilings and the space between the ceiling and the floor or roof sheathing, deck or slab above. Smoke barriers are not required to extend through interstitial spaces if the space is designed and constructed such that fire and smoke will not spread from one smoke compartment to another; therefore, the construction assembly forming the bottom of the interstitial space must provide the required fire-resistance rating and be capable of resisting the passage of smoke from the spaces below.

Smoke partitions are nonrated walls that serve to resist the spread of fire and the unmitigated movement of smoke for an unspecified period of time. Their primary purpose is to prevent the ready and quick passage of smoke into corridors in Group I-2 or for elevator lobby protection in a sprinklered building. Unlike 1-hour fire-resistance-rated smoke barriers, unless required by the IBC, smoke partitions are not required to have a fire-resistance rating. Smoke partitions are intended to provide less protection than a smoke barrier, and therefore are not required to be continuous through the concealed spaces and through the ceiling. The construction of a smoke partition is prescribed in Section 710 of the IBC; however, the level of performance or a method of testing them is not provided.

Because these assemblies and their opening protectives are critical life safety components of a build-

ing, they must be maintained throughout the life of the building. Opening protective maintenance provisions for these types of assemblies are contained in NFPA 105. For further information on incidental uses, smoke barriers and smoke partitions, see the commentary to Sections 509, 709 and 710 of the IBC, respectively.

**703.1.3 Fire walls, fire barriers and fire partitions.** Required *fire walls*, *fire barriers* and *fire partitions* shall be maintained to prevent the passage of fire. Openings protected with *approved* doors or fire dampers shall be maintained in accordance with NFPA 80.

❖ Fire walls, fire barriers and fire partitions are also key components in a passive fire- and life-safety design. Fire walls constructed in accordance with Section 706 of the IBC serve to create separate buildings (see the commentary to the definition of “Area, building” in Chapter 2 of the code); therefore, all applicable provisions of the code are applied individually to the building on each side of the fire wall. As such, the fire wall must also provide the same protection afforded by exterior walls, namely: structural integrity, structural independence and adequate fire resistance for exposure protection.

Fire barriers constructed in accordance with Section 707 of the IBC provide a higher degree of protection than fire partitions, but lack the inherent structural integrity of fire walls and, unlike fire partitions, there are no circumstances under which a fire barrier wall is permitted to terminate at a ceiling. Fire barriers are used for a variety of purposes, including but not limited to, separating exits and certain areas of refuge, mixed occupancies and incidental use areas, shafts, floor opening enclosures, hazardous materials control areas and fire areas. It is important to note that, since fire barriers are intended to provide a reliable subdivision of areas, the construction that structurally supports the assembly is required to provide and maintain at least the same hourly fire-resistance rating as the fire barrier being supported.

Fire partitions constructed in accordance with Section 708 of the IBC are wall assemblies that enclose exit access corridors; separate tenant spaces in covered malls, dwelling units and sleeping units; and separate elevator lobbies from the balance of a floor. Openings in fire partitions must be properly protected, but the total area of openings in a fire partition is not limited. Unlike the continuity requirements for fire walls and fire barriers, fire partition continuity must only be continuous from floor slab to the floor slab or roof deck above or to the ceiling of a fire-resistance-rated floor/ceiling or roof/ceiling assembly. Although fire partitions must normally be supported by construction having a comparable fire-resistance rating in buildings of Type IIB, IIIB and VB construction, as defined in the IBC, Section 708.4 of that code does not require such supportive construction for sleeping units and tenant separations and exit access corridor walls.

The IBC includes requirements for fire-resistance rating, continuity and opening and penetration protection in these types of assemblies. Because these assemblies and their opening protectives are critical life safety components of a building, they must be maintained throughout the life of the building. Opening protective maintenance provisions for these types of assemblies are contained in NFPA 80. For further information on fire walls, fire barriers and fire partitions, see the commentaries to Sections 706, 707 and 708 of the IBC, respectively.

**703.2 Opening protectives.** Opening protectives shall be maintained in an operative condition in accordance with NFPA 80. Where allowed by the *fire code official*, the application of field-applied labels associated with the maintenance of opening protectives shall follow the requirements of the *approved* third-party certification organization accredited for *listing* the opening protective. Fire doors and *smoke barrier* doors shall not be blocked or obstructed, or otherwise made inoperable. Fusible links shall be replaced promptly whenever fused or damaged. Fire door assemblies shall not be modified.

❖ Openings in fire-resistance-rated assemblies must be protected to prevent the passage of fire in accordance with Section 716 of the IBC. After opening protectives are installed and approved, they may become damaged, corroded or otherwise less effective than required. This section specifically requires that all opening protectives required by the IBC be maintained in compliance with NFPA 80 so that they can perform their intended function, which is to prevent the passage of smoke, fire or combustion products through openings in fire-resistance-rated walls, ceilings and shafts during a fire emergency. Sections 703.2.2 and 703.2.3 of the code indicate specific points of inspection and enforcement regarding these doors. Prohibited modifications to fire door assemblies include the attachment of materials, cutting, boring holes or other alterations that could affect the performance of the door as a fire protection-rated assembly.

This section also addresses the very real issue of maintaining labeled opening protectives by requiring field-applied labels to follow the requirements of the third-party certification organization, which is accredited for listing the specific opening protective. The relabeling of existing fire doors is a common practice and due to the importance of the rating requirements a level of monitoring by a third party to ensure the labeling matches the rating of the door assembly is necessary.

In the listing documentation, there are specific criteria for field application of labels. One of the criteria is whether the local fire code official allows this practice, and this section provides guidance in this area to the fire code official. IBC Section 716.5.7.1 requires that new fire doors or new fire door assemblies must be labeled at the factory (see the definition of “Labeled” in Chapter 2 of the code). However, it is not uncommon for an existing fire door to have either a

damaged or missing label, or a label that has been painted over or otherwise obscured. The fire code official needs to make a determination as to whether field application of the label is acceptable or not. If field application is allowed, then the certification organization can follow the proper criteria for labeling the opening protective.

Proper maintenance necessitates that the manufacturer’s installation instructions and the listing organization’s instructions are followed in order to maintain the listing and proper operation of the assemblies and devices as required by the code, the manufacturer and the listing organization.

**703.2.1 Signs.** Where required by the *fire code official*, a sign shall be permanently displayed on or near each fire door in letters not less than 1 inch (25 mm) high to read as follows:

1. For doors designed to be kept normally open: FIRE DOOR—DO NOT BLOCK.
2. For doors designed to be kept normally closed: FIRE DOOR—KEEP CLOSED.

❖ Any door in a fire-resistance-rated wall assembly represents a potential “weak link” in maintaining the degree of compartmentation intended by the code. That is the reason for requiring a rated assembly. The IBC calls for adequate opening protection in the form of a door with a specified fire protection rating. This section allows the fire code official to require signage on or near the rated doors to make the occupants aware of the importance of the door as a fire- and life-safety feature. Also, see the commentary to Section 703.2.2 for a discussion on door closing and the improper use of props to hold doors open.

**703.2.2 Hold-open devices and closers.** Hold-open devices and automatic door closers, where provided, shall be maintained. During the period that such device is out of service for repairs, the door it operates shall remain in the closed position.

❖ The only devices acceptable for holding fire doors open are fire-detector-activated automatic-closing devices that automatically close the doors (or allow the doors to swing closed using self-closing devices) in the event of a fire. Numerous devices, such as electromagnetic hold-opens, pneumatic systems and systems of pulleys and weights connected to a fusible link, are available.

The detection method for the closing device must be consistent with the purpose of the opening protective; that is, doors in smoke barriers must be activated by smoke detectors. Heat detectors or fusible links are adequate where maintenance of the fire-resistance rating alone is required.

Where smoke-detector-activated automatic door closers are used and the detectors are interconnected with a required fire alarm system, the devices and wiring methods must be checked for compatibility with the fire alarm system control panel before installation. Some fire alarm control equipment is compatible only with the manufacturer’s automatic smoke

detectors. Fire detectors used for automatic door release service in buildings that are not equipped with a fire alarm system must comply with Section 907.3.

A common violation of fundamental safety principles, as well as this section of the code, is having wooden or rubber wedges, or kick-down-type door hold-opens prop open fire doors or smoke barrier doors. This renders them totally ineffective as opening protectives. Building maintenance personnel who do not understand the purpose of these doors often do this to aid movement of people, equipment or air in a hallway or other area without realizing the potential hazard to life safety if a fire were to occur. This violation is especially problematic as it pertains to means of egress stairwells or horizontal exit doors as well. For further information on door closing requirements for fire doors, see Section 716.5.9 of the IBC.

**703.2.3 Door operation.** Swinging fire doors shall close from the full-open position and latch automatically. The door closer shall exert enough force to close and latch the door from any partially open position.

❖ Fire doors must be closed to be effective. Swinging fire doors should be frequently checked to make sure they close and latch on their own power from any position.

**703.3 Ceilings.** The hanging and displaying of salable goods and other decorative materials from acoustical ceiling systems that are part of a fire-resistance-rated horizontal assembly, shall be prohibited.

❖ This section is only applicable to acoustical ceiling systems that are a component of an approved fire-resistance-rated floor/ceiling or roof/ceiling assembly required to be rated by the type of construction of the building. Fire-resistance-rated floor/ceiling and roof/ceiling assemblies must be tested using the methods in ASTM E119 to demonstrate a fire-resistance rating. Locating a substantial fuel load and additional weight directly beneath an acoustical ceiling, however, may expose the ceiling to a direct fire source and weight overload not contemplated in the ASTM E119 testing and that could breach the ceiling, which is an integral part of the tested assembly. Depending on the contribution of the ceiling to the overall fire-resistance rating, this may result in the assembly not functioning as the code intends or failing completely.

New acoustical ceiling systems, whether or not they are a component of an approved fire-resistance-rated assembly, are required to comply with Section 808 of the IBC. Section 808.1.1 of the IBC requires that acoustical ceiling systems comply with the manufacturer's installation instructions. Section 808.1.1.1 of the IBC further requires compliance with several ASTM standards that govern the installation of such systems. Those standards do not contemplate the addition of loads to the metal support framework of the system beyond the load of the system itself plus light fixtures, or other components that might be part of the approved design. Adding any weight to the system beyond that which it was

designed for and approved by the building official could lead to failure of the system and should only be done after a review of the structural components by a registered design professional.

**703.4 Testing.** Horizontal and vertical sliding and rolling fire doors shall be inspected and tested annually to confirm proper operation and full closure. Records of inspections and testing shall be maintained.

❖ Annual tests are intended to determine that required fire doors operate freely and close completely. Where fusible links are used as the releasing mechanism, the link may be temporarily removed rather than activated during testing. Fusible links in poor condition must be replaced as part of the maintenance of fire-resistance components. Smoke detectors and heat detectors other than fusible links must be tested as required by the manufacturer's instructions (see NFPA 72 for recommended testing procedures for various fire detectors).

This section also requires that written records of inspection and testing of opening protectives must be kept and should indicate the date, the time and the name of the person conducting the inspection or repair for each rated assembly. These records must be maintained by the owner and should be made available to the fire code official for review when requested. This requirement relieves the fire code official of the administrative burden of maintaining test records.

## SECTION 704 FLOOR OPENINGS AND SHAFTS

**704.1 Enclosure.** Interior vertical shafts including, but not limited to, *stairways*, elevator hoistways, service and utility shafts, that connect two or more stories of a building shall be enclosed or protected as required in Chapter 11. New floor openings in existing buildings shall comply with the *International Building Code*.

❖ Vertical openings that are not properly protected can act as a chimney for smoke, hot gases and products of combustion. Unprotected floor openings have been a major contributing factor in many large loss-of-life fires. Unless indicated otherwise, Chapter 11 retroactively requires the enclosure of vertical openings between floors with approved fire barriers. See commentary, Sections 1103.4 through 1103.4.10.

**704.2 Opening protectives.** Where openings are required to be protected, opening protectives shall be maintained self-closing or automatic-closing by smoke detection. Existing fusible-link-type automatic door-closing devices are permitted if the fusible link rating does not exceed 135°F (57°C).

❖ This section requires that fire door assemblies provided for protection of openings in vertical enclosures be self-closing or automatic-closing in order to maintain the integrity of the vertical opening enclosure. This section also recognizes that some opening protectives in existing buildings may already be

## FIRE AND SMOKE PROTECTION FEATURES

equipped with heat-actuated closing devices rather than the smoke-detector-actuated devices otherwise required by the section. Such devices are allowed to continue in service, provided that the temperature rating of their fusible element is as low as is available [i.e., 135°F (57°C)] to provide the fastest possible operation in the event of a fire. In the event that an existing fusible link on an opening protective is rated higher than the maximum 135°F (57°C) allowed by this section, it would need to be removed and the door maintained as self-closing or be replaced with a smoke-detector-actuated closer in accordance with this section and Section 907.3. New opening protectives must comply with Section 716 of the IBC. See the commentary to that section for further information.

### Bibliography

The following resource material was used in the preparation of the commentary for this chapter of the code:

*Code Changes Resource Collection—2015 International Fire Code*. Washington, DC: International Code Council, 2014.

# Chapter 8: Interior Finish, Decorative Materials and Furnishings

## General Comments

This chapter is consistent with the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>), which regulates the interior finishes of buildings through the regulation of their flame spread potential. The code goes beyond interior finishes, also regulating furnishings and vegetation in buildings in certain occupancies. Additionally, the code addresses interior finishes and decorative materials in existing buildings.

This chapter is related to fire growth and spread potential in terms of the immediate effect on building occupants. The flame spread characteristics of certain materials will affect the potential fire scenarios within a building. Fire-resistance-rated construction, which is dealt with in Chapter 7 of both the IBC and this code, is more concerned with the spread of fire throughout the structure once the fire has reached a substantial size, with an emphasis on structural failure during a fire.

The regulation of flame spread can be traced back to large life-loss events, such as the Coconut Grove nightclub fire that killed 492 people in 1942. This fire was thought to have started when a light bulb in a basement cocktail lounge came in contact with the cotton cloth that had been applied to the ceiling for decorative purposes. Post-fire testing of the cotton cloth indicated that it had a flame spread rating of 2,500, more than 33 times the maximum allowable flame spread in today's codes. This factor, in addition to a series of problems with the egress system, led to one of the worst fire disasters in history. The need for these regulations was

further emphasized after The Station nightclub fire in West Warwick, Rhode Island, where 100 people died in February 2003. The soundproofing material in the nightclub was not approved for such use and was a major factor in the fire growth.

In addition to flame spread ratings of surface materials, certain furnishing types and vegetation, such as Christmas trees, pose a significant fire hazard because of their potential fire size and intensity. The materials used in furnishings have changed dramatically from past materials and many more plastics are now used for both decoration and furnishings. Plastics not only burn more vigorously than materials like cotton and wood, but also produce more toxic fire effluents.

## Purpose

The overall purpose of Chapter 8 is to regulate interior finishes, furnishings and vegetation so they do not significantly add to or create fire hazards in buildings. The provisions tend to aim at occupancies with specific risk characteristics, such as vulnerability of occupants, density of occupants, lack of familiarity with the building and societal expectations of importance. Since this is a fire code, there is an emphasis on both new and existing buildings.

More information on the development of this chapter and its sections, as well as all other revised provisions of the code, can be found in the *Complete Revision History to the 2015 I-Codes*.

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## SECTION 801 GENERAL

**801.1 Scope.** The provisions of this chapter shall govern interior finish, interior trim, furniture, furnishings, decorative materials and decorative vegetation in buildings. Existing buildings shall comply with Sections 803 through 808. New buildings shall comply with Sections 804 through 808, and Section 803 of the *International Building Code*.

❖ This chapter reflects the same scope of issues as Chapter 8 of the IBC but has a slightly different emphasis. Fire codes are intended to address fire hazards of buildings and facilities over their life span; therefore, there is greater emphasis on the furnishings and contents of buildings and on the maintenance of flame spread indexes over time. Section

803 requires the same flame spread indexes as the IBC. Generally, regulating the combustibility of contents is a fairly difficult task once the building is occupied and is considered existing. Because of this difficulty, only some combustible contents and decorative materials are regulated in a limited number of occupancies. More specifically, the use of combustible furnishings, contents and decorative materials in Group A occupancies is addressed because of the high occupant load and the lack of familiarity of most occupants with the building. The type of furniture allowed in Group I occupancies is limited because of the vulnerability of the occupants and the likely fire scenarios that may occur when the building is non-sprinklered.

**SECTION 802  
DEFINITIONS**

**802.1 Definitions.** The following terms are defined in Chapter 2:

**FLAME SPREAD.**

**FLAME SPREAD INDEX.**

**INTERIOR FLOOR-WALL BASE.**

**SITE-FABRICATED STRETCH SYSTEM.**

**SMOKE-DEVELOPED INDEX.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see commentary, Sections 201 through 201.4).

**SECTION 803  
INTERIOR WALL AND CEILING FINISH  
AND TRIM IN EXISTING BUILDINGS**

**803.1 General.** The provisions of this section shall limit the allowable fire performance and smoke development of interior wall and ceiling finishes and interior wall and ceiling trim in existing buildings based on location and occupancy classification. Interior wall and ceiling finishes shall be classified in accordance with Section 803 of the *International Building Code*. Such materials shall be grouped in accordance with ASTM E84, as indicated in Section 803.1.1, or in accordance with NFPA 286, as indicated in Section 803.1.2.

**Exceptions:**

1. Materials having a thickness less than 0.036 inch (0.9 mm) applied directly to the surface of walls and ceilings.
  2. Exposed portions of structural members complying with the requirements of buildings of Type IV construction in accordance with the *International Building Code* shall not be subject to interior finish requirements.
- ❖ This section specifically addresses existing buildings, whereas Sections 804 through 808 address both new and existing buildings. This section provides two methods for compliance with interior wall and ceiling finish fire performance requirements. Both are fire test methods that address the potential for flame to spread.
- The first test—ASTM E84, also known as the “Steiner tunnel” or the “tunnel test”—has been around for many years. The second test method referenced is NFPA 286, which is called a “room corner test.” These two tests will be discussed further in the commentary for Sections 803.1.1 and 803.1.2, respectively. Requirements for interior wall and ceiling finishes and interior wall and ceiling trim within exist-

ing buildings are based upon occupancy. Section 803.3 and Table 803.3 address these occupancy limitations in more detail.

There are two exceptions to Section 803.1 that would allow materials without testing. They are very thin materials, less than or equal to 0.036 inch (0.9 mm) in thickness, when applied directly to the wall, and exposed structural members in Type IV construction. These exceptions are the same as those in the IBC.

Note that Section 803 also addresses the following:

- Textiles and expanded vinyl used as a wall or ceiling finish.
- Limitations on the use of foam.
- Polyethylene and polypropylene used as interior finish.
- Site-fabricated stretch systems.

**803.1.1 Classification in accordance with ASTM E84.** Interior finish materials shall be grouped in the following classes in accordance with their flame spread and smoke-developed index where tested in accordance with ASTM E84.

Class A: flame spread index 0–25; smoke-developed index 0–450.

Class B: flame spread index 26–75; smoke-developed index 0–450.

Class C: flame spread index 76–200; smoke-developed index 0–450.

❖ Wall and ceiling interior finish and trim materials are required to have limits on flame spread and smoke-developed indexes as prescribed in Section 803.3, based upon occupancy. ASTM E84 is one of the tests available to demonstrate compliance with the requirements of Section 803. This test method has been around since 1944 [see Commentary Figure 803.1.1(1)]. It is the primary method used but, as noted earlier, NFPA 286 is an alternative test, which is discussed in the commentary for Section 803.1.2. ASTM E84 is intended to determine the relative burning behavior of materials on exposed surfaces, such as ceilings and walls, by visually observing the flame spread along the test specimen [see Commentary Figure 803.1.1(2)]. Flame spread and smoke density indexes are then reported. The test method is not appropriate for materials that are not capable of supporting themselves, or of being supported in the test tunnel. There may also be concerns with materials that drip, melt or delaminate and that are very thin. A distinction is made, therefore, for textile wall or ceiling coverings, expanded vinyl wall or ceiling coverings, wood veneers applied on site, foam plastic insulation materials, high density polyethylene and polypropylene and site-fabricated stretch systems (see Sections 803.5, 803.6, 803.7 and 803.8, 803.9 and 803.10).

ASTM E84 establishes a flame spread index based on the area under a curve when the actual flame spread distance is plotted as a function of time. The code has divided the acceptable range of flame

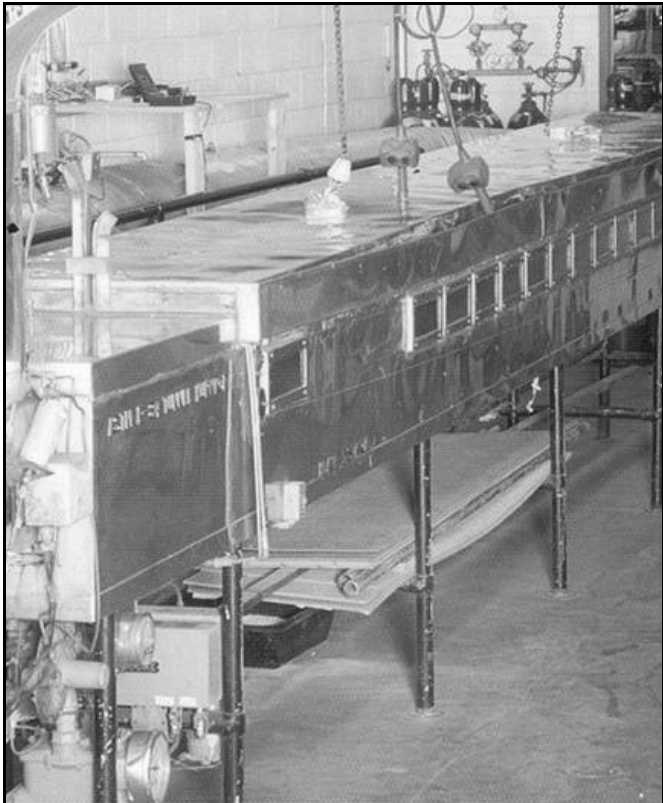
spread indexes (0–200) into three classes: Class A (0–25), Class B (26–75) and Class C (76–200). For all three classes, the code has established a common acceptable range of smoke-developed index of 0–450. An indication of relative fire performance is as follows: an inorganic reinforced-cement board has a flame spread and smoke-developed index of zero, while select grade red oak wood flooring has a flame spread and smoke-developed index of 100. Not to preclude more detailed information resulting from an ASTM E84 test report, Commentary Figure

803.1.1(3) identifies the typical flame spread properties of certain building materials.

**803.1.2 Classification in accordance with NFPA 286.** Interior wall or ceiling finishes shall be allowed to be tested in accordance with NFPA 286. Finishes tested in accordance with NFPA 286 shall comply with Section 803.1.2.1. Interior wall and ceiling finish materials tested in accordance with NFPA 286 and meeting the acceptance criteria of Section 803.1.2.1 shall be allowed to be used where a Class A classification in accordance with ASTM E84 is required.

❖ The alternative test method for determining compliance for interior wall and ceiling finish and trim, other than textiles, is found in test standard NFPA 286. This test is known as a “room corner” fire test and is similar to that referenced for textile wall coverings in Section 803.5 (see NFPA 265) [see Commentary Figures 803.1.2(1) and 803.1.2(2)]. In this test, materials are mounted covering three walls of the compartment (excluding the wall containing the door) and the ceiling. In the case where testing is only for ceiling finish properties, the sample only needs to be mounted on the ceiling. Then a fire source consisting of a gas burner is placed in one corner, flush against both walls (furthest from the doorway) of the compartment with the following exposure conditions:

- 40 kilowatts (kW) for 5 minutes; then
- 160 kW for 10 minutes.



**Figure 803.1.1(1)  
ASTM E84 TUNNEL TEST**



**Figure 803.1.1(2)  
FLAME IN TUNNEL TEST**

Material	Flame spread
Glass-fiber sound-absorbing blanks	15 to 30
Mineral-fiber sound-absorbing panels	10 to 25
Shredded wood fiberboard (treated)	20 to 25
Sprayed cellulose fibers (treated)	20
Aluminum (with baked enamel finish on one side)	5 to 10
Asbestos-cement board	0
Brick or concrete block	0
Cork	175
Gypsum board (with paper surface on both sides)	10 to 25
Northern pine (treated)	20
Southern pine (untreated)	130 to 190
Plywood paneling (untreated)	75 to 275
Plywood paneling (treated)	100
Carpeting	10 to 600
Concrete	0

**Figure 803.1.1(3)  
TYPICAL FLAME SPREAD OF COMMON MATERIALS**

The test then measures heat release and smoke release through the collection of the fire effluents and measurement of oxygen concentrations in the exhaust duct. Heat release is calculated by the oxygen consumption principle, which has shown that heat release is a function of the decrease in oxygen concentration in the fire effluents. Thus, exhaust duct measurements include temperatures, pressures and smoke values for use in the calculations. Temperatures and heat fluxes are also measured in the room. This generally provides a more realistic

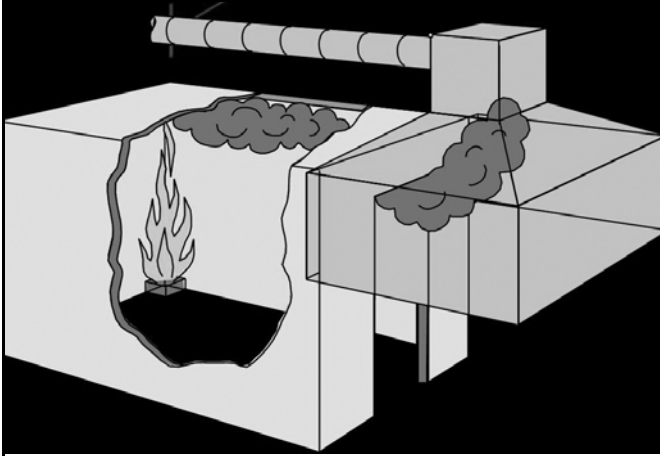


Figure 803.1.2(1)  
ROOM CORNER TEST



Figure 803.1.2(2)  
FLAME IN ROOM CORNER TEST

understanding of the fire hazard associated with the materials (see also Section 803.5.1 for more details on the room corner test concept).

The NFPA 286 test method does not contain pass/fail criteria; however, the code provides such criteria in Section 803.1.2.1.

**803.1.2.1 Acceptance criteria for NFPA 286.** The interior finish shall comply with the following:

1. During the 40 kW exposure, flames shall not spread to the ceiling.
2. The flame shall not spread to the outer extremity of the sample on any wall or ceiling.
3. Flashover, as defined in NFPA 286, shall not occur.
4. The peak heat release rate throughout the test shall not exceed 800 kW.
5. The total smoke released throughout the test shall not exceed 1,000 m<sup>2</sup>.

❖ As noted in Section 803.1.2, there are two levels of exposure during an NFPA 286 fire test in order to better represent a growing fire: 40 kW fire size for 5 minutes and 160 kW for 10 minutes. The 40 kW exposure represents the beginning of a fire where the initial spread is critical; therefore, the stated criteria is that the fire cannot spread to the ceiling. The 160 kW exposure is obviously a more intense fire situation and the criteria relates to preventing flashover (as defined by NFPA 286) and the extent of flame spread throughout the entire test assembly. There is also a total smoke production criterion of 1,000 m<sup>2</sup>. It should be noted that the criteria used in NFPA 286 and NFPA 265 to determine if flashover has occurred would include any two of the following:

- Heat release exceeds 1 mega watt (MW).
- Heat flux at the floor exceeds 20 kW/m<sup>2</sup>.
- Average upper layer temperature exceeds 1112°F (600°C).
- Flames exit the doorway.
- Autoignition of paper target on the floor occurs.

It should be noted that there is an additional criteria when applying NFPA 286 for new buildings, which is a maximum peak heat release rate of 800 kW. The reasoning for this criterion relates to the fact that some poorer performing materials can achieve compliance with the flashover criteria but could have a higher peak heat release rate.

**803.2 Stability.** Interior finish materials regulated by this chapter shall be applied or otherwise fastened in such a manner that such materials will not readily become detached where subjected to room temperatures of 200°F (93°C) for not less than 30 minutes.

❖ Interior finishes are not to become detached for a minimum of 30 minutes under exposure to elevated temperatures [200°F (93°C)]. No standard test method has yet been developed to evaluate this requirement. Some sections of the IBC, however, do offer some

additional guidance. For example, the performance of the method of attachment of finish materials during a fire-resistance test will usually be an adequate indication of performance. The stability criterion is necessary because, if these materials were to fall off of walls or the ceiling during a fire, they may contribute to the fire and increase the hazard beyond what is typically expected.

**803.3 Interior finish requirements based on occupancy.** Interior wall and ceiling finish shall have a flame spread index not greater than that specified in Table 803.3 for the group and location designated.

❖ The requirements for flame spread indexes for interior finish materials applied to walls and ceilings are contained in Table 803.3. The referenced test for determining flame spread indexes is ASTM E84, which establishes a relative measurement of flame spread across the surface of the material. The classifications

used in Table 803.3 are defined in Section 803.1.1 (see the commentary to Section 803.1.1 for additional information on the uses and limitations of the test procedure). Again, NFPA 286 can be used as an alternative to ASTM E84. Passing NFPA 286 means that the material would be considered to be equivalent to a Class A material.

**TABLE 803.3.** See below.

❖ This table prescribes the minimum requirements for interior finishes applied to walls and ceilings; therefore, the use of a Class A material in an area that requires a minimum Class B material is always allowed. Likewise, when the table requires Class C materials, Classes A and B can also be used. The requirements are based on the use of the space. To determine the applicable criteria, first determine whether the space is an exit passageway, interior exit stairway or interior exit ramp; a corridor; or a room or

**TABLE 803.3**  
**INTERIOR WALL AND CEILING FINISH REQUIREMENTS BY OCCUPANCY<sup>k</sup>**

GROUP	SPRINKLERED <sup>l</sup>			NONSPRINKLERED		
	Interior exit stairways and interior exit ramps and exit passageways <sup>a,b</sup>	Corridors and enclosure for exit access stairways and exit access ramps	Rooms and enclosed spaces <sup>e</sup>	Interior exit stairways and interior exit ramps and exit passageways <sup>a,b</sup>	Corridors and enclosure for exit access stairways and exit access ramps	Rooms and enclosed spaces <sup>e</sup>
A-1 & A-2	B	B	C	A	A <sup>d</sup>	B <sup>c</sup>
A-3 <sup>f</sup> , A-4, A-5	B	B	C	A	A <sup>d</sup>	C
B, E, M, R-1, R-4	B	C	C	A	B	C
F	C	C	C	B	C	C
H	B	B	C <sup>g</sup>	A	A	B
I-1	B	C	C	A	B	B
I-2	B	B	B <sup>h,i</sup>	A	A	B
I-3	A	A <sup>j</sup>	C	A	A	B
I-4	B	B	B <sup>h,i</sup>	A	A	B
R-2	C	C	C	B	B	C
R-3	C	C	C	C	C	C
S	C	C	C	B	B	C
U	No Restrictions			No Restrictions		

For SI: 1 inch = 25.4 mm, 1 square foot = 0.0929 m<sup>2</sup>.

- a. Class C interior finish materials shall be allowed for wainscoting or paneling of not more than 1,000 square feet of applied surface area in the grade lobby where applied directly to a noncombustible base or over furring strips applied to a noncombustible base and fireblocked as required by Section 803.11 of the *International Building Code*.
- b. In exit enclosures of buildings less than three stories in height of other than Group I-3, Class B interior finish for nonsprinklered buildings and Class C for sprinklered buildings shall be permitted.
- c. Requirements for rooms and enclosed spaces shall be based upon spaces enclosed by partitions. Where a fire-resistance rating is required for structural elements, the enclosing partitions shall extend from the floor to the ceiling. Partitions that do not comply with this shall be considered as enclosing spaces and the rooms or spaces on both sides shall be considered as one. In determining the applicable requirements for rooms and enclosed spaces, the specific occupancy thereof shall be the governing factor regardless of the group classification of the building or structure.
- d. Lobby areas in Group A-1, A-2 and A-3 occupancies shall not be less than Class B materials.
- e. Class C interior finish materials shall be allowed in Group A occupancies with an occupant load of 300 persons or less.
- f. In places of religious worship, wood used for ornamental purposes, trusses, paneling or chancel furnishing shall be allowed.
- g. Class B material is required where the building exceeds two stories.
- h. Class C interior finish materials shall be allowed in administrative spaces.
- i. Class C interior finish materials shall be allowed in rooms with a capacity of four persons or less.
- j. Class B materials shall be allowed as wainscoting extending not more than 48 inches above the finished floor in corridors.
- k. Finish materials as provided for in other sections of this code.
- l. Applies when the vertical exits, exit passageways, corridors or rooms and spaces are protected by an approved automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2.

enclosed space. Interior finishes in spaces that are not separated from a corridor (for example, waiting areas in business or health care facilities) must comply with the requirements for a corridor space. As shown in the table, the code places a higher emphasis on the allowable flame spread index for exits than for enclosed rooms because of the critical nature and relative importance of maintaining exit integrity to aid in building evacuation. Numerous notes amend the basic requirements of Table 803.3. Notes a through l apply only where specifically referenced in the table.

**Note a**

A limited amount of combustible wainscoting or other paneling material does not appreciably reduce the level of safety of an exit element; therefore, up to 1,000 square feet (93 m<sup>2</sup>) of Class C wainscoting or paneling is permitted by Note a in a grade-level lobby used as an exit element when applied in accordance with Section 803.3 of the IBC.

**Note b**

This note allows the reduction of flame spread indexes in exit enclosures in buildings less than three stories high, not including Group I-3 occupancies. The time required to exit a building less than three stories is much shorter than that for taller buildings and enough time usually exists to use other exit enclosures.

**Note c**

Because the intended use of certain rooms in buildings is sometimes more hazardous than the group classification for the overall building, the finish classification must be determined by the group and occupancy classification for the room or area. Additionally, rooms or enclosed spaces not properly separated from one another must be looked at as a single space for the purposes of applying flame spread index requirements.

**Note d**

This note allows lobbies in Group A-1, A-2 and A-3 occupancies to be Class B instead of Class A. This is likely a result of the low fire load in such areas.

**Note e**

Note e recognizes that with a relatively small number of occupants, egress is accomplished more quickly and the activities tend to be more structured and manageable than with a large number of occupants. When the design occupant load is 300 or less in rooms or spaces of Group A-1 and A-2 occupancies, the interior finish materials may be Class C instead of Class B for rooms and enclosed spaces.

**Note f**

This note correlates with the allowance in Section 807.5.1.3 for places of religious worship.

**Note g**

The time required for exiting increases with the number of stories of the structure. Interior finish

materials can play a major role in fire spread within a structure. Because of the materials stored and used within a Group H occupancy, interior wall and ceiling finish materials with high heat release (or flame spread) potential can have a significant impact on the way a fire spreads throughout the building. To abate the hazard of rapid fire growth, Note g places a further restriction of a minimum of a Class B classification on interior finishes of enclosed spaces within sprinklered buildings when the building exceeds two stories.

**Note h**

Spaces that are used as offices in Group I-2 and I-4 occupancies have a low occupant load, the activity in those spaces is generally not very hazardous and the occupants are not as vulnerable as the general population of those facilities, partially because of their knowledge of the exits; therefore, Class C materials are allowed in administrative spaces.

**Note i**

Rooms in Group I-2 and I-4 occupancies with low occupant loads (four or less) pose a low risk and are quickly evacuated; therefore, Class C finish materials are appropriate.

**Note j**

In Group I-3 occupancy corridors, Note j allows interior finish materials, such as wainscoting, that are a maximum height of 48 inches (1219 mm) above the floor to be Class B. This reduction from Class A is based on full-scale fire research demonstrating that Class B wall finish used on the lower 4 feet (1219 mm) of a corridor wall is not likely to spread fire because fire primarily spreads on ceilings and upper walls before affecting the lower portions of walls.

**Note k**

This note is referenced in the title of Table 803.3 and refers to other sections of the code that may have further restrictions or allowances for material classification for specific uses.

**Note l**

Sprinklered facilities provide more protection to occupants than nonsprinklered facilities. In many instances, materials with lower restrictions on fire performance may be used, as shown in Table 803.3. The footnote clarifies what areas of the building need to be sprinklered in order to qualify for these reductions in interior finish classifications.

**803.4 Fire-retardant coatings.** The required flame spread or smoke-developed index of surfaces in existing buildings shall be allowed to be achieved by application of *approved* fire-retardant coatings, paints or solutions to surfaces having a flame spread index exceeding that allowed. Such applications shall comply with NFPA 703 and the required fire-retardant properties shall be maintained or renewed in accordance with the manufacturer's instructions.

❖ Many times, fire retardants can be used to reduce the flame spread index of a material that, without treatment, has an index higher than permissible. It should

be recognized that the most desirable situation is to have a material that has a specific flame spread rating or has been tested and passed in accordance with NFPA 286. It is also recognized that in existing buildings there are often situations where such an approach is not possible and the application of fire retardants is the only solution. Flame retardants may either be factory or field applied. A wide variety of proprietary flame retardants for field application are on the market. Both factory- and field-applied products may require reapplication to sustain the flame retardancy of a particular article. When reviewing an installation, the fire code official should require the owner or other responsible person to submit a manufacturer's or contractor's certificate documenting a given treatment. This documentation should specify if a particular treatment must be repeated and, if so, at what intervals. If no retreatment interval is specified, the manufacturer's or contractor's warranty should be recognized as the retreatment interval because it is the longest period for which that individual accepts responsibility for the product's performance. Fire code officials evaluating flame-retardant treatments should carefully evaluate the performance conditions of these preparations. Many of them are not intended to be exposed to direct sunlight, high humidity or weather. Flame-retardant treatment must be used or applied in a manner consistent with the manufacturer's instructions.

There are several methods of increasing the flame resistance of materials. The strategy is either to slow

the ignition process or control combustion itself. Commentary Figure 803.4 lists various methods and whether they can be achieved in the field.

It should also be noted that in more recent times there has been growing concern over the use of polybrominated diphenyl ethers (PBDE) to achieve flame resistance due to the possible health effects. Some states, including California, have passed legislation to ban the use of such products. Several manufacturers have also begun a voluntary phase-out of such chemicals. Federal legislation is also under consideration.

**803.5 Textiles.** Where used as interior wall or ceiling finish materials, textiles, including materials having woven or nonwoven, napped, tufted, looped or similar surface, shall comply with the requirements of this section.

❖ This section is primarily intended to apply to carpet and carpet-like wall or ceiling coverings that include textile materials having woven or nonwoven, napped, tufted, looped or similar surfaces. If not addressed, these easily ignitable materials can contribute extensively to a fire.

**803.5.1 Textile wall or ceiling coverings.** Textile wall or ceiling coverings shall comply with one of the following:

1. The wall or ceiling covering shall have a Class A flame spread index in accordance with ASTM E84 or UL 723, and be protected by automatic sprinklers installed in accordance with Section 903.3.1.1 or 903.3.1.2.
2. The wall covering shall meet the criteria of Section 803.5.1.1 when tested in the manner intended for use in

METHOD OF ACHIEVING FLAME RESISTANCE	APPROPRIATE USE	APPLICATION	OTHER INFORMATION
Chemical	Synthetics; Plastics	Chemical added during manufacturing process  Example: Polymers	Actual chemical change occurs  Changes the behavior of materials
Impregnation	Absorbent or porous materials; not wood (too dense)	In the field by spray or immersion	Sometimes done at wet pulp stage (Paper, acoustical tile and building panels)
Coating	Nonabsorbant materials  Example: Wood paneling, ceiling tiles, etc.	In the field by spray, brush or roller application	Actively inhibits flame spread or simply provides a noncombustible surface  Needs periodic renewal per manufacturer
Pressure Impregnation	Dense, nonabsorbent materials such as wood	Only during manufacturing	Replaces air pockets with fire-retardant solution  Chemical deposits while drying  Vacuum-pressure methods are used to impregnate materials  Far more effective than impregnation alone

**Figure 803.4  
APPLIED FLAME-RETARDANT COATINGS**

accordance with NFPA 265 using the product-mounting system, including adhesive, of actual use.

3. The wall or ceiling covering shall meet the criteria of Section 803.1.2.1 when tested in accordance with NFPA 286 using the product-mounting system, including adhesive, of actual use.
- ❖ This section requires that textile materials on walls or ceilings have a Class A flame spread index and be located in a sprinklered area in accordance with NFPA 13 or 13R. As an alternative to a Class A flame spread index and sprinklers, testing in accordance with NFPA 265 may be used for textile wall coverings. Just as discussed for NFPA 286, NFPA 265 is known as a full-scale room corner fire test. This test helps to determine the contribution of textile wall coverings to overall fire growth and spread in a compartment fire. Past research conducted with this kind of configuration has shown that flame spread indexes produced by ASTM E84 or UL 723 may not reliably predict the fire behavior of textile wall coverings in realistic fire scenarios. Thus, NFPA 265 is based on a more reliable test procedure, developed at the University of California. The research findings are described in a report from the University of California Fire Research Laboratory titled, "Room Fire Experiments of Textile Wall Coverings." The NFPA 265 test is only slightly different from NFPA 286. NFPA 286 is more severe in three ways:

1. The gas diffusion burner used to expose the material on the wall in the room fire test starts with a heat release rate exposure of 40 kW for the first 5 minutes in both tests, but it is then followed by 150 kW for 10 minutes in NFPA 265 and 160 kW for 10 minutes in NFPA 286.
2. The gas burner is placed 2 inches (51 mm) from each of the walls in NFPA 265, whereas it is placed flush against both walls in NFPA 286.
3. The test sample is mounted on the walls only in NFPA 265, whereas it is mounted on both the walls and ceiling in NFPA 286.

A key result of the difference in intensity and location of the gas burner is that the burner flame does not reach the ceiling during the 150 kW exposure (while it does reach the ceiling during the 160 kW exposure in NFPA 286). Therefore, NFPA 265 is not considered suitable for testing ceiling coverings.

It should be noted that the code does not require measurement of smoke release from materials tested to NFPA 265 unless the material is newly introduced, but does have a smoke pass/fail criterion for NFPA 286. NFPA 265 has two test methods, but the code only allows the use of Method B. In the Method A test protocol, 2-foot-wide (610 mm) strips of the material are mounted on the two walls closest to the corner with the burner, whereas in the Method B test protocol the sample is mounted completely covering three walls (except for the wall containing the door). There-

fore, Method B is more severe. This test method does not contain pass/fail criteria, just as NFPA 286 does not. The code therefore provides such criteria, based on the use of only the Method B test protocol from NFPA 265, in Section 803.5.1.1. It should be noted that the IBC also only allows the use of Method B from NFPA 265. The code applies to existing buildings and the IBC would only apply to new buildings with regard to this particular test.

**803.5.1.1 Method B test protocol.** During the Method B protocol, the textile wall covering or expanded vinyl wall covering shall comply with the following:

1. During the 40-kW exposure, flames shall not spread to the ceiling.
2. The flame shall not spread to the outer extremities of the samples on the 8-foot by 12-foot (203 by 305 mm) walls.
3. Flashover, as defined in NFPA 265, shall not occur.
4. For newly introduced wall and ceiling coverings, the total smoke released throughout the test shall not exceed 1,000 m<sup>2</sup>.

❖ The criteria are very similar to those used in NFPA 286. The pass/fail criteria in the code are as follows:

The flame cannot spread to the ceiling when the textile is exposed to the burner at 40 kW.

With the burner at 150 kW, the following criteria must be met:

- Flashover, as defined by NFPA 265, must not occur.
- The fire cannot reach the outer areas of the 8-foot by 12-foot (2438 mm by 8657 mm) wall.
- Newly introduced wall coverings are limited to a total smoke release of 1,000 m<sup>2</sup>.

**803.5.2 Newly introduced textile wall and ceiling coverings.** Newly introduced textile wall and ceiling coverings shall comply with one of the following:

1. The wall or ceiling covering shall have a Class A flame spread index in accordance with ASTM E84 or UL 723, and be protected by automatic sprinklers installed in accordance with Section 903.3.1.1 or 903.3.1.2. Test specimen preparation and mounting shall be in accordance with ASTM E2404.
2. The wall covering shall meet the criteria of Section 803.5.1.1 when tested in the manner intended for use in accordance with NFPA 265 using the product-mounting system (including adhesive) of actual use.
3. The wall or ceiling covering shall meet the criteria of Section 803.1.2.1 when tested in accordance with NFPA 286 using the product-mounting system (including adhesive) of actual use.

❖ This section is basically the same as Section 803.5.1 with one exception focused on preparing test specimens for the tunnel test (ASTM E84). The reason for this difference is that existing materials would possi-

bly be out of compliance since they were tested prior to the development of ASTM E2404, which has specific mounting requirements for materials during the test. It was felt reasonable in existing buildings to hold new textile wall and ceiling coverings to this higher standard. The correct specimen preparation and mounting method for textile, paper and vinyl wall and ceiling coverings tested in accordance with the ASTM E84 (Steiner tunnel) test is ASTM E2404. The ASTM E05 Committee on Fire Standards developed a standard practice for test specimen preparation and mounting, ASTM E2404, for textile, paper or vinyl wall or ceiling coverings specifically to provide a mandatory, standardized way of preparing test specimens and mounting them in the tunnel. This replaced optional guidance on mounting methods found in the appendix of ASTM E84 and ensures testing consistency.

This section also allows the use of NFPA 265 and NFPA 286 with the same criteria as cited in Section 803.5.1. Note that NFPA 265 is not applicable for the testing of ceiling materials due to the limitations of that test (see commentary, Section 803.5.1).

**803.6 Expanded vinyl wall or ceiling coverings.** Expanded vinyl wall or ceiling coverings shall comply with one of the following:

1. The wall or ceiling covering shall have a Class A flame spread index in accordance with ASTM E84 or UL 723, and be protected by automatic sprinklers installed in accordance with Section 903.3.1.1 or 903.3.1.2. Test specimen preparation and mounting shall be in accordance with ASTM E2404.
2. The wall covering shall meet the criteria of Section 803.5.1.1 when tested in the manner intended for use in accordance with NFPA 265 using the product-mounting system (including adhesive) of actual use.
3. The wall or ceiling covering shall meet the criteria of Section 803.1.2.1 when tested in accordance with NFPA 286 using the product-mounting system (including adhesive) of actual use.

❖ This section contains the same criteria as Section 803.5.2 but is specific to expanded vinyl wall or ceiling coverings. It allows all three tests of ASTM E84 with products mounted in compliance with ASTM E2404 and in sprinklered buildings.

This section also differs in that it does not limit the requirements to newly introduced materials but instead will cover any expanded vinyl wall or ceiling coverings. See also the commentary to Sections 803.5.2 and 803.5.1.

**803.7 Facings or wood veneers intended to be applied on site over a wood substrate.** Facings or veneers intended to be applied on site over a wood substrate shall comply with one of the following:

1. The facing or veneer shall have a Class A, B or C flame spread index and smoke-developed index, based on the requirements of Table 803.3, in accordance with

ASTM E84 or UL 723. Test specimen preparation and mounting shall be in accordance with ASTM E2404.

2. The facing or veneer shall meet the criteria of Section 803.1.2.1 when tested in accordance with NFPA 286 using the product-mounting system, including adhesive, described in Section 5.8.9 of NFPA 286.

❖ This section addresses the correct mounting method for wall coverings in ASTM E84 (namely ASTM E2404), to detail the proper way to test facings or wood veneers intended to be applied over a wood substrate. They are to be treated the same way as any other wall or ceiling covering applied “on site” to a wood substrate, but differently from panels where the facing or veneer is applied in the factory over the wood substrate and the entire panel is installed. A separate proposal addresses factory-produced panels. This section allows the use of either ASTM E84 or NFPA 286. As noted, the ASTM E2404 mounting method must be applied if the ASTM E84 test method is chosen.

**803.8 Foam plastic materials.** Foam plastic materials shall not be used as interior wall and ceiling finish unless specifically allowed by Section 803.8.1 or 803.8.2. Foam plastic materials shall not be used as interior trim unless specifically allowed by Section 803.8.3.

❖ This section allows foam plastic interior wall and ceiling finish materials to be used in accordance with Section 803.8.1 or 803.8.2. The ASTM E84 test has the potential to produce misleading fire test results when used to test foam plastic interior wall and ceiling finish materials. In particular, if the foam plastics have low density, the amount of material may be insufficient for the ASTM E84 Steiner tunnel test to properly evaluate the plastics’ flame spread characteristics. Moreover, if the foams are thermoplastic, they are likely to melt and fall away from the flame front when exposed in the test and provide artificially low flame spread information on the surface of the test sample, and thus give an inaccurate indication of the fire hazard. It was thus generally agreed, in the early 1970s, that foam insulation products should be assessed for combustibility with a test that represents more realistically the way the materials behave in actual applications, and tests, such as UL 1715, UL 1040, FM 4880 and NFPA 286, were developed for such purposes to be used instead of ASTM E84.

**803.8.1 Combustibility characteristics.** Foam plastic materials shall be allowed on the basis of fire tests that substantiate their combustibility characteristics for the use intended under actual fire conditions, as indicated in Section 2603.9 of the *International Building Code*. This section shall apply both to exposed foam plastics and to foam plastics used in conjunction with a textile or vinyl facing or cover.

❖ This section requires that when foam plastics are used as interior wall or ceiling finish, they must meet the requirements of Section 2603.9 of the IBC. The IBC states that foam plastic is not permitted to be used exposed as interior finish unless it has been

tested under actual fire conditions. The IBC requires foam plastic insulation to be tested in accordance with a standard such as FM 4880, UL 1040, NFPA 286 or UL 1715, all of which are large-scale fire tests measuring heat release. NFPA 286 does not have pass/fail criteria; they are contained in Section 803.1.2 of the code. This section also clarifies that covering the foam plastic with a vinyl or textile cover (as is often done in high school gymnasiums) will not change the requirements, so that the same tests should be applied to the covered foam.

**803.8.2 Thermal barrier.** Foam plastic material shall be allowed if it is separated from the interior of the building by a thermal barrier in accordance with Section 2603.4 of the *International Building Code*.

❖ Another option the code allows is to use foam plastic when it is separated from the room interior by means of a thermal barrier, so that the foam plastic is not exposed and is not actually used as interior finish. This section refers the user to Section 2603.4 of the IBC to address how this is to be accomplished. Section 2603.4 of the IBC requires a 1/2-inch (12.7 mm) gypsum wallboard or equivalent thermal barrier. Section 2603.4 of the IBC also provides criteria for testing equivalent thermal barriers.

**803.8.3 Trim.** Foam plastic shall be allowed for trim in accordance with Section 804.2.

❖ See the commentary to Section 804.2.

**[BF] 803.9 High-density polyethylene (HDPE) and polypropylene (PP).** Where high-density polyethylene or polypropylene is used as an interior finish it shall comply with Section 803.1.2.

❖ High-density polyethylene (HDPE) and polypropylene (PP) are thermoplastics that give off considerable energy and produce a pooling flammable liquid fire when they burn. Recent full-scale room-corner tests of HDPE using NFPA 286 have demonstrated a significant hazard. These tests had to be terminated prior to the standard 15-minute duration due to flash-over occurring while there was still much of the product left to burn. Extensive flammable liquid pool fires occurred during the tests, yet this same material, when tested in accordance with the tunnel test, ASTM E84, is often given a flame spread index of 25 or less. However, the resulting test is so intense some labs will not test HDPE partitions due to the damage such tests can do to the tunnel. This section ensures that when using HDPE partitions they will be formulated in such a manner as to reduce the hazard that they present by specifically requiring compliance with NFPA 286. The following are some of the data gleaned from one of the NFPA 286 tests: Peak Heat Release Rate 1733 kW; Total Heat Released 121 MJ; Peak Heat Flux to the Floor 35.2 kW/m<sup>2</sup>; Peak Average Ceiling Temperature 805°C, 1481°F. Polypropylene is very similar in material and fire performance.

**[BF] 803.10 Site-fabricated stretch systems.** Where used as newly installed interior wall or interior ceiling finish materials, site-fabricated stretch systems containing all three components described in the definition in Chapter 2 shall be tested in the manner intended for use, and shall comply with the requirements of Section 803.1.1 or 803.1.2. If the materials are tested in accordance with ASTM E84 or UL 723, specimen preparation and mounting shall be in accordance with ASTM E2573.

❖ Site-fabricated stretch systems are interior finish materials that are stretched taut across walls or ceilings with a frame that holds a fabric and core. These systems are now being used extensively because they can stretch to cover decorative walls and ceilings with unusual looks and shapes. The systems consist of three parts: a fabric (or vinyl), a frame and an infill core material. Therefore, they must be fire tested like all other interior wall and ceiling materials, using either ASTM E84 (the Steiner tunnel test) or NFPA 286 (the room-corner test). The ASTM Committee on Fire Standards (ASTM E05) has issued ASTM E2573, a standard practice for specimen preparation and mounting of site-fabricated stretch systems. It is not a test method but rather a mounting method that was developed specifically for use when testing these materials in the ASTM E84 Steiner tunnel test. Until now, there was no correct mandatory way to test these systems. The testing has often been done of each component separately instead of testing the composite system. That is an inappropriate way to test and not the safe way to conduct the testing. Now that a consensus standard method of testing exists, the code recognizes it.

It is important to note that these materials are not curtains or drapes because they are not free hanging like curtains. Therefore, it would be inappropriate for them to be tested using NFPA 701, a test for vertically hanging fabrics, or any other test that was developed for free-hanging materials.

As previously stated, it is important to test all components together. If the system in question does not contain all three components of site-fabricated stretch systems, then such systems should be tested in a manner appropriate to their use. In particular, systems that contain a stretch membrane only and no core material have been shown to behave very differently in a fire situation than site-fabricated stretch systems. It is important that the correct mounting method be used for each system.

## SECTION 804 INTERIOR WALL AND CEILING TRIM AND INTERIOR FLOOR FINISH IN NEW AND EXISTING BUILDINGS

**804.1 Interior trim.** Material, other than foam plastic, used as interior trim in new and existing buildings shall have minimum Class C flame spread and smoke-developed indices,

when tested in accordance with ASTM E84 or UL 723, as described in Section 803.1.1. Combustible trim, excluding handrails and guardrails, shall not exceed 10 percent of the specific wall or ceiling areas to which it is attached.

❖ In accordance with Section 801.1, Section 804.1 addresses both new and existing buildings whereas Section 803 is applicable only to existing buildings. In occupancies of any group, unless otherwise noted in the code, the minimum classification of all trim must be at least Class C. Additionally, combustible trim may not exceed 10 percent of the area of the individual wall or ceiling in which it is located. The 10-percent calculation does not need to include handrails and guardrails. Although a Class C flame spread index may be lower than the flame spread index required for a particular building or facility, this quantity of combustible material will not significantly increase the fuel load.

**804.1.1 Alternative testing.** When the interior trim material has been tested as an interior finish in accordance with NFPA 286 and complies with the acceptance criteria in Section 803.1.2.1, it shall not be required to be tested for flame spread index and smoke-developed index in accordance with ASTM E84.

❖ This section is a clarification of the testing requirements for interior finishes. Chapter 8 of the IBC and Section 803.1.2 of the code already make it clear that any material that meets the criteria of Section 803.1.2.1 is permitted to be used for interior finish. The criteria for interior trim (whether a foam plastic or not) are basically just less severe and apply to smaller areas only. If the material is allowed to be used to cover the entire wall or ceiling, it is also allowed to be used to cover 10 percent of it.

**804.2 Foam plastic.** Foam plastic used as interior trim shall comply with Sections 804.2.1 through 804.2.4.

❖ As noted in Section 803.8.3, foam plastic is allowed as interior trim under certain conditions. This section introduces Sections 804.2.1 through 804.2.4 which establish that some dense foam plastic materials may be used as interior trim if the thickness, width and area of coverage is specifically limited.

**804.2.1 Density.** The minimum density of the interior trim shall be 20 pounds per cubic foot (320 kg/m<sup>3</sup>).

❖ This section establishes a minimum density of 20 pounds per cubic foot (pcf) (320 kg/m<sup>3</sup>) for foam interior trim. A minimum instead of a maximum density is specified because the denser the foam plastic material, the less likely it is that it will generate misleading ASTM E84 test results due to having insufficient material for fire testing of the foam.

**804.2.2 Thickness.** The maximum thickness of the interior trim shall be 1/2 inch (12.7 mm) and the maximum width shall be 8 inches (203 mm).

❖ Even though other trim materials are not limited in dimension, the maximum thickness and width of foam

plastic trim is limited to 1/2 inch (12.7 mm) and 8 inches (203 mm), respectively. These dimensions were selected because they were typical of the maximums being produced at the time this provision was included in the code.

**804.2.3 Area limitation.** The interior trim shall not constitute more than 10 percent of the specific wall or ceiling area to which it is attached.

❖ Trim cannot constitute more than 10 percent of the individual area of the wall and ceiling of a room. This limitation is simply a restatement of the general requirement for all combustible trim, which appears in Section 804.1.

**804.2.4 Flame spread.** The flame spread index shall not exceed 75 where tested in accordance with ASTM E84 or UL 723. The smoke-developed index shall not be limited.

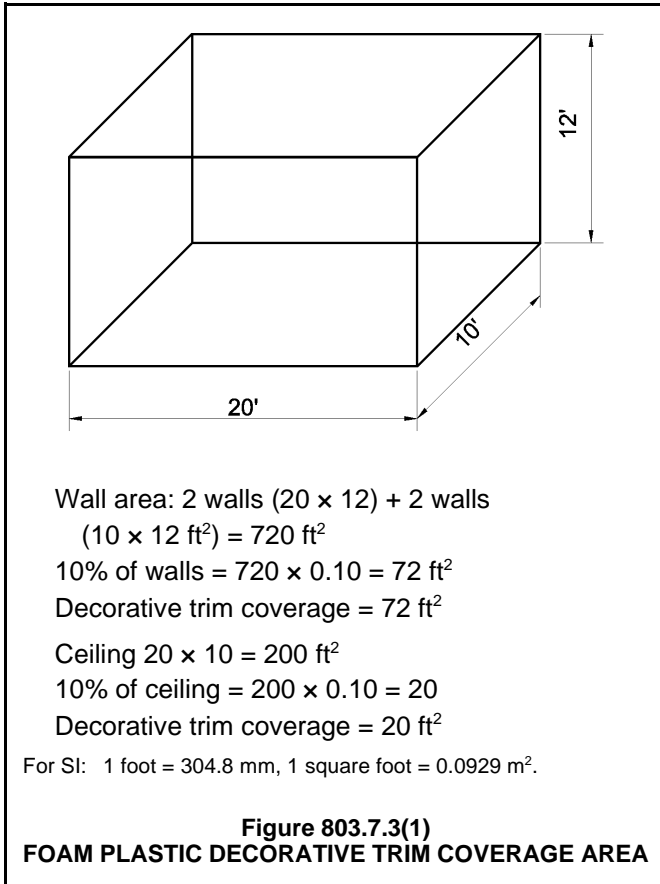
**Exception:** When the interior trim material has been tested as an interior finish in accordance with NFPA 286 and complies with the acceptance criteria in Section 803.1.2.1, it shall not be required to be tested for flame spread index in accordance with ASTM E84 or UL 723.

❖ This section specifically calls out a numerical flame spread index limitation of 75 for foam plastic used as trim, which is a Class B flame spread index. The value of 75 was selected to be consistent with the requirement for foam plastic insulation, even though other materials used as trim are permitted to have flame spread indexes of up to 200 in many locations. No thermal barrier is required for the use of foam plastic as trim and the smoke-developed index is not limited. It should be noted that Section 2604 of the IBC, which regulates the use of foam plastic as trim for new construction, has essentially identical requirements to those found in this section. Neither this section nor Section 2603.4.1.11 of the IBC requires a thermal barrier for interior trim [see Commentary Figures 803.7.3(1) and 803.7.3(2)]. The exception recognizes the stringency of testing in accordance with NFPA 286 as being equivalent to this section.

**804.3 New interior floor finish.** New interior floor finish and floor covering materials in new and existing buildings shall comply with Sections 804.3.1 through 804.3.3.2.

**Exception:** Floor finishes and coverings of a traditional type, such as wood, vinyl, linoleum or terrazzo, and resilient floor covering materials that are not composed of fibers.

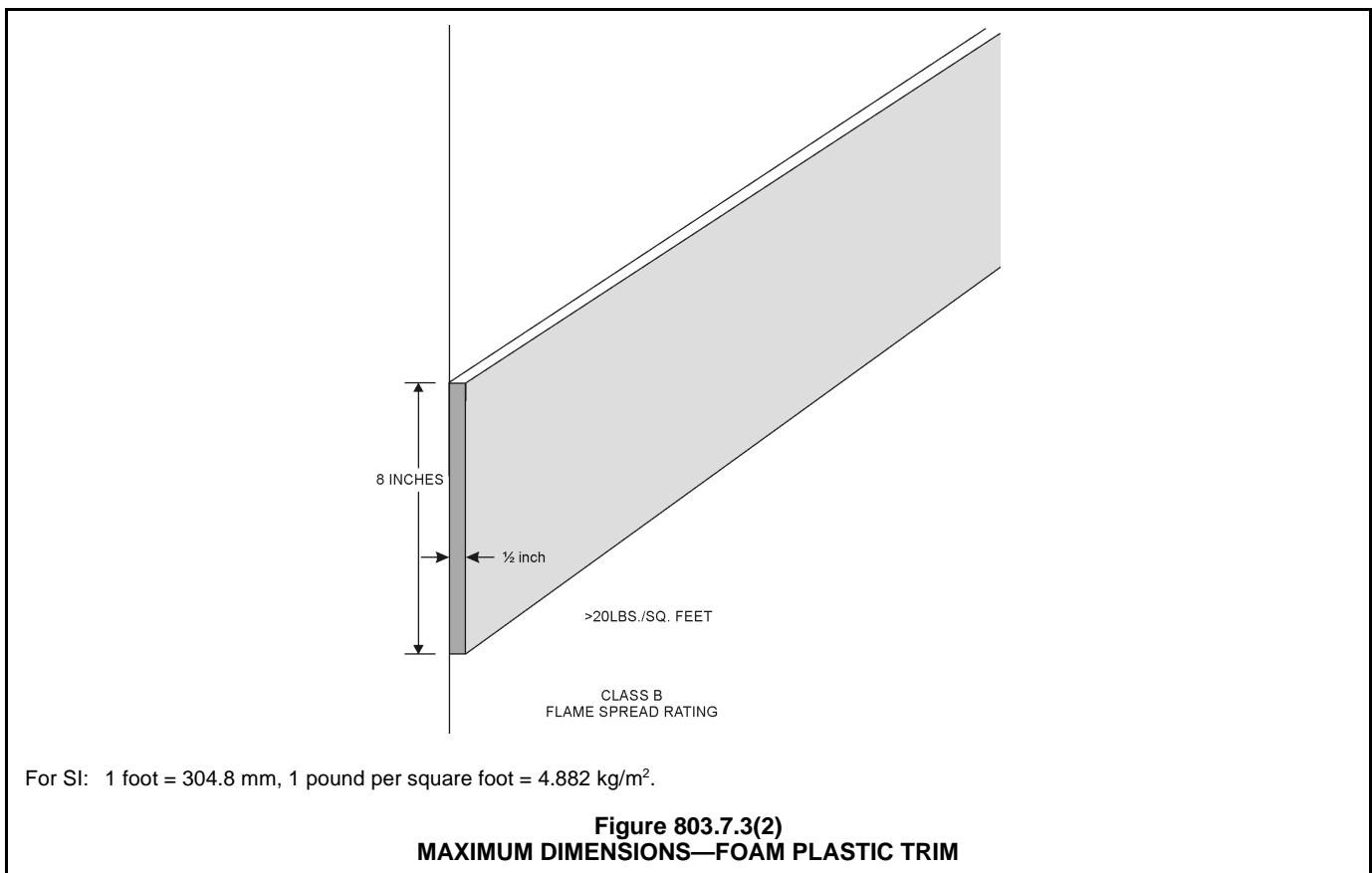
❖ This section regulates the design and installation of floor finish and floor covering materials and is identical to Section 804 of the IBC. Since Section 804.3 is located within a section that could apply to both existing and new buildings it is specifically clarified that these requirements are only applicable to new flooring. Traditional floor coverings, such as wood, vinyl, terrazzo and other resilient floor covering material, must be exempt from this section since they generally contribute minimally to a fire. The focus is on textile floor coverings such as carpets.



**804.3.1 Classification.** Interior floor finish and floor covering materials required by Section 804.3.3.2 to be of Class I or II materials shall be classified in accordance with NFPA 253. The classification referred to herein corresponds to the classifications determined by NFPA 253 as follows: Class I, 0.45 watts/cm<sup>2</sup> or greater; Class II, 0.22 watts/cm<sup>2</sup> or greater.

❖ The use of a classification system eliminates the need to state the actual critical radiant flux value for a product to meet the identification requirements of Section 804.3. Over the years, a classification system has been found to be much easier for the industry to follow and still provides the building official with the information required to verify compliance. The test required to measure the combustibility of floor coverings is NFPA 253. This standard is a radiant floor panel test, which basically simulates materials subjected to heat from a fire above. The primary concern with flooring is related to the spread of a fire that has already been ignited within a space or room to a different room. Commentary Figure 804.3.1 shows the test apparatus. The critical heat flux indicates the threshold value above which flame spread occurs in the testing environment.

**804.3.2 Testing and identification.** Interior floor finish and floor covering materials shall be tested by an *approved* agency in accordance with NFPA 253 and identified by a hang tag or other suitable method so as to identify the manufacturer or supplier and style, and shall indicate the interior floor finish or floor covering classification in accordance

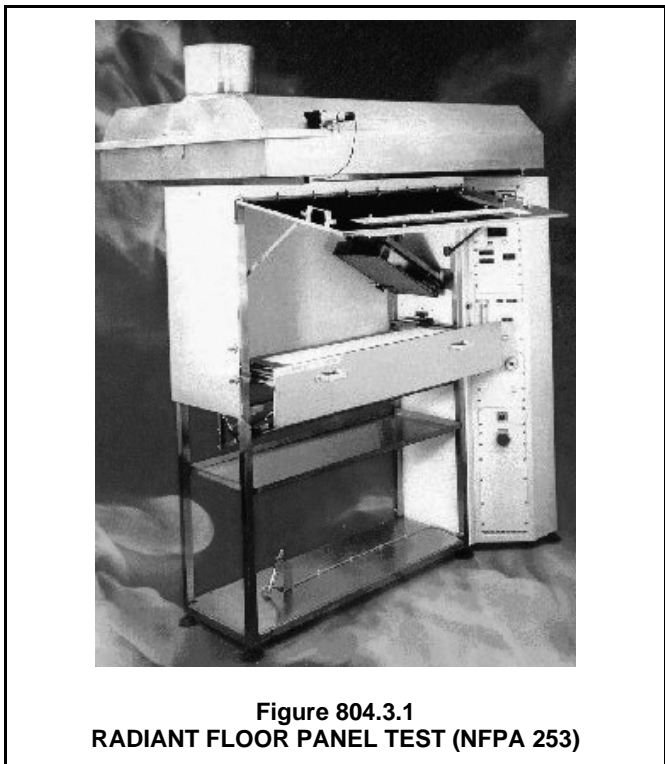


with Section 804.3.1. Carpet-type floor coverings shall be tested as proposed for use, including underlayment. Test reports confirming the information provided in the manufacturer's product identification shall be furnished to the *fire code official* upon request.

❖ The only method to ascertain that a floor meets the criteria of this section is to request a copy of the test report for the specific material being installed; therefore, it is critical that the carpeting be properly identified in order to verify that acceptable materials are being provided in the appropriate locations. The identification is to be provided on the material itself since a manufacturer's designation is required.

**804.3.3 Interior floor finish requirements.** New interior floor coverings materials shall comply with Sections 804.3.3.1 and 804.3.3.2, and interior floor finish materials shall comply with Section 804.3.1.

❖ Sections 804.3.3.1 and 804.3.3.2 prescribe when the pill test for floor covering material is applicable and which occupancies and locations require a Class I or Class II classification in accordance with NFPA 253. Section 804.3.1 specifies the criteria for Classes I and II. More information about the specific test is discussed in Section 804.3.1. Generally the focus is on more critical areas, such as exit passageways, interior exit stairways and exit access corridors.



**Figure 804.3.1**  
**RADIANT FLOOR PANEL TEST (NFPA 253)**

**804.3.3.1 Pill test.** In all occupancies, new floor covering materials shall comply with the requirements of the DOC FF-1 "pill test" (CPSC 16 CFR Part 1630) or of ASTM D2859.

❖ DOC FF-1, also referred to as the "Methenamine Pill Test," was developed as a means of preventing the distribution of highly flammable soft floor coverings within the United States. The test essentially evaluates the performance of the floor covering when subject to a cigarette-type ignition by using a small methenamine tablet. All carpeting greater than 24 square feet (2.2 m<sup>2</sup>) in area sold in the United States is required by federal law to pass this test procedure as a minimum.

**804.3.3.2 Minimum critical radiant flux.** In all occupancies, new interior floor finish and floor covering materials in enclosures for *stairways* and *ramps*, *exit passageways*, *corridors* and rooms or spaces not separated from *corridors* by full-height partitions extending from the floor to the underside of the ceiling shall withstand a minimum critical radiant flux. The minimum critical radiant flux shall be not less than Class I in Groups I-1, I-2 and I-3 and not less than Class II in Groups A, B, E, H, I-4, M, R-1, R-2 and S.

**Exception:** Where a building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2, Class II materials shall be permitted in any area where Class I materials are required and materials complying with DOC FF-1 "pill test" (CPSC 16 CFR Part 1630) or with ASTM D2859 shall be permitted in any area where Class II materials are required.

❖ This section prescribes the minimum requirements for interior floor finish materials that are used in interior exit stairways, exit passageways and exit access corridors. The criteria are based on the occupancy classification and the relationship of the space to the egress system. Similar to Table 803.3, the occupancy classification designation is meant to apply to the actual occupancy of the space and not necessarily the overall building classification.

Classifications I and II as used in this section are defined in Section 804.3.1 and are based on the results of the NFPA 253 test procedure.

Recognizing the ability of automatic sprinkler systems to control a fire and the minimal contribution of interior floor finishes to the early stages of fire growth, the exception allows the required interior floor finish ratings to be reduced when an automatic sprinkler system is provided throughout the building. The reference to Section 903.3.1.1 or 903.3.1.2 clarifies that the system is to be installed in accordance with NFPA 13 or 13R. In cases where Class II materials are required and an automatic sprinkler system is provided, the minimum requirement is that the material simply meet the DOC FF-1 test criteria.

**804.4 Interior floor-wall base.** Interior floor-wall base that is 6 inches (152 mm) or less in height shall be tested in accordance with NFPA 253 and shall be not less than Class II. Where a Class I floor finish is required, the floor-wall base shall be Class I. The classification referred to herein corresponds to the classifications determined by NFPA 253 as follows: Class I, 0.45 watt/cm<sup>2</sup> or greater; Class II, 0.22 watts/cm<sup>2</sup> or greater.

**Exception:** Interior trim materials that comply with Section 804.1.

❖ In trimming out the interior of a building, rather than install separate baseboards or materials, in many cases the floor covering material is simply seamlessly turned up for a few inches or used at the intersection of the floor and the wall, thus becoming the floor-wall base trim. Previously, these materials could have been considered as interior trim in accordance with Section 804.1 and would have been required to be tested in accordance with ASTM E84 even though the floor covering may be required to be tested in accordance with NFPA 253. Based on the small amount of material used, it is very difficult to test these materials in a reliable manner, upside down in the ASTM E84 test method. This section addresses the issue of testing and regulation of wall base interior floor finish trim materials and eliminates the difficulty of testing these materials in a reliable manner.

Because of their location at the floor line, wall base materials are not likely to be involved in a fire until the floor covering is also involved, usually at room flashover. Thus, it is reasonable that wall base materials meet the same criteria as floor coverings. This is true since in some applications, for sanitary reasons, the floor covering is seamlessly turned up on the wall to form a wall base. Thus, the proposal specifies that the wall base be tested in accordance with NFPA 253 as required for floor coverings and has requirements for its use. This section also limits the height of the wall base such that its application is controlled in a similar manner as the 10-percent limitation for interior trim. The exception recognizes that some materials used as interior finish trim that meet the flammability requirements of Section 804.1 can be used in this specific application without the need for additional testing.

## SECTION 805 UPHOLSTERED FURNITURE AND MATTRESSES IN NEW AND EXISTING BUILDINGS

❖ Furnishings and contents are subjects that codes have not addressed very strongly in the past. Ultimately, the fire hazard potential within a building depends heavily upon what is in the building and where it is placed. First, the burning characteristics of the materials will vary and the location of the material will change the characteristics of a fire. For instance, a couch within a small compartment will create a

much different fire event than the same couch burning in a large open atrium (see Commentary Figure 805.1). The compartment may be limited by the amount of oxygen available, while the atrium fire will be limited only by the amount of combustibles to burn because oxygen will be plentiful; therefore, the compartment is likely to reach flashover while the atrium will not. Generally, upholstered furniture and mattresses are the largest fire hazards in most residential buildings because mattresses or upholstered furniture are the only products typically present where people live that can cause room flashover on their own.

**805.1 Group I-1, Condition 2.** The requirements in Sections 805.1.1 through 805.1.2 shall apply to facilities in Group I-1, Condition 2.

❖ This section introduces Sections 805.1.1 through 805.1.2.3 which contain requirements for controlling the hazards associated with upholstered furniture and mattresses in new and existing Group I-1, Condition 2 occupancies. Group I-1, Condition 2 occupancies contain, in a supervised setting, more than 16 persons on a 24-hour basis because of age, mental disability or other reasons. It should be noted that Group I-1, Condition 2 occupancies have occupants who need limited assistance both verbally and physically to evacuate whereas occupants of Group I-1, Condition 1 do not need such assistance. The provisions throughout the I-Codes differentiate between these two types of occupancy classifications. In general, these occupants are considered more vulnerable than the general population and have had a history of starting fires in beds or upholstered furniture. There is also more of a concern than with a Group I-2 occupancy over occupants having the ability to purposely start a fire. This is less likely in an assisted living setting but more likely in a halfway house setting; therefore, limitations on combustibility of upholstered furniture and mattresses are also required. Reducing ignitability and combustibility will significantly reduce the level of fire hazard. The requirements are slightly different than for Group I-2 occupancies in that different tests and performance criteria are required because of the nature of the hazards.

**805.1.1 Upholstered furniture.** Newly introduced upholstered furniture shall meet the requirements of Sections 805.1.1.1 through 805.1.1.3.

❖ This section informs the user that two aspects of upholstered furniture are regulated: the ignitability by cigarettes and the maximum allowable heat release in accordance with ASTM E1537.

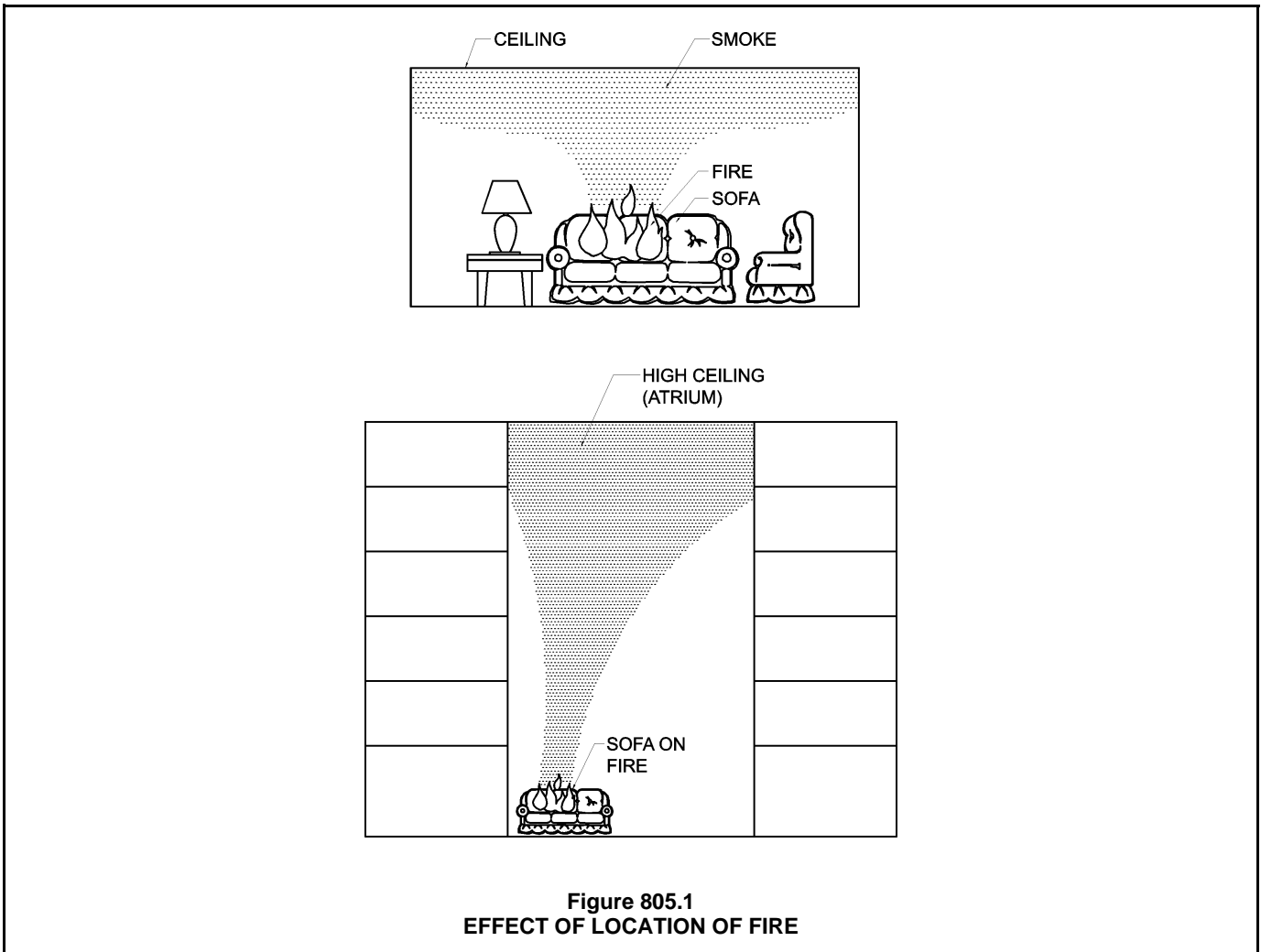
**805.1.1.1 Ignition by cigarettes.** Newly introduced upholstered furniture shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with one of the following:

1. Mocked-up composites of the upholstered furniture shall have a char length not exceeding 1.5 inches (38 mm) when tested in accordance with NFPA 261.

2. The components of the upholstered furniture shall meet the requirements for Class I when tested in accordance with NFPA 260.

❖ This section focuses on the ignitability of furniture when exposed to lighted cigarettes and is consistent with Section 805.2.1.1 for Group I-2 occupancies and Section 805.3.1.1 for Group I-3 detention and correctional facilities. It offers an alternative test (NFPA 261) for approval of cigarette ignition resistance of newly introduced upholstered furniture in Group I-1 occupancies (board and care facilities). The same test method is already permitted for use in Group I-2 and I-3 occupancies. The difference between NFPA 260 and NFPA 261 is that NFPA 260 uses an overall classification system that looks at the cigarette ignition behavior of the individual components that may be found in upholstered furniture while NFPA 261 specifically looks at ignitability of a mock-up of upholstered furniture. It presents a method for study of the ignitability of the furniture mock-up and a technique to measure the char length, and limits the maximum char length to 1.5 inches (38.1 mm). In fact, results from NFPA 261 are more likely to be predictive of real fire behavior.

The previously existing exception to this section for upholstered furniture in rooms or spaces protected by an approved NFPA 13 automatic sprinkler system has been deleted because: a. Sprinklers have no effect on controlling smoldering ignition (ignition by cigarettes), since they require an increase in room temperature to act and there will be no increase in room temperature until well after the upholstered furniture which fails the cigarette test has erupted into flames; and b. Newly introduced upholstered furniture is very likely to meet smoldering ignition requirements. The trade association for manufacturers of residential upholstered furniture, Upholstered Furniture Action Council (UFAC), its sister organization, American Furniture Manufacturers Association (AFMA) and the trade association for manufacturers of institutional and contract upholstered furniture, Business and Institutional Furniture Manufacturers Association (BIFMA), require that their members comply with the smoldering resistance test. UFAC requires NFPA 260 (equivalent to ASTM E1353 and the UFAC test) and BIFMA requires NFPA 261 (equivalent to ASTM E1352). Note that this section does not affect existing upholstered furniture.



**805.1.1.2 Heat release rate.** Newly introduced upholstered furniture shall have limited rates of heat release when tested in accordance with ASTM E1537 or California Technical Bulletin 133, as follows:

1. The peak rate of heat release for the single upholstered furniture item shall not exceed 80 kW.

**Exception:** Upholstered furniture in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

2. The total energy released by the single upholstered furniture item during the first 10 minutes of the test shall not exceed 25 megajoules (MJ).

**Exception:** Upholstered furniture in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

❖ The two tests specified in this section measure the overall combustibility of furniture. When a building is sprinklered in accordance with NFPA 13, this section does not apply. Upholstered furniture must be tested to either ASTM E1537 or California Technical Bulletin 133 (which are basically the same test, but ASTM E1537 has no pass/fail criteria). This test uses a full-scale calorimeter, with the furniture item either in a standard room or under a hood. A full-scale calorimeter allows a representative piece of furniture to be burned and the products of combustion to be collected and analyzed in the exhaust duct by measuring gases (principally oxygen) in order to measure heat release. The test also measures weight loss during the test [see Commentary Figure 805.1.1.2(1) for a representation of the test]. The acceptance criteria set by the code are as follows:

- Peak heat release is limited to 80 kW; and
- Total energy (or heat) release within the first 10 minutes cannot exceed 25 megajoules (MJ).

Limitations are placed on the maximum intensity and fire effluents produced by restricting the peak heat release rate and the amount of combustibles actually burned. The total energy release of 25 MJ could be translated to a steady fire as follows, where:

$$X = \text{Steady fire heat release rate expressed in kW:}$$

$$X \times 10 \text{ minutes} = 25 \text{ MJ}$$

$$(10 \text{ minutes} = 600 \text{ sec and } 25 \text{ MJ} = 25,000 \text{ kJ})$$

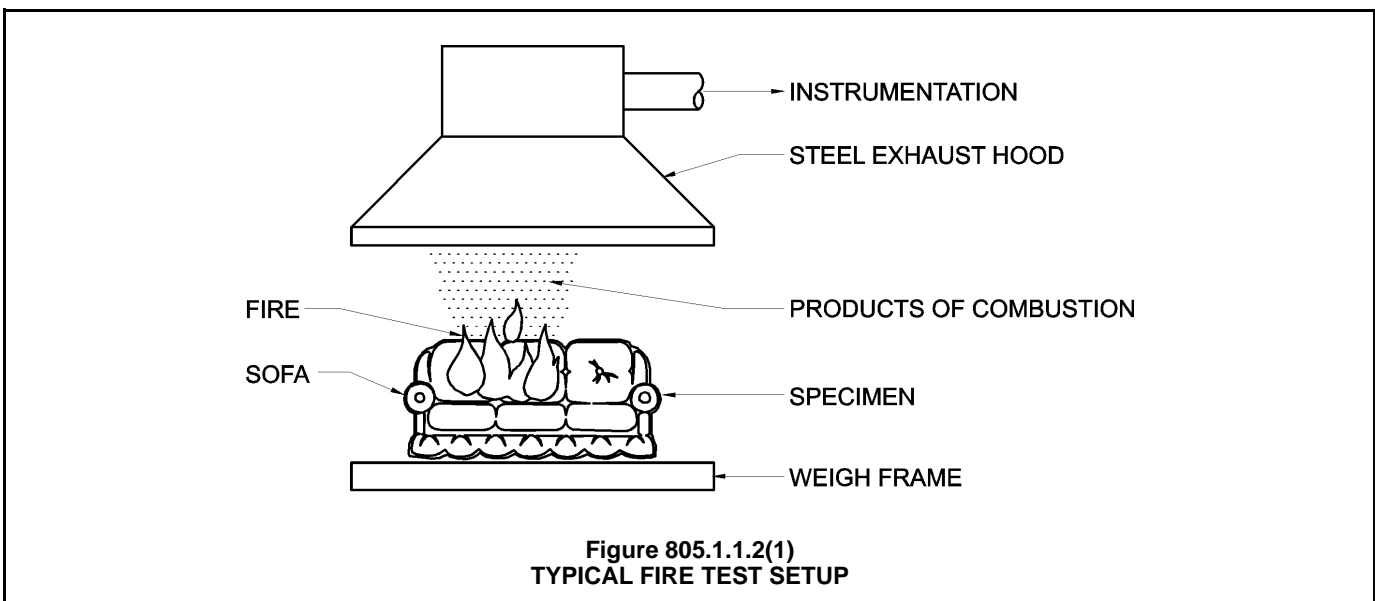
$$X \times 600 \text{ sec} = 25,000 \text{ kJ}$$

$$X = 25,000 \text{ kJ}/600 \text{ sec} = 41.66 \text{ kJ/sec}$$

$$X = 41.66 \text{ kJ/sec} = 41.66 \text{ kW} \sim 42 \text{ kW heat release rate}$$

A steady fire of 42 kW (133 kJ/sec) for 10 minutes will result in a total energy release of 25 MJ.

Because fires in more realistic conditions do not burn steadily and vary in their characteristics, the criterion is given in the form of a peak heat release rate and total energy release. To provide a better understanding, if the fire were burning at the maximum peak heat release rate of 80 kW for the first 10 minutes, the total energy output would be 75 MJ, [80 kW (kJ/sec) H 10 minutes (600 sec) = 48,000 kJ = 48 MJ], which is well over the criterion of 25 MJ. A fire burning at a steady rate from start to finish is not realistic because fires must go through an initial growth stage before a peak heat release rate will be reached, followed by a decay phase; therefore, because a realistic fire will not burn at the peak heat release rate from the start of the fire, it is possible for a piece of furniture to have a peak heat release rate of 80 kW and still stay within the 25 MJ limitation. Commentary Figure 805.1.1.2(2) demonstrates the difference between a steady fire and a more realistic unsteady fire. As stated in the exceptions, the heat release rates will not apply to buildings sprinklered in



accordance with NFPA 13. Sections 805.2.1.2 and 805.3.1.2 address the heat release rate limitations for upholstered furniture in the same manner. It should be noted that Section 805.3.1.2 does not reference California Technical Bulletin 133.

See also the commentary for mattresses in Section 805.1.2.

**805.1.1.3 Identification.** Upholstered furniture shall bear the label of an *approved* agency, confirming compliance with the requirements of Sections 805.1.1.1 and 805.1.1.2.

❖ In order to achieve verifiable compliance, labeling by an approved agency is required. Otherwise, this information would be extremely difficult to verify in the field. See the commentary for the definition of “Labeled” in Section 202.

**805.1.2 Mattresses.** Newly introduced mattresses shall meet the requirements of Sections 805.1.2.1 through 805.1.2.3.

❖ Sections 805.1.2.1 and 805.1.2.2 deal with the combustibility of mattresses. Section 805.1.2.1 focuses on initial ignition and the ability of a mattress to sustain a fire; Section 805.1.2.2 is focused primarily on the burning characteristics of mattresses.

**805.1.2.1 Ignition by cigarettes.** Newly introduced mattresses shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with DOC 16 CFR Part 1632 and shall have a char length not exceeding 2 inches (51 mm).

❖ This section sets a maximum char length of 2 inches (51 mm) when the mattress is tested under DOC 16 CFR, Part 1632. This test is a mandatory regulation for all mattresses sold in the United States. More specifically, it is part of the regulations governed by the Consumer Products Safety Commission (CPSC) under the Department of Commerce (DOC). Sections 805.2.2.1 and 805.3.2.1 have the same reference and requirements for Group I-2 and I-3 occupancies.

Thus, mattresses that fail to meet the 16 CFR 1632 test will be those sold either before the CPSC regulation went into effect (in 1972) or outside of the United States.

**805.1.2.2 Heat release rate.** Newly introduced mattresses shall have limited rates of heat release when tested in accordance with ASTM E1590 or California Technical Bulletin 129, as follows:

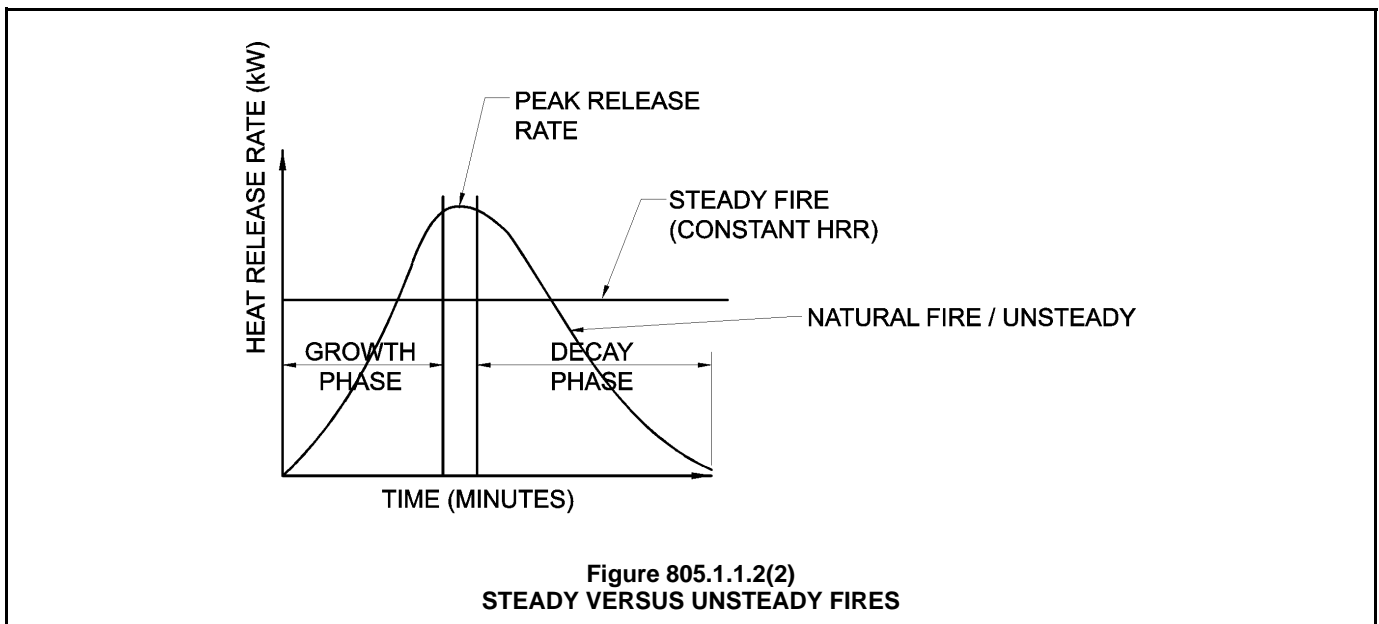
1. The peak rate of heat release for the single mattress shall not exceed 100 kW.

**Exception:** Mattresses in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

2. The total energy released by the single mattress during the first 10 minutes of the test shall not exceed 25 MJ.

**Exception:** Mattresses in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

❖ As noted, an occupant smoking in bed and initiating a mattress fire is a major fire hazard in Group I-1, Condition 2 occupancies. This section, like Section 805.1.1.2, limits combustibility by restricting the peak heat release rate and on the total energy output in the first 10 minutes of burning. These limitations vary slightly from those for upholstered furniture. Each mattress is allowed a maximum heat release rate of 100 kW, whereas each upholstered furniture item is limited to 80 kW. The total energy (or heat) release limitation is the same as for upholstered furniture items, which is 25 MJ in the first 10 minutes. As with upholstered furniture, these restrictions are not applicable in buildings sprinklered in accordance with NFPA 13. The tests that determine the peak heat release rate and total energy (or heat) release are specific to mattresses. These tests are detailed in ASTM E1590 and California Technical Bulletin 129



(which are the same test, except that ASTM E1590 does not have pass/fail criteria). These tests, like that referenced in Section 805.1.1.2, make use of a full scale calorimeter to measure the products of combustion. There are two differences between ASTM E1537 and ASTM E1590: the object being tested (see commentary, Section 805.1.1.2) and the ignition source. Both tests use a gas burner, but they are different in geometry, gas flow rate, duration of gas flow and position of flame application. Section 805.2.2.2 contains the same restrictions and testing requirements on combustibility for mattresses in Group I-2 occupancies, Section 805.3.2.2 for Group I-3 detention and correctional facilities and Section 805.4.2.2 for Group R-2 dormitories.

**805.1.2.3 Identification.** Mattresses shall bear the label of an *approved* agency, confirming compliance with the requirements of Sections 805.2.2.1 and 805.2.2.2.

❖ This section provides the fire code official with a valuable tool in evaluating and approving mattresses in Group I-2 occupancies. In order to achieve verifiable compliance, labeling by an approved agency is required. Otherwise, this information would be extremely difficult to verify in the field. See the commentary for the definition of “Labeled” in Section 202.

**805.2 Group I-2, nursing homes and hospitals.** The requirements in Sections 805.2.1 through 805.2.2 shall apply to nursing homes and hospitals classified in Group I-2.

❖ This section introduces Sections 805.2.1 through 805.2.2.3 which contain requirements for controlling the hazards associated with upholstered furniture and mattresses in new and existing Group I-2 occupancies. Occupants of nursing homes (Group I-2, Condition 1) and hospitals (Group I-2, Condition 2) are considered more vulnerable than the general population. Many of the patients of nursing homes and hospitals are confined because of respirators, IVs and other medical equipment and may not be capable of self-preservation. Hospital employees may have to make several trips into the fire area to assist in evacuating patients; therefore, it is imperative that every effort be made to preserve the integrity of the corridors and minimize the fuel loading caused by furnishings and contents, such as upholstered furniture and mattresses.

Historically, fires have been ignited through the use of cigarettes in bed or falling asleep while smoking in a chair. In addition to these hazards, such occupancies usually have additional medical oxygen sources within their rooms. This section, therefore, states several ignitability and combustibility limitations for upholstered furniture and mattresses that might be introduced into such occupancies.

**805.2.1 Upholstered furniture.** Newly introduced upholstered furniture shall meet the requirements of Sections 805.2.1.1 through 805.2.1.3.

❖ This section informs the user that two aspects of upholstered furniture are regulated: the ignitability by

cigarettes and the maximum allowable heat release in accordance with ASTM E1537.

**805.2.1.1 Ignition by cigarettes.** Newly introduced upholstered furniture shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with one of the following: (a) mocked-up composites of the upholstered furniture shall have a char length not exceeding 1.5 inches (38 mm) when tested in accordance with NFPA 261 or (b) the components of the upholstered furniture shall meet the requirements for Class I when tested in accordance with NFPA 260.

**Exception:** Upholstered furniture belonging to the patients in sleeping rooms of nursing homes (Group I-2), provided that a smoke detector is installed in such rooms. Battery-powered, single-station smoke alarms shall be allowed.

❖ The exception allows nursing home patients to bring their furniture with them into their rooms without having to comply with the test requirements provided that the basic protection of a system smoke detector (in buildings equipped with a fire alarm system) or a battery-operated smoke alarm is present in the room (see commentary, Section 805.1.1.1). Note that all new Group I-2, Condition 1 occupancies are required to be equipped throughout with an automatic sprinkler system. Additionally, Section 1105.8 requires an automatic sprinkler system in existing Group I-2 occupancies. This requirement is retroactive, which means it applies regardless of whether work is being done to the building.

**805.2.1.2 Heat release rate.** Newly introduced upholstered furniture shall have limited rates of heat release when tested in accordance with ASTM E1537 or California Technical Bulletin 133, as follows:

1. The peak rate of heat release for the single upholstered furniture item shall not exceed 80 kW.

**Exception:** Upholstered furniture in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

2. The total energy released by the single upholstered furniture item during the first 10 minutes of the test shall not exceed 25 MJ.

**Exception:** Upholstered furniture in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

❖ This section is identical to Section 805.1.1.2 and focuses on the potential heat release rate of upholstered furniture if a fire occurs (see commentary, Section 805.1.1.2).

**805.2.1.3 Identification.** Upholstered furniture shall bear the label of an *approved* agency, confirming compliance with the requirements of Sections 805.2.1.1 and 805.2.1.2.

❖ In order to achieve verifiable compliance, labeling by an approved agency is required. Otherwise, this infor-

mation would be extremely difficult to verify in the field. See the commentary to the definition of “Labeled” in Section 202.

**805.2.2 Mattresses.** Newly introduced mattresses shall meet the requirements of Sections 805.2.2.1 through 805.2.2.3.

❖ Sections 805.2.2.1 and 805.2.2.2 deal with the combustibility of mattresses. Section 805.2.2.1 focuses on initial ignition and the ability of a mattress to sustain a fire; Section 805.2.2.2 is focused primarily on the burning characteristics of mattresses.

**805.2.2.1 Ignition by cigarettes.** Newly introduced mattresses shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with DOC 16 CFR Part 1632 and shall have a char length not exceeding 2 inches (51 mm).

❖ This section is the same as Sections 805.1.2.1 and 805.3.2.1 and requires compliance with DOC 16 CFR Part 1632 (see commentary, Section 805.1.2.1).

**805.2.2.2 Heat release rate.** Newly introduced mattresses shall have limited rates of heat release when tested in accordance with ASTM E1590 or California Technical Bulletin 129, as follows:

1. The peak rate of heat release for the single mattress shall not exceed 100 kW.

**Exception:** Mattresses in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

2. The total energy released by the single mattress during the first 10 minutes of the test shall not exceed 25 MJ.

**Exception:** Mattresses in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

❖ This section is the same as Section 805.1.2.2 in limiting the maximum heat release rate and the total energy release (see commentary, Section 805.1.2.2).

**805.2.2.3 Identification.** Mattresses shall bear the label of an *approved agency*, confirming compliance with the requirements of Sections 805.2.2.1 and 805.2.2.2.

❖ In order to achieve verifiable compliance, labeling by an approved agency is required. Otherwise, this information would be extremely difficult to verify in the field. See the commentary to the definition of “Labeled” in Section 202.

**805.3 Group I-3, detention and correction facilities.** The requirements in Sections 805.3.1 through 805.3.2 shall apply to detention and correction facilities classified in Group I-3.

❖ This section introduces Sections 805.3.1 through 805.3.2.3, which contain requirements for controlling the hazards associated with upholstered furniture and mattresses in new and existing Group I-3 detention and correctional occupancies. These facilities have a higher likelihood of incendiary activities, and because of the restrictions on movement, the occupants are placed in a more vulnerable position than the general

public; therefore, combustibility limitations are placed on furniture and mattresses.

**805.3.1 Upholstered furniture.** Newly introduced upholstered furniture shall meet the requirements of Sections 805.3.1.1 through 805.3.1.3

❖ This section informs the user that two aspects of upholstered furniture are regulated: the ignitability by cigarettes and the maximum allowable heat release in accordance with ASTM E1537.

**805.3.1.1 Ignition by cigarettes.** Newly introduced upholstered furniture shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with one of the following:

1. Mocked-up composites of the upholstered furniture shall have a char length not exceeding 1.5 inches (38 mm) when tested in accordance with NFPA 261.
2. The components of the upholstered furniture shall meet the requirements for Class I when tested in accordance with NFPA 260.

❖ These requirements are the same as those found in Sections 805.1.1.1 and 805.2.1.1 (see commentary, Section 805.1.1.1).

**805.3.1.2 Heat release rate.** Newly introduced upholstered furniture shall have limited rates of heat release when tested in accordance with ASTM E1537, as follows:

1. The peak rate of heat release for the single upholstered furniture item shall not exceed 80 kW.
2. The total energy released by the single upholstered furniture item during the first 10 minutes of the test shall not exceed 25 MJ.

❖ See the commentary to Section 805.1.1.2.

**805.3.1.3 Identification.** Upholstered furniture shall bear the label of an *approved agency*, confirming compliance with the requirements of Sections 805.3.1.1 and 805.3.1.2.

❖ In order to achieve verifiable compliance, labeling by an approved agency is required. Otherwise, this information would be extremely difficult to verify in the field. See the commentary to the definition of “Labeled” in Section 202.

**805.3.2 Mattresses.** Newly introduced mattresses shall meet the requirements of Sections 805.3.2.1 through 805.3.2.3.

❖ Sections 805.3.2.1 and 805.3.2.2 deal with the combustibility of mattresses. Section 805.3.2.1 focuses on initial ignition and the ability of a mattress to sustain a fire; Section 805.3.2.2 focuses primarily on the burning characteristics of mattresses.

**805.3.2.1 Ignition by cigarettes.** Newly introduced mattresses shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with DOC 16 CFR Part 1632 and shall have a char length not exceeding 2 inches (51 mm).

❖ This section is the same as Sections 805.1.2.1 and 805.3.2.1 and requires compliance with DOC 16 CFR Part 1632 (see commentary, Section 805.1.2.1).

**805.3.2.2 Fire performance tests.** Newly introduced mattresses shall be tested in accordance with Section 805.3.2.2.1 or 805.3.2.2.2.

❖ This section provides two options for fire tests: ASTM E1590, which is a cone calorimeter test, and Annex A3 of ASTM F1085, which provides a simple burn test to determine how much mass the mattress will lose with this exposure.

**805.3.2.2.1 Heat release rate.** Newly introduced mattresses shall have limited rates of heat release when tested in accordance with ASTM E1590 or California Technical Bulletin 129, as follows:

1. The peak rate of heat release for the single mattress shall not exceed 100 kW.
2. The total energy released by the single mattress during the first 10 minutes of the test shall not exceed 25 MJ.

❖ This section is the same as Section 805.1.2.2 in limiting the maximum heat release rate and the total energy (or heat) release (see commentary, Section 805.1.2.2).

**805.3.2.2.2 Mass loss test.** Newly introduced mattresses shall have a mass loss not exceeding 15 percent of the initial mass of the mattress where tested in accordance with the test in Annex A of ASTM F1085.

❖ The test in Annex A3 of ASTM F1085 was developed originally for use in detention and correctional occupancies and is a very severe test that is a reasonable (and less expensive) alternative to ASTM E1590. This test is very simple, can be conducted at any facility and does not require the use of an instrumented fire test lab. The test can be described in a few words: it involves rolling up a mattress, placing it at an angle (for example by holding it with a brick), introducing newspaper into the volume surrounding the rolled up mattress and igniting the newspaper with a match.

If mattress materials melt away from the flame with flaming drips they may “pass” the ASTM E1590 test; however, melting would result in a failure of the ASTM F1085 Annex A test. In this test, the material that flames on the floor will keep burning the mattress itself.

Commentary Figure 805.3.2.2.2 provides a table that shows the results using the ASTM F1085 Annex A3 test for a number of mattresses in two studies (one in 1980 and one in 2003) and it also shows whether the mattresses meet the ASTM E1590 requirements in the code. It is clear from the table that mattresses will either burn up almost completely or lose very little mass. The ASTM F1085 test will not pass mattresses that fail ASTM E1590.

The test from Annex A3 of ASTM F1085 is also described in Section 10.2 of ASTM F1870 (Standard Guide for Selection of Fire Test Methods for the Assessment of Upholstered Furnishings in Detention and Correctional Facilities) as a test method “Designed for Detention and Correction Facilities.”

**805.3.2.3 Identification.** Mattresses shall bear the label of an *approved* agency, confirming compliance with the requirements of Sections 805.3.2.1 and 805.3.2.2.

❖ In order to achieve verifiable compliance, labeling by an approved agency is required. Otherwise, this information would be extremely difficult to verify in the field. See the commentary to the definition of “Labeled” in Section 202.

**805.4 Group R-2 college and university dormitories.** The requirements of Sections 805.4.1 through 805.4.2.3 shall apply to college and university dormitories classified in Group R-2, including decks, porches and balconies.

❖ This section introduces Sections 805.4.1 through 805.4.2.3, which contain requirements for controlling the hazards associated with upholstered furniture and mattresses in new and existing Group R-2 college

MATTRESS	ASTM F1085 MASS LOSS %	ASTM E1590 PER SECTION 805.3.2.2.1 PASS OR FAIL
1 (2003)	1.22	Pass
2 (2003)	9.47	Pass
3 (2003)	3.30	Pass
4 (2003)	100	Fail
5 (2003)	100	Fail
1 (1980)	100	Fail
2 (1980)	100	Fail
3 (1980)	98.5	Fail
4 (1980)	91.1	Fail
5 (1980)	91	Fail
6 (1980)	83.1	Fail
7 (1980)	44.7	Fail
8 (1980)	3.0	Pass

**Figure 805.3.2.2.2  
ANNEX A3 ASTM F1085 TEST RESULTS**

and university dormitories. Fire represents a significant risk to life and property in dormitory occupancies, particularly at residential schools, colleges and universities. The large number of young people living in close proximity to one another creates the potential for a relatively small fire to have serious and possibly fatal consequences. According to NFPA fire loss data, there are an average of 1,425 fires each year in dormitories causing \$6.3 million in direct property damage. For these reasons, upholstered furniture and mattresses in dormitories must comply with the same requirements for fire performance as those in Group I-1, I-2 and I-3 occupancies. The test methods and criteria are identical to those in Sections 805.1, 805.2 and 805.3 of the code. Section 805.3.2.2.2 provides an option for a mass loss test for mattresses.

Note that this section also includes upholstered furniture and mattresses on porches, decks and balconies, which, for this particular occupancy, can be frequently found in such locations. Since the decks, porches or balconies are likely not sprinklered, this would severely limit or eliminate the allowance of such items in these areas. Many jurisdictions have specifically banned furniture such as couches from these areas. These provisions are not as strict but will limit the potential for fires to spread to the structure.

Section 805.4 provides the fire code official and college and university campus housing authorities with the needed authority to limit the combustibility of student-owned furnishings. Those furnishings can include both upholstered furniture and mattresses, which are the high-fuel items in Group R-2 dormitory occupancies. Strictly enforced, these provisions, coupled with the limitations on the use of open flames in Group R-2 dormitories found in Section 308.4.1, should provide a much-improved level of fire safety in these occupancies.

**805.4.1 Upholstered furniture.** Newly introduced upholstered furniture shall meet the requirements of Sections 805.4.1.1 through 805.4.1.3

❖ This section informs the user that two aspects of upholstered furniture are regulated: the ignitability by cigarettes and the maximum allowable heat release in accordance with recognized standards.

**805.4.1.1 Ignition by cigarettes.** Newly introduced upholstered furniture shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with one of the following:

1. Mocked-up composites of the upholstered furniture shall have a char length not exceeding 1½ inches (38 mm) when tested in accordance with NFPA 261.

2. The components of the upholstered furniture shall meet the requirements for Class I when tested in accordance with NFPA 260.

❖ These requirements are the same as those found in Sections 805.1.1.1, 805.2.1.1 and 805.3.1.1 (see commentary, Section 805.1.1.1).

**805.4.1.2 Heat release rate.** Newly introduced upholstered furniture shall have limited rates of heat release when tested in accordance with ASTM E1537 or California Technical Bulletin 133, as follows:

1. The peak rate of heat release for the single upholstered furniture item shall not exceed 80 kW.

**Exception:** Upholstered furniture in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

2. The total energy released by the single upholstered furniture item during the first 10 minutes of the test shall not exceed 25 MJ.

**Exception:** Upholstered furniture in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

❖ This section is identical to Sections 805.1.1.2 and 805.2.1.2 and focuses on the potential heat release rate of upholstered furniture if a fire occurs (see commentary, Section 805.1.1.2).

**805.4.1.3 Identification.** Upholstered furniture shall bear the label of an *approved* agency, confirming compliance with the requirements of Sections 805.4.1.1 and 805.4.1.2.

❖ In order to achieve verifiable compliance, labeling by an approved agency is required. Otherwise, this information would be extremely difficult to verify in the field. See the commentary for the definition of “Labeled” in Section 202.

**805.4.2 Mattresses.** Newly introduced mattresses shall meet the requirements of Sections 805.4.2.1 through 805.4.2.3.

❖ Sections 805.4.2.1 and 805.4.2.2 deal with the combustibility of mattresses. Section 805.4.2.1 focuses on initial ignition and the ability of a mattress to sustain a fire; Section 805.4.2.2 focuses primarily on the burning characteristics of mattresses.

**805.4.2.1 Ignition by cigarettes.** Newly introduced mattresses shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with DOC 16 CFR Part 1632 and shall have a char length not exceeding 2 inches (51 mm).

❖ This section is the same as Sections 805.1.2.1, 805.2.2.1 and 805.3.2.1 and requires compliance

with DOC 16 CFR Part 1632 (see commentary, Section 805.1.2.1).

**805.4.2.2 Heat release rate.** Newly introduced mattresses shall have limited rates of heat release when tested in accordance with ASTM E1590 or California Technical Bulletin 129, as follows:

1. The peak rate of heat release for the single mattress shall not exceed 100 kW.

**Exception:** Mattresses in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

2. The total energy released by the single mattress during the first 10 minutes of the test shall not exceed 25 MJ.

**Exception:** Mattresses in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

❖ This section is the same as Sections 805.1.2.2, 805.2.2.2 and 805.3.2.2.1 in limiting the maximum heat release rate and the total energy (or heat) release (see commentary, Section 805.1.2.2).

**805.4.2.3 Identification.** Mattresses shall bear the label of an *approved agency*, confirming compliance with the requirements of Sections 805.4.2.1 and 805.4.2.2.

❖ In order to achieve verifiable compliance, labeling by an approved agency is required. Otherwise, this information would be extremely difficult to verify in the field. See the commentary to the definition of “Labeled” in Section 202.

## SECTION 806 DECORATIVE VEGETATION IN NEW AND EXISTING BUILDINGS

**806.1 Natural cut trees.** Natural cut trees, where allowed by this section, shall have the trunk bottoms cut off not less than 0.5 inch (12.7 mm) above the original cut and shall be placed in a support device complying with Section 806.1.2.

❖ This section focuses on the fire hazards posed by vegetation within a building. The majority of this section deals specifically with fresh Christmas trees. Natural cut trees, such as Christmas trees, within buildings pose a significant fire threat to occupants if they are not properly cared for. Because of the symmetric way in which these trees are normally groomed, the large surface area of the foliage and the amount of airspace throughout the branches, fires have the potential to burn very efficiently and vigorously if the tree is dry. The National Institute of Standards and Technology (NIST) website has the following statements: “The National Fire Protection Association (NFPA) reports that there are an estimated annual average of 210 home structure fires that begin with Christmas trees. Based on data from 2002 through 2005, these fires caused an average of 24 civilian deaths, 27 civilian injuries, and \$13.3 mil-

lion in direct property damage per year. The NFPA analysis also shows that although the number of Christmas tree fires is low, these fires represent a higher level of hazard. On average, one of every nine Christmas tree fires resulted in a fatality compared to an average of one death per 75 nonconfined home structure fires overall. Further, 49 percent of Christmas tree fires spread beyond the room of origin. The fires that spread beyond the room of origin caused 94 percent of the associated fatalities. The percentage of trees involved in structure fires represents an extremely small portion of the total number of natural Christmas trees sold in the United States each year, which is estimated at 30 million. The moisture content of each tree can play a dominant role in determining the fire hazard it represents. Properly maintaining a cut Christmas tree is important to retaining a high moisture content in the needles of the tree to limit accidental ignition and prevent rapid flame spread. A tree that has dry needles can readily ignite with a flaming source and generate heat release rates that are capable of causing flashover in residential scale rooms. The above statistics addressed home structure fires and natural Christmas trees, which are required by the IFC to be kept moist and fresh at all times.”

In tests performed at NIST in 1999 to better understand the severity of Christmas tree fires, eight Scotch pine Christmas trees were placed in a room at 73°F (23°C) at approximately 50-percent relative humidity for approximately three weeks. Seven of the eight trees were given no additional moisture; the eighth tree was watered according to local rules for trees within business occupancies. This required the tree to be cut in a certain manner and placed in a stand with at least a 2-gallon (7.6 L) capacity. The seven dry trees were ignited and burned intensely; however, the tree that had been watered continuously throughout the three weeks could not be ignited. The peak heat releases from the dry trees ranged from approximately 1,600 kW to 5,000 kW within about 50 to 80 seconds of ignition [see Commentary Figure 806.1(1) for a summary of results and Commentary Figure 806.1(2) for a graphical representation of Test No. 3]. These test results demonstrate that the proper care for trees (i.e., making sure that the tree remains humid or wet) makes a significant difference on the fire hazard presented. This section requires at least 1/2 inch (12.7 mm) of tree trunk to be removed above the original cut to optimize the tree’s ability to absorb water to maintain a minimum level of moisture. This section also requires a support device (tree stand or equivalent) that meets the criteria of Section 806.1.2. Such devices are intended to bring the correct amount of moisture into contact with the tree. The specifics of this section cannot realistically be monitored in all buildings within a jurisdiction. The focus must be on occupancies

such as assembly or mercantile. All occupancies benefit, however, because there is now a method that a fire department could use to educate the general public on the treatment of Christmas trees. This tool can be helpful in fire prevention within a jurisdiction.

**806.1.1 Restricted occupancies.** Natural cut trees shall be prohibited within ambulatory care facilities and Group A, E, I-1, I-2, I-3, I-4, M, R-1, R-2 and R-4 occupancies.

**Exceptions:**

1. Trees located in areas protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2 shall not be prohibited in Groups A, E, M, R-1 and R-2.

2. Trees shall be allowed within *dwelling units* in Group R-2 occupancies.

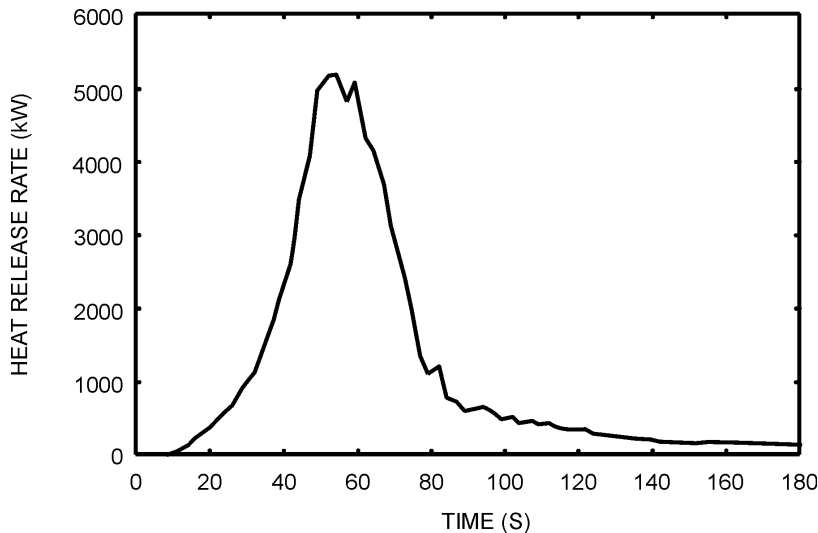
❖ Although trees that have been properly watered and handled are less hazardous, there is still a concern that they should not be located in certain occupancies and specific uses. The occupancies listed in this section are those where the occupant load is high, occupants are vulnerable or the potential hazards that exist if the tree is not properly handled are too great. These occupancies and specific uses include ambulatory care facilities and Group A, E, I-1, I-2, I-3, I-4, M, R-1 and R-2 occupancies. There are exceptions for Group A, E, M, R-1 and R-2 occupancies when the trees are located in areas that are sprinklered in

TEST NO.	WEIGHT (kg)		HEIGHT (m)	WIDTH <sup>a</sup> (m)	MOISTURE CONTENT (%)
	Before Test	After Test			
1	17.2	6.8	2.6	1.7	30
2	15.9	8.2	2.7	1.3	27
3	20.0	6.8	2.3	1.7	30
4	9.5	5.0	2.5	1.2	30
5	19.1	8.6	2.5	1.7	28
6	12.7	7.7	2.5	1.1	32
7	18.6	7.7	3.1	1.5	25
8	28.1	28.1	2.7	1.4	36

(From NIST Report FR 4010)

a. The width is measured at the widest point of the tree.

**Figure 806.1(1)  
SUMMARY OF TREE PARAMETERS**



(From NIST Report FR 4010)

**Figure 806.1(2)  
GRAPH OF HEAT RELEASE RATE VERSUS TIME FOR TEST NUMBER 3**

accordance with NFPA 13 or 13R, as applicable, and for trees within individual dwelling units in Group R-2. Essentially, the only occupancies that would be completely prohibited from having cut trees are institutional occupancies because of the vulnerability of the occupants and, in some cases, concerns for incendiary tendencies of some occupants.

**806.1.2 Support devices.** The support device that holds the tree in an upright position shall be of a type that is stable and that meets all of the following criteria:

1. The device shall hold the tree securely and be of adequate size to avoid tipping over of the tree.
2. The device shall be capable of containing a minimum two-day supply of water.
3. The water level, when full, shall cover the tree stem not less than 2 inches (51 mm). The water level shall be maintained above the fresh cut and checked not less than once daily.

❖ This section is intended to prevent the tree from tipping over, potentially into an ignition source, and ensure that the support device is designed and used to keep the water supply to the tree at a useful level. More specifically, Item 1 requires the device to prevent the tree from tipping; Item 2 states that the device must be capable of holding a two-day water supply; and Item 3 requires a minimum coverage of water to 2 inches (51 mm) above the bottom of the stem. The water level must be checked at least once daily to verify that an adequate supply remains. The restrictions in Section 806.1.1 are in place because the provisions in Section 806.1.2 are generally difficult for a fire department to monitor. Having a sprinkler system or generally prohibiting natural cut trees in higher risk occupancies provides a redundancy to deal with the potential hazards.

**806.1.3 Dryness.** The tree shall be removed from the building whenever the needles or leaves fall off readily when a tree branch is shaken or if the needles are brittle and break when bent between the thumb and index finger. The tree shall be checked daily for dryness.

❖ Lack of moisture is the primary problem with natural cut trees within buildings. This section describes a daily test to assist in evaluating whether the tree is considered too dry to remain in the building.

**806.2 Artificial vegetation.** Artificial decorative vegetation shall meet the flame propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701. Meeting the flame propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701 shall be documented and certified by the manufacturer in an *approved* manner. Alternatively, the artificial decorative vegetation item shall be tested in accordance with NFPA 289, using the 20 kW ignition source, and shall have a maximum heat release rate of 100 kW.

❖ Much of the attention of Section 806 has been focused on natural vegetation, primarily Christmas trees. This section addresses artificial vegetation,

which generally contains a high concentration of plastic material in the form of plastic artificial leaves. The goal, therefore, is to reduce initial ignitability by treating artificial vegetation with flame retardants to improve fire performance or to use materials that have inherently better fire performance. Artificial decorative vegetation is required by this section to be tested either to the flame propagation performance criteria of NFPA 701 or in accordance with NFPA 289 using the 20 kW ignition source and with a maximum allowed heat release rate of 100 kW.

NFPA 289 is a furniture calorimeter heat release fire test specifically developed for these types of products. NFPA 289 uses a propane gas burner as the ignition source. The 20 kW gas burner ignition source in NFPA 289 was specifically designed with the intent of being a substitute for UL 1975 and would be suitable as an ignition source for Christmas trees.

As discussed extensively in Section 806.1, there are substantial fire safety requirements for natural Christmas trees; however, testing in accordance with NFPA 701 was the only option until this requirement was added.

**806.3 Obstruction of means of egress.** The required width of any portion of a *means of egress* shall not be obstructed by decorative vegetation. Natural cut trees shall not be located within an exit, corridor, or a lobby or vestibule.

❖ Decorative vegetation is often placed in a location that does not normally accommodate combustibles. This section restricts locations so that the vegetation does not block the egress width and increase the fire hazard in such areas. For example, this would likely prohibit trees in main lobby areas of a movie theater.

**806.4 Open flame.** Candles and open flames shall not be used on or near decorative vegetation. Natural cut trees shall be kept a distance from heat vents and any open flame or heat-producing devices at least equal to the height of the tree.

❖ This section addresses the primary ignition hazards associated with decorative vegetation. More specifically, candles should never be placed on or near Christmas trees. Also, heat sources such as vents may pose an ignition hazard in addition to being a source of airflow that could dry out a tree, making it more susceptible to ignition.

**806.5 Electrical fixtures and wiring.** The use of unlisted electrical wiring and lighting on natural cut trees and artificial decorative vegetation shall be prohibited. The use of electrical wiring and lighting on artificial trees constructed entirely of metal shall be prohibited.

❖ Decorations are quite often used year after year on Christmas trees. Some of this decor consists of lights that are not specifically listed and can fail and become very hot, potentially posing an ignition source. Additionally, this wiring may arc and create an ignition source. In fact, it has been found that many Christmas tree fires have actually been started by the decorative lights on them. Therefore, this section simply prohibits the use of unlisted wiring or light-

ing (such lights and ornaments are listed in accordance with UL 588). Additionally, because of the shock and ignition potential resulting from a short or direct contact of part of the tree with one of the light sockets, electrical wiring and lighting is not allowed on metal trees.

**SECTION 807  
DECORATIVE MATERIALS OTHER  
THAN DECORATIVE VEGETATION IN NEW  
AND EXISTING BUILDINGS**

**807.1 General.** Combustible decorative materials, other than decorative vegetation, shall comply with Sections 807.2 through 807.5.6.

❖ The requirements in this section apply to decorative materials other than vegetation. The bulk of the requirements in this section are applicable to all occupancy groups. Section 807.3 is applicable to all groups, except Group I-3, as combustible decorative materials are prohibited (See Section 807.5.4). Decorative materials must be noncombustible or meet the flame propagation performance criteria of Section 806.4 and NFPA 701. Note that Section 807.5 is occupancy based and addresses combustible decorative materials that may not comply with Section 807.3, such as artwork in classrooms. Instead, specific limitations on amounts and types of materials are provided. The occupancies addressed include Group A, E, I and R-2 dormitories.

**807.2 Limitations.** The following requirements shall apply to all occupancies:

1. Furnishings or decorative materials of an explosive or highly flammable character shall not be used.
2. Fire-retardant coatings in existing buildings shall be maintained so as to retain the effectiveness of the treatment under service conditions encountered in actual use.
3. Furnishings or other objects shall not be placed to obstruct exits, access thereto, egress therefrom or visibility thereof.
4. The permissible amount of noncombustible decorative materials shall not be limited.

❖ This section addresses some basic hazards with certain finishes and materials associated with decorative materials. These are discussed below.

1. This is a general statement prohibiting furnishings and contents or decorative materials that pose an extreme fire potential. These materials tend to have a significant impact on fire size in a building.
2. In many cases, the IBC and the code allow use of certain combustible or flammable materials based on the application of a fire-retardant coating (see commentary, Section 803.4).

3. Similar to Section 806.3, this section prohibits any decorations or other objects from obstructing the means of egress, including visibility.
4. It is clarified that noncombustible decorative materials are not limited, as they pose no fire hazard. It is important that they comply with Item 3 in terms of obstruction of the means of egress.

**807.3 Combustible decorative materials.** In other than Group I-3, curtains, draperies, fabric hangings and other similar combustible decorative materials suspended from walls or ceilings shall comply with Section 807.4 and shall not exceed 10 percent of the specific wall or ceiling area to which they are attached.

Fixed or movable walls and partitions, paneling, wall pads and crash pads applied structurally or for decoration, acoustical correction, surface insulation or other purposes shall be considered *interior finish*, shall comply with Section 803 and shall not be considered *decorative materials* or furnishings.

**Exceptions:**

1. In auditoriums in Group A, the permissible amount of curtains, draperies, fabric hangings and other similar combustible decorative material suspended from walls or ceilings shall not exceed 75 percent of the aggregate wall area where the building is equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1, and where the material is installed in accordance with Section 803.11 of the *International Building Code*.
2. In Group R-2 dormitories, within sleeping units and dwelling units, the permissible amount of curtains, draperies, fabric hangings and other similar decorative materials suspended from walls or ceilings shall not exceed 50 percent of the aggregate wall areas where the building is equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.
3. In Group B and M occupancies, the amount of combustible fabric partitions suspended from the ceiling and not supported by the floor shall comply with Section 807.4 and shall not be limited.

❖ Meeting the flame propagation performance criteria of NFPA 701, which is required by Section 807.4, does not mean that materials will not burn, only that they are going to spread flame relatively slowly. These materials are, therefore, limited to a maximum of 10 percent of the total wall or ceiling area of the space under consideration. Unlike incidental trim, decorative materials are not necessarily distributed evenly throughout the room. Additionally, consideration of the long-term maintenance of the materials, including possible periodic retreatment, should be taken into account.

In any occupancy classification, when a movable wall, partition, paneling, wall pads or crash pads

cover larger areas, they need to be dealt with as interior finishes instead of as decorative materials.

The first two exceptions relate to the 10-percent limitation in Section 807.3. Exception 1 is for Group A auditoriums that would allow 75-percent coverage of the walls and ceilings (instead of the limit of 10 percent) if the space is sprinklered in accordance with NFPA 13 and the material is applied in accordance with Section 803.11 of the IBC.

Exception 2 allows an increased amount of decorative materials in Group R-2 dormitories. An allowance of up to 50 percent is provided as long as the building is equipped throughout with an automatic sprinkler system. The reference to Section 903.3.1 allows the use of a NFPA 13 or 13R system as applicable. This allowance is likely provided as it is more realistic to what is typically found in dormitories and is more easily managed from an enforcement standpoint. The sprinklers provide the necessary protection to allow such an increase.

Exception 3 of this section clarifies that, in Group B and M occupancies, fabric partitions suspended from the ceiling but not physically contacting the floor should be treated as decorative materials similar to curtains or draperies and comply with the flame propagation performance heat release criteria of Section 807.4. These partitions are also permitted to be unlimited. This is with or without the use of sprinklers within a building.

**807.4 Acceptance criteria and reports.** Where required to exhibit improved fire performance, curtains, draperies, fabric hangings and other similar combustible decorative materials suspended from walls or ceilings shall be tested by an *approved* agency and meet the flame propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701 or exhibit a maximum rate of heat release of 100 kW when tested in accordance with NFPA 289, using the 20 kW ignition source. Reports of test results shall be prepared in accordance with the test method used and furnished to the *fire code official* upon request.

- ❖ One of the standard test methods used to evaluate the ability of a material to propagate flame is NFPA 701, which contains two test methods. Test 1 is less severe than Test 2 and uses smaller specimens. Test 1 is intended for lighter weight materials and single layer fabrics: the limit is a linear density of 700 g/m<sup>2</sup> (21 oz/yd<sup>2</sup>). Test 2 is intended for higher density materials and multilayered fabrics. It also applies to vinyl-coated fabric blackout linings and lined draperies using any density, because they have been shown to give misleading results using Test 1. NFPA 701 sets out the types of materials, including fabrics that should be tested using each method.

Essentially, NFPA 701 provides a mechanism to distinguish between materials that allow flames to spread quickly and those that do not when using a small fire exposure.

Materials tested only to NFPA 701 are not permitted for use as interior finish materials, but instead are generally used as shades, swags, curtains and other similar materials. These tests are used to determine whether materials propagate flame beyond the area exposed to the ignition source. They are not intended to indicate whether the material tested will resist the propagation of flame under fire exposures more extreme than the test conditions.

It should be noted that the historic “small-scale test” is no longer accepted.

The other standard test method that can be used is NFPA 289. This test method quantifies the contribution of materials to heat and smoke release when subjected to different ignition sources. This test method also determines the potential for growth of a fire and the fire-spread of a given material when exposed to an ignition source in a controlled environment. See the commentary to Section 807.5.1.1 for a more detailed discussion of this test method.

**807.5 Occupancy-based requirements.** In occupancies specified, combustible decorative materials not complying with Section 807.3 shall comply with Sections 807.5.1 through 807.5.6.

- ❖ The provisions of Sections 807.5.1 through 807.5.6 address the vulnerability of occupants by addressing hazards likely found in certain occupancies. Group A occupancies are generally densely populated with occupants being unfamiliar with their surroundings. Such occupancies are also more likely to contain a large amount of decorative materials, such as stage scenery or exhibit booths utilizing foam plastics. Group E, I and R-2 dormitories have the potential to deal with a large amount of decorative materials and storage. Occupants in Group E, I and R-2 dormitories are also considered more vulnerable than other occupancies, such as Group B or M, because of occupant age or infirmity and occupancies such as dormitories where the occupants sometimes place themselves at increased risks. Group I-3, as will be discussed, should not have any combustible decorative materials. It is important to stress that this section specifically addresses materials that do not meet the requirements of NFPA 701, as is required in Section 807.3.

**807.5.1 Group A.** In Group A occupancies, the requirements in Sections 807.5.1.1 through 807.5.1.4 shall apply.

- ❖ The requirements in Sections 803.5.1.1 through 803.5.1.4 are specific to Group A occupancies. These particular requirements are fairly specific to activities and uses that occur in Group A occupancies, such as trade shows and movie theaters. Generally, fire hazards are moderate in Group A occupancies. The concerns are more closely related to the high occupant density and the occupants’ lack of familiarity with the building.

**807.5.1.1 Foam plastics.** Exposed foam plastic materials and unprotected materials containing foam plastic used for decorative purposes or stage scenery or exhibit booths shall have a maximum heat release rate of 100 kW when tested in accordance with UL 1975, or when tested in accordance with NFPA 289 using the 20 kW ignition source.

**Exceptions:**

1. Individual foam plastic items or items containing foam plastic where the foam plastic does not exceed 1 pound (0.45 kg) in weight.
2. Cellular or foam plastic shall be allowed for trim in accordance with Section 804.2.

❖ As discussed in Section 803.8, foam plastics can produce misleading results when tested to ASTM E84. In some instances, they can burn vigorously and at high rates of heat release. Group A occupancies tend to contain materials for stages, movie theaters and exhibit halls. These uses will likely have combustible scenery or exhibit booths that contain foam plastics. Therefore, because the occupants are unlikely to be familiar with the premises, and the hazards presented by these combustibles can be high, a heat release rate limit of 100 kW, when tested in accordance with UL 1975 or NFPA 289, is placed on foam plastic materials used in Group A occupancies.

In the past, restrictions on the combustibility of materials were based on the heat content of the materials instead of the rate at which the heat content is released. The problem with using heat content (which can be equated to “potential energy” of the material) as the limitation criterion is that it does not provide a good understanding of the rate at which the “potential energy” is released. The rate at which heat is released is a more important characteristic of fire and is a measure of the intensity of the fire. UL 1975 and NFPA 289 are furniture calorimeter types of tests that assess the actual heat release rate based on the exposure of the foam plastics to a specific heat input (340-gram wood crib for UL 1975 and 20kW propane gas burner ignition source for NFPA 289) as specified in the test.

Some alternatives to testing are provided in the exceptions, which primarily focus on limiting the amount of combustibles. The exceptions give two prescriptive approaches with no direct relationship to the actual combustibility of the foam plastic except to limit the amount used. Exception 1 is related to plastic display items, such as a small statue. Exception 2 relates specifically to decorative trim and directs the code user to the requirements for that material found in Section 804.2 (see commentary, Section 804.2).

**807.5.1.2 Motion picture screens.** The screens upon which motion pictures are projected in new and existing buildings of Group A shall either meet the flame propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701 or shall comply with the requirements for a Class

B interior finish in accordance with Section 803 of the *International Building Code*.

❖ Movie screens are not considered interior finish and, therefore, would not be addressed by Chapter 8 of the IBC. These screens consist of a fabric base covered with a thin coating impregnated with reflective glass beads. Movie screens are generally fairly large and typically take up most of the front wall of a movie theater; therefore, the flame spread characteristics must be addressed. Because movie theaters tend to be densely occupied, a material with a high rate of flame spread can pose a significant hazard. Screens can comply in one of two ways. The screen must meet the applicable flame propagation performance criteria set out in NFPA 701 Test Method 1 or 2 (which focus on combustibles such as curtains, shades and window treatments, but are not appropriate for wall coverings), or qualify as a Class B interior finish material in accordance with ASTM E84. NFPA 286, which is also found in Section 803, would be a viable alternative for testing. It should be noted that the historic “small-scale test” in NFPA 701 is no longer accepted.

**807.5.1.3 Wood use in places of religious worship.** In places of religious worship, wood used for ornamental purposes, trusses, paneling or chancel furnishing shall not be limited.

❖ Places of religious worship are generally open spaces. The occupants, because of the nature of the activities in these assemblies, tend to be orderly. For this reason, wood, which is a combustible material, is allowed extensively as a finish material without restriction.

**807.5.1.4 Pyroxylin plastic.** Imitation leather or other material consisting of or coated with a pyroxylin or similarly hazardous base shall not be used.

❖ Use of pyroxylin plastics, also known as cellulose nitrate plastics, in Group A occupancies as imitation leather or other materials is strictly prohibited because of the normally high occupant loads of such occupancies. This type of material is very hazardous because it will begin decomposition at temperatures starting at 300°F (149°C), and has the potential to develop explosive atmospheres with high heat emission once it ignites. Because cellulose nitrate tends to become somewhat unstable and is easily ignitable, its use has generally declined. Specifically, use of cellulose nitrate for motion picture film was discontinued in 1951.

**807.5.2 Group E.** Group E occupancies shall comply with Sections 807.5.2.1 through 807.5.2.3.

❖ Group E occupancies are occupancies used by six or more persons for educational purposes through the 12th grade or buildings and structures used for educational, supervision or personal care services for

more than five children over the age of 2½ years. This section regulates the amount of combustibles within corridors, lobbies and classrooms by regulating clothing, personal effects and artwork.

**807.5.2.1 Storage in corridors and lobbies.** Clothing and personal effects shall not be stored in *corridors* and lobbies.

**Exceptions:**

1. *Corridors* protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.
2. *Corridors* protected by an *approved fire alarm system* installed in accordance with Section 907.
3. Storage in metal lockers, provided the minimum required egress width is maintained.

❖ Materials, such as clothing, other personal effects and artwork, have the potential for creating a fire hazard within the main path of egress travel. This section allows the storage of clothing and other personal effects within these areas only if corridors and lobbies contain one of the following features:

- Sprinkler system.
- Fire alarm system.
- Metal lockers for storage.

The sprinkler system must meet the requirements of NFPA 13. The fire alarm system must be approved by the fire code official. The fire alarm system is intended to specifically focus on the contents of the corridors and would typically be a smoke detection system. The system is not intended to be required throughout.

**807.5.2.2 Artwork in corridors.** Artwork and teaching materials shall be limited on the walls of *corridors* to not more than 20 percent of the wall area.

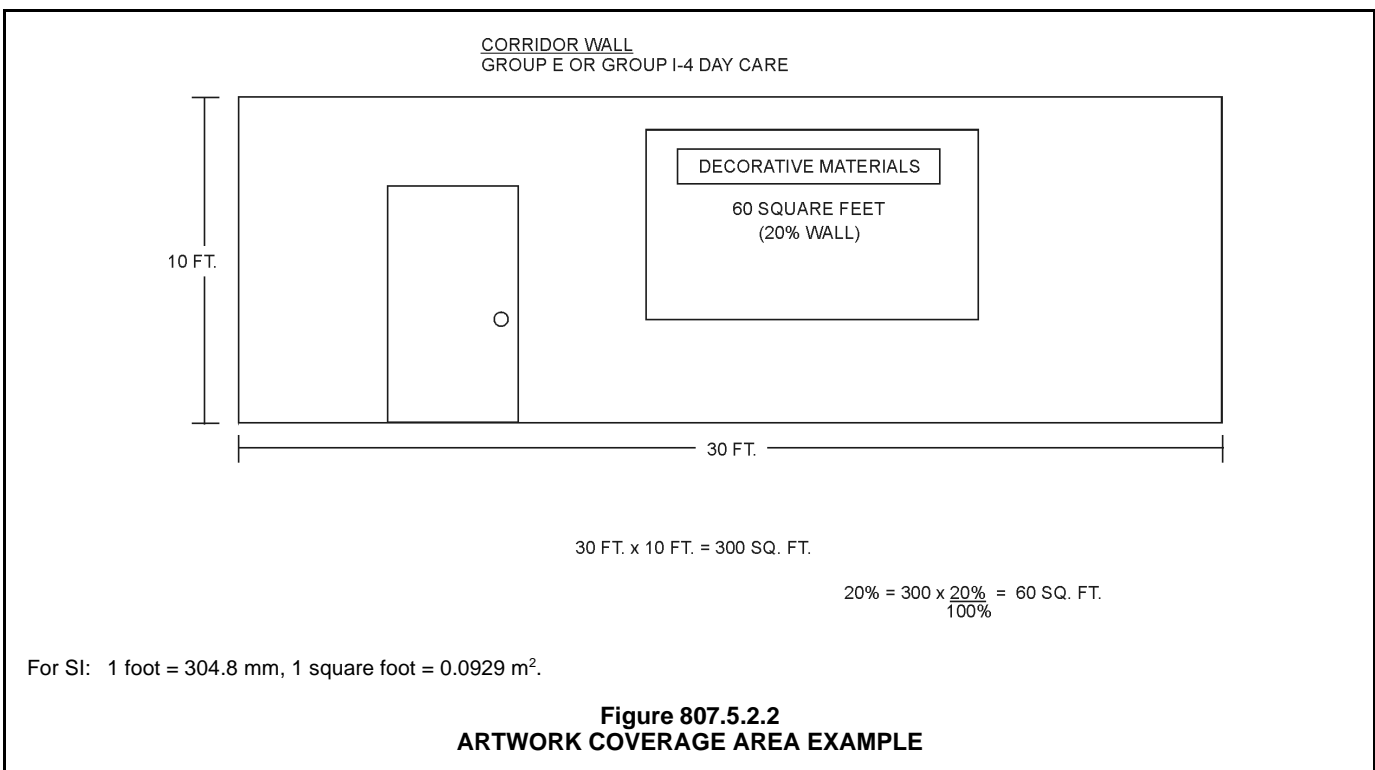
❖ Educational occupancies tend to display various artwork and related educational materials on the walls of classrooms and corridors. This section limits the potential combustibility levels of artwork in critical areas of the means of egress system; therefore, decorations or artwork can cover no more than 20 percent of the corridor walls. See Commentary Figure 807.5.2.2 for representation of the 20-percent coverage area.

**807.5.2.3 Artwork in classrooms.** Artwork and teaching materials shall be limited on walls of classrooms to not more than 50 percent of the specific wall area to which they are attached.

❖ This is consistent with requirements for restrictions on artwork in the corridors. The limit is less restrictive at 50 percent versus the 20 percent that is permitted for corridors. This relates to the fact that the corridors make up the more critical portion of the exit access for the building.

**807.5.3 Groups I-1 and I-2.** In Group I-1 and I-2 occupancies, combustible *decorative materials* shall comply with Sections 807.5.3.1 through 807.5.3.4.

❖ Sections 807.5.3.1 through 807.5.3.4 provide a series of requirements for care facilities where the occupants are at increased level of risk due to their physical and cognitive limitations. In Group I-1 and I-2 occupancies, the occupants are present 24 hours a day with varying levels of care depending on the type



of occupancy. Section 407.2.1 of the IBC allows waiting or similar areas to be open to corridors. These types of spaces typically have magazines, bulletin boards with paper notices tacked to them, and other combustible items not treated with flame retardants or tested to NFPA 701. Allowing a specified percentage of untreated, combustible decorative materials in Group I-1 and I-2 buildings equipped throughout with an automatic sprinkler system will not exceed the “ordinary occupancy” classification outlined in NFPA 13, nor does it increase the fire loading above what is currently permitted. These requirements offer consistent language to aid enforcement and a guide to providers to determine compliance within their facilities. The intent of these requirements is to eliminate the haphazard and inconsistent application of these provisions in facilities nationwide.

**807.5.3.1 Group I-1 and I-2 Condition 1 within units.** In Group I-1 and Group I-2 Condition 1 occupancies, equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1, within sleeping units and dwelling units, combustible decorative materials placed on walls shall be limited to not more than 50 percent of the wall area to which they are attached.

❖ This section is focused on the sleeping units and dwelling units within Group I-1, which are typically assisted living and similar occupancies, and Group I-2 Condition 1, which are nursing homes. Since the requirements are focused within the sleeping and dwelling unit, the requirements are more lenient than those associated with the main exit access. Similar to the artwork restrictions for classrooms, such spaces are permitted to have 50 percent of the wall area occupied by combustible decorative materials. It should be noted that Group I-2 occupancies require the retroactive installation of sprinklers in accordance with Section 1105.8. All new Group I occupancies require the installation of an automatic sprinkler system.

**807.5.3.2 In Group I-1 and I-2 Condition 1 for areas other than within units.** In Group I-1 and Group I-2 Condition 1 occupancies, equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1, combustible decorative materials placed on walls in areas other than within dwelling and sleeping units shall be limited to not more than 30 percent of the wall area to which they are attached.

❖ This section focuses on the same occupancies as Section 807.5.3.1, but on areas outside the sleeping and dwelling units. The allowance in sprinklered buildings is 30 percent versus the 50 percent in Section 807.5.3.1. These areas tend to expose a greater percentage of the building occupants to the hazards of combustible decorative materials. It should be noted that Group I-2 occupancies require the retroactive installation of sprinklers in accordance with Sec-

tion 1105.8. All new Group I occupancies require the installation of an automatic sprinkler system.

**807.5.3.3 In Group I-2 Condition 2.** In Group I-2 Condition 2 occupancies, equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1, combustible decorative materials placed on walls shall be limited to not more than 30 percent of the wall area to which they are attached.

❖ This section is the same as Section 807.5.3.2, except that it is focused on hospitals—specifically, areas of the hospital where more occupants are exposed to combustible decorative materials. As noted in Sections 807.5.3.1 and 807.5.3.2, all Group I-2 occupancies require the retroactive installation of an automatic sprinkler system. Note that Section 1105.8 only requires sprinkler installation from the story containing the Group I-2 occupancy to the level of exit discharge.

**807.5.3.4 Other areas in Groups I-1 and I-2.** In Group I-1 and I-2 occupancies, in areas not equipped throughout with an *approved automatic sprinkler system*, combustible decorative materials shall be of such limited quantities that a hazard of fire development or spread is not present.

❖ This section addresses Group I-1 and I-2 occupancies. The focus is on areas of such buildings where an automatic sprinkler system does not provide coverage. As noted, Group I-2 occupancies require the retroactive installation of an automatic sprinkler system but Group I-1 occupancies do not. Although Group I-2 occupancies should be provided with sprinklers, there may be transitional periods where this is not the case. This requirement in general is nonspecific and generally gives authority to the fire code official to address situations that appear hazardous.

**807.5.4 Group I-3.** In Group I-3, combustible *decorative materials* are prohibited.

❖ Due to the nature of such occupancies, where occupants have a tendency to start fires, combustible decorative materials are prohibited.

**807.5.5 Group I-4.** Group I-4 occupancies shall comply with the requirements in Sections 807.5.5.1 through 807.5.5.3.

❖ A Group I-4 day care facility is an occupancy that cares for people of any age for less than 24 hours per day. Most often, these facilities are for small children not yet able to attend school, but also included are adult day care facilities. These occupancies will have features similar to those of Group E occupancies; therefore, the same restrictions on combustibles in corridors, lobbies and classrooms exist. The key issue here is that the occupants of Group I-4 facilities are often not capable of self-preservation without some level of assistance; therefore, combustibles must be kept to a minimum, especially in critical portions of the means of egress system.

**807.5.5.1 Storage in corridors and lobbies.** Clothing and personal effects shall not be stored in *corridors* and lobbies.

**Exceptions:**

1. *Corridors* protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.
2. *Corridors* protected by an *approved fire alarm system* installed in accordance with Section 907.
3. Storage in metal lockers, provided the minimum required egress width is maintained.

❖ See the commentary to Section 807.5.2.1.

**807.5.5.2 Artwork in corridors.** Artwork and teaching materials shall be limited on walls of *corridors* to not more than 20 percent of the wall area.

❖ See the commentary to Section 807.5.2.2.

**807.5.5.3 Artwork in classrooms.** Artwork and teaching materials shall be limited on walls of classrooms to not more than 50 percent of the specific wall area to which they are attached.

❖ See the commentary to Section 807.5.2.3.

**807.5.6 Dormitories in Group R-2.** In Group R-2 dormitories, within sleeping units and dwelling units, the combustible decorative materials shall be of limited quantities such that a hazard of fire development or spread is not present.

❖ This section is consistent with the needs of facilities where occupants often take unnecessary risks. This provides a mechanism for the fire code official to limit the potential hazards in such sleeping units and dwelling units. Note that Section 807.3, Exception 2 allows up to 50 percent of the aggregate wall areas to contain decorative materials if an automatic sprinkler system is provided.

**SECTION 808  
FURNISHINGS OTHER THAN UPHOLSTERED  
FURNITURE AND MATTRESSES OR DECORATIVE  
MATERIALS IN NEW AND EXISTING BUILDINGS**

**808.1 Wastebaskets and linen containers in Group I-1, I-2 and I-3 occupancies.** Wastebaskets, linen containers and other waste containers, including their lids, located in Group I-1, I-2 and I-3 occupancies shall be constructed of noncombustible materials or of materials that meet a peak rate of heat release not exceeding 300 kW/m<sup>2</sup> when tested in accordance with ASTM E1354 at an incident heat flux of 50 kW/m<sup>2</sup> in the horizontal orientation. Metal wastebaskets and other metal waste containers with a capacity of 20 gallons (75.7 L) or more shall be *listed* in accordance with UL 1315 and shall be provided with a noncombustible lid. Portable containers exceeding 32 gallons (121 L) shall be stored in an area classified as a waste and linen collection room and constructed in accordance with Table 509 of the *International Building Code*.

❖ Although residents of Group I-1, I-2 and I-3 occupancies are generally closely monitored, there is an

increased life safety risk in these facilities since in each type, the occupants have limited or no self-evacuation ability. Plastic containers can add a tremendous fuel load to a fire in a trash or linen container; many plastic containers will more than triple the fuel load in a fire situation. This section will control the fuel load for these containers that are used routinely throughout the facilities and will correlate the code with federal regulations for these facilities. Steps can be taken to reduce the impact of a fire once it has been ignited by limiting wastebaskets to those that can meet certain combustibility criteria in accordance with ASTM E1354. ASTM E1354 is a small-scale calorimeter test that measures heat flux output based on a given heat source. This concept is similar to that required in full-scale tests for upholstered furniture and mattresses in Section 805. It should be noted that this section is not focused on ignition prevention but instead assumes that ignition has occurred. The focus is reducing the contribution of the trash container to a fire.

Compliance with this test allows any material that can pass the test to be used. This may allow the use of fire-retardant plastics or other materials that will meet the criteria of the test. Generally, in larger areas of the facility, if a fire can be contained to a wastebasket, it will not spread but will simply burn out.

Since a larger wastebasket means a larger fire, this section also addresses larger metal wastebaskets by requiring compliance with UL 1315 and that they be equipped with a noncombustible lid. This increases the likelihood that the fire will stay contained to the wastebasket and possibly reduce the fire size by restricting the combustion process. The general performance of wastebaskets meeting the requirements of UL 1315 is as follows:

- Limit the external surface temperatures of the container bottom should their contents become ignited.
- Extinguish the fire.
- Contain the contents without contributing fuel to the fire.

See also the commentary to Sections 304.3.2, 304.3.4 and 318.1.

**808.2 Waste containers with a capacity of 20 gallons or more in Group R-2 college and university dormitories.** Waste containers, including their lids, located in Group R-2 college and university dormitories, and with a capacity of 20 gallons (75.7 L) or more, shall be constructed of noncombustible materials or of materials that meet a peak rate of heat release not exceeding 300 kW/m<sup>2</sup> when tested in accordance with ASTM E1354 at an incident heat flux of 50 kW/m<sup>2</sup> in the horizontal orientation. Metal wastebaskets and other metal waste containers with a capacity of 20 gallons (75.7 L) or more shall be *listed* in accordance with UL 1315 and shall be provided with a noncombustible lid. Portable containers exceeding 32 gallons (121 L) shall be stored in an area classified as a waste and linen collection room constructed in

accordance with Table 509 of the *International Building Code*.

- ❖ This section is similar to Section 808.1, but is applicable to larger capacity containers (exceeding 20 gallons) and is focused on Group R-2 college and university dormitories. The large waste containers in college and university dormitories should comply with the same requirements as any waste container in Group I-2 and I-3 occupancies. Most nonmetallic waste containers are manufactured from polyethylene, which has a fuel value over double that of newsprint and can generate a high heat release rate fire. These waste containers hold combustible waste (much of which is paper) while having very combustible walls. See the commentary to Section 808.1 for more information on the test methods prescribed.

**808.3 Signs.** Foam plastic signs that are not affixed to interior building surfaces shall have a maximum heat release rate of 150 kW when tested in accordance with UL 1975, or when tested in accordance with NFPA 289 using the 20-kW ignition source.

**Exception:** Where the aggregate area of foam plastic signs is less than 10 percent of the floor area or wall area of the room or space in which the signs are located, whichever is less, subject to the approval of the *fire code official*.

- ❖ This section correlates with the requirements in Section 402.6.4.4 of the IBC, which requires a limit on the combustibility of signs in covered mall buildings, though it should be noted that the requirements of the code are not specific to such buildings. The requirement of this section is that, when a foam plastic sign is tested in accordance with UL 1975 or NFPA 289 (see commentary, Section 807.5.1.1), a maximum heat release rate of 150 kW is allowed.

Note that smoke development is not part of the acceptance criteria.

The exception recognizes that a relatively small aggregate surface coverage of a room or space by these signs (i.e., when the aggregate area of foam plastic signs constitutes the lesser of 10 percent of the floor or wall area of the room or space in which the signs are located) does not present a sufficient enough hazard to require compliance with the section. However, specific approval by the fire code official is required.

**808.4 Combustible lockers.** Where lockers constructed of combustible materials are used, the lockers shall be considered interior finish and shall comply with Section 803.

**Exception:** Lockers constructed entirely of wood and non-combustible materials shall be permitted to be used wherever interior finish materials are required to meet a Class C classification in accordance with Section 803.1.1.

- ❖ Traditionally, lockers in schools (high schools, middle schools, universities), clubs, swimming pools and gymnasiums were constructed of steel. In recent years, the use of lockers constructed of combustible materials has become prevalent. These lockers typically line an entire wall (for example, a corridor in a

school) and are not regulated by the code. Lockers are not usually considered interior finish. The only other materials regulated by the code at present are interior trim, upholstered furniture, decorations, decorative vegetation, wastebaskets, linen containers and signs. Lockers do not fall into any of those categories.

Combustible lockers can present a significant fire load and, if ignited, are likely to spread fire the same way that interior finish materials spread fire. They are considered interior finish materials and regulated like all other interior finish materials for any occupancy. Plastic lockers have the benefit of being more immune to the effects of water from wet clothing and are generally very durable—but, with these benefits comes a fire hazard. The lockers by one manufacturer are constructed of  $\frac{3}{8}$ -inch-thick (9.52 mm) solid plastic bodies and heavy duty  $\frac{1}{2}$ -inch-thick (12.7 mm) doors. Typically the “solid plastic” used is either high-density polyethylene or polypropylene. Polypropylene, as discussed in the commentary to Section 803.9, is a thermoplastic that gives off considerable energy and produces a pooling flammable liquid fire when it burns.

### Bibliography

The following resource material was used in the preparation of the commentary for this chapter of the code:

DeLauter, L., J. Lee, G. Roadarmel and D.W. Stroup. “Scotch Pine Christmas Tree Fire Tests.” FR4010. Gaithersburg, MD: National Institute of Standards and Technology, US Department of Commerce, 1999.



# Chapter 9: Fire Protection Systems

## General Comments

The requirements of Chapter 9 are just one aspect of the overall fire protection system of a building or structure. All fire protection requirements contained in the code must be considered as a package or overall system. Noncompliance with any part of the overall system may cause other parts of the system to fail, which may result in an increased loss of life and property from the reduced level of protection.

Every effort must be made to verify the proper design and installation of a given fire protection system, especially those that result in construction alternatives and other code trade-offs.

The requirements in Chapter 9 are active fire safety provisions. They are directed at containing and extinguishing a fire once it has erupted. This chapter parallels and duplicates much of Chapter 9 in the *International Building Code*® (IBC®). The code, however, contains additional specific provisions that are applicable only to existing buildings. It also contains periodic testing criteria that are not duplicated in the IBC. Proper testing, inspection and maintenance of the various systems are critical to establish the reliability of the system. Additionally,

Chapter 9 references and adopts numerous National Fire Protection Association (NFPA) standards, including the acceptance testing criteria within the standard. The referenced standards will also contain more specific design and installation criteria than are found in this chapter. As noted in Section 102.7, where differences occur between code requirements and the referenced standard, the code provisions apply.

## Purpose

Fire protection systems may serve one or more purposes in providing adequate protection from fire. Chapter 9 prescribes the minimum requirements for an active system or systems of fire protection to perform the following functions: detecting a fire; alerting the occupants or fire department of a fire emergency; controlling smoke and controlling or extinguishing the fire. Generally, the requirements are based on the occupancy, the height and the area of the building, because these are the factors that most affect fire-fighting capabilities and the relative hazard of a specific space or area.

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## SECTION 901 GENERAL

**901.1 Scope.** The provisions of this chapter shall specify where *fire protection systems* are required and shall apply to the design, installation, inspection, operation, testing and maintenance of all *fire protection systems*.

❖ Chapter 9 contains requirements for fire protection systems that may be installed or located in a building. These include automatic suppression systems; stand-pipe systems; fire alarm and detection systems; smoke control systems; smoke and heat vents and portable fire extinguishers. Besides indicating the conditions under which respective systems are required, this chapter contains the design, installation, maintenance, testing and operational criteria for fire protection systems. While the code requires proper maintenance for the reliability of the systems, the actual maintenance provisions (periodic testing, inspections and maintenance) may be contained in one of the referenced standards.

Chapter 9 is intended to apply to buildings of new construction or when deemed applicable because of a change in occupancy or an addition, unless specifically indicated to be applicable to existing buildings only.

The scoping provisions in Chapter 1 should be consulted for determining the proper requirements for additions, alterations and remodelings.

This chapter also addresses the requirements for fire command centers, fire department connections, fire pumps and emergency radio systems. These features all directly relate to the proper function of fire protection systems.

**901.2 Construction documents.** The *fire code official* shall have the authority to require *construction documents* and calculations for all *fire protection systems* and to require permits be issued for the installation, rehabilitation or modification of any *fire protection system*. *Construction documents* for *fire protection systems* shall be submitted for review and approval prior to system installation.

❖ The construction documents and related calculations for all fire protection systems must be reviewed before a permit is issued. The review is performed to determine compliance with the code requirements and the applicable provisions in the referenced standards.

Typical shop drawings for fire protection systems are usually not prepared during the initial submittal for a construction permit. Many jurisdictions require a separate submittal and issue a separate permit to the con-

tractor installing the system (see Section 901.3). Factors, such as classification of the hazard, amount of agent or water supply available and the design criteria, including the density or concentration to be achieved by the system, are to be included with the shop drawings. Specific equipment data sheets identifying sprinklers, pipe dimensions, power requirements for smoke detectors, etc., must also be included with the submittal in addition to any required calculations. See also the commentary to Section 907.1.1 regarding fire alarm system construction documents and Section 907.1.2 regarding fire alarm system shop drawings.

**901.2.1 Statement of compliance.** Before requesting final approval of the installation, where required by the *fire code official*, the installing contractor shall furnish a written statement to the *fire code official* that the subject *fire protection system* has been installed in accordance with *approved* plans and has been tested in accordance with the manufacturer's specifications and the appropriate installation standard. Any deviations from the design standards shall be noted and copies of the approvals for such deviations shall be attached to the written statement.

❖ A certificate or other approved written statement must be submitted to the fire code official with the proper documentation from the installing contractor specifying that the fire protection system has been installed in accordance with the requirements of the code. The certificate should also indicate that all required inspections and tests of the system have been conducted at the time of application for a certificate of occupancy.

The written statement is to indicate that the system has been installed in accordance with code requirements. As previously stated, contractors may have certificates that specify the criteria of the referenced standards since many of them contain sample certificates. While such certificates may be used, the contractor is required to certify that the system complies with the provisions of the code, which in some instances may vary from the referenced standards. These variations and any other variations involved in the installation, whether by change order, variance or field condition, must also be included with the written statement.

**901.3 Permits.** Permits shall be required as set forth in Sections 105.6 and 105.7.

❖ Section 105 requires permits of two separate but related types. Section 105.6 requires an operational permit. These permits are required to conduct certain types of businesses or hazardous operations that require a higher level of scrutiny from the fire code official. The second type of permit, required by Section 105.7, is the construction permit, which is required for the installation and modification of all fire protection systems.

**901.4 Installation.** *Fire protection systems* shall be maintained in accordance with the original installation standards for that system. Required systems shall be extended, altered or augmented as necessary to maintain and continue protection where the building is altered, remodeled or added to. *Alterations to fire protection systems* shall be done in accordance with applicable standards.

❖ This section emphasizes that systems installed and maintained in compliance with the codes and standards in effect at the time they were placed in service must remain operational at all times. It is not the intent of the code to require existing systems that are otherwise not being altered to comply with current code and standard requirements. An existing system, even if it does not meet current standards, is allowed to continue in service as long as it continues to provide no less quality in service than what was originally in place. Hence, if an alteration or expansion of the system is proposed, the key is whether or not the level of protection afforded by the system is the same or greater than what it was before the alteration or expansion was considered. Any added sections of the system must meet the requirements for new fire protection according to the system involved.

**901.4.1 Required fire protection systems.** *Fire protection systems* required by this code or the *International Building Code* shall be installed, repaired, operated, tested and maintained in accordance with this code. A *fire protection system* for which a design option, exception or reduction to the provisions of this code or the *International Building Code* has been granted shall be considered to be a required system.

❖ Fire protection systems that are required by Chapter 9 or by another section of either the IBC or the code must be considered as required systems. The fire protection system is an integral component of the protection features of the building and must be properly installed, repaired, operated, tested and maintained in accordance with the code. Improperly installed or maintained systems can fail to provide the anticipated protection and, in some cases, create a hazard in itself.

Although the code may not require a fire protection system for a specific building or portion of a building because of its occupancy, the fire protection system would still be considered a required system if some other code alternative, exception or reduction was taken based on the installation of that fire protection system. For example, a typical small office building may not require an automatic sprinkler system solely because of its Group B occupancy classification. However, if an exit access corridor fire-resistance-rating reduction is taken as allowed by Table 1020.1 for buildings equipped throughout with an NFPA 13 sprinkler system, that sprinkler system is now considered a required system. Code trade-offs, exceptions, reductions or other design options are not unique to the IBC. Such tradeoffs occur more than 60 times in the code.

**901.4.2 Nonrequired fire protection systems.** A *fire protection system* or portion thereof not required by this code or the *International Building Code* shall be allowed to be furnished for partial or complete protection provided such installed system meets the applicable requirements of this code and the *International Building Code*.

❖ A building owner or designer may elect to install a fire protection system that is not required in the code. Even though such a system is not required, it must comply with the applicable requirements of Chapter 9. This requirement is based on the concept that any fire protection system not installed as required by the code is lacking because it could give a false impression of properly installed protection.

For example, if a building owner chooses to install sprinkler protection in a certain area and that protection is not required by any provisions of the code, the system must be installed in accordance with NFPA 13 or 13R, as applicable and other applicable requirements of the code, such as water supply and supervision. The extent of the protection provided would not be regulated. Once the system is installed, it is subject to the same code requirements for maintenance and testing with which any other system would be required to comply.

If the optional sprinkler system is intended to be used to provide alternatives found elsewhere in the code, the system would cease to be voluntary. In such a case, it becomes a required system and subject to Section 901.4.1.

**901.4.3 Fire areas.** Where buildings, or portions thereof, are divided into *fire areas* so as not to exceed the limits established for requiring a *fire protection system* in accordance with this chapter, such *fire areas* shall be separated by *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both, having a fire-resistance rating of not less than that determined in accordance with Section 707.3.10 of the *International Building Code*.

❖ This section provides specific guidance on how a building needs to be divided into fire areas in order to avoid requiring a fire protection system to be installed. A single occupancy group would require fire barriers or horizontal assemblies in order to create multiple fire areas (see Table 707.3.10 of the IBC), each having an area below the threshold for fire protection system installation.

**901.4.4 Additional fire protection systems.** In occupancies of a hazardous nature, where special hazards exist in addition to the normal hazards of the occupancy, or where the *fire code official* determines that access for fire apparatus is unduly difficult, the *fire code official* shall have the authority to require additional safeguards. Such safeguards include, but shall not be limited to, the following: automatic fire detection systems, fire alarm systems, automatic fire-extinguishing systems, standpipe systems, or portable or fixed extinguishers. Fire protection equipment required under this section shall be

installed in accordance with this code and the applicable referenced standards.

❖ This section allows the fire code official to require fire protection safeguards beyond the minimum requirement of Chapter 9 when warranted by potential unsafe conditions. The provisions of the code cannot anticipate every occupancy condition. Hazardous material occupancies or buildings with limited fire department access are potentially a greater hazard to both building occupants and fire fighters. Any additional safeguards should be those needed to abate potential hazards. This section does not give the fire code official the right to require additional systems without cause. If the condition is adequately addressed by the code, then additional safeguards are not warranted. Should additional safeguards be deemed necessary, then the fire protection components regulated by this section must be considered required systems.

**901.4.5 Appearance of equipment.** Any device that has the physical appearance of life safety or fire protection equipment but that does not perform that life safety or fire protection function shall be prohibited.

❖ All required or provided life safety or fire protection-related equipment must be continued in use and be maintained to meet the requirements in effect at the time of the original installation. Nonrequired equipment that has been taken out of service or cannot function as intended must be dismantled and removed to prevent creating a false impression of protection.

Simply because a nonrequired system does not meet the current standards is neither cause to require its removal (see Section 901.4), nor a reason to require the system to be upgraded. As long as the system is maintained in the manner in which it was intended when installed, it can be allowed to continue.

**901.4.6 Pump and riser room size.** Where provided, fire pump rooms and *automatic sprinkler system* riser rooms shall be designed with adequate space for all equipment necessary for the installation, as defined by the manufacturer, with sufficient working space around the stationary equipment. Clearances around equipment to elements of permanent construction, including other installed equipment and appliances, shall be sufficient to allow inspection, service, repair or replacement without removing such elements of permanent construction or disabling the function of a required fire-resistance-rated assembly. Fire pump and *automatic sprinkler system* riser rooms shall be provided with a door(s) and an unobstructed passageway large enough to allow removal of the largest piece of equipment.

❖ Section 901.4.6 establishes that, where a pump or riser room is necessary, the rooms housing fire protection system risers or fire pumps and their components have adequate space to facilitate their maintenance. This section does not require the construction of a room to house fire protection systems;

however, if a room is provided, this section requires that it be adequately sized to allow for maintenance.

Instead of prescribing arbitrary dimensions, this provision bases the room area on clearances specified by the equipment manufacturers to ensure adequate space is available for its installation or removal. The design must provide enough area so that walls, finish materials and doors are not required to be removed during maintenance activities. The provision also prescribes that the size of the door serving a riser or pump room is of a size to accommodate the removal of the largest piece of equipment.

Given that the design of fire protection systems generally commences during the period that building construction drawings and specifications are being reviewed by the jurisdiction, it will be especially important for the building's designer to establish dialogue with the fire protection system contractor early in the design process to ensure that the room and at least one door can accommodate the largest equipment and provide the space needed for maintenance.

**901.5 Installation acceptance testing.** Fire detection and alarm systems, fire-extinguishing systems, fire hydrant systems, fire standpipe systems, fire pump systems, private fire service mains and all other *fire protection systems* and appurtenances thereto shall be subject to acceptance tests as contained in the installation standards and as *approved* by the *fire code official*. The *fire code official* shall be notified before any required acceptance testing.

- ❖ Fire protection systems must pass an acceptance test to determine that the system will operate as required by the code. Acceptance tests are usually part of the final inspection procedures. The referenced standards contain specific acceptance test procedures. In most instances, the acceptance test procedures require 100-percent operation of the testable system components to determine that they are operational and functioning as required. Often, the design professional may require additional testing that may be beyond the code requirements to verify that the system operates as designed. The design professional may also establish the appropriate testing criteria for special systems, such as smoke control systems. These proposed testing protocols, where not addressed elsewhere in the code, must be approved by the fire code official before being performed.

The inclusion of the requirement for acceptance tests in the code is not intended to assign responsibility for witnessing the tests. The responsibility to witness the acceptance test is an administrative issue that each municipality must address. Because the acceptance test is critical during design and construction and is a requirement of occupancy, the requirement is located in the code. The section also clarifies that it is the owner's responsibility to conduct the test and the role of the fire code official to witness the test. Typically, the owner will assign the responsibility of conducting the test to the installing contractor.

**901.5.1 Occupancy.** It shall be unlawful to occupy any portion of a building or structure until the required fire detection, alarm and suppression systems have been tested and *approved*.

- ❖ Partial occupancy of any structure must not be permitted unless all fire protection systems for the occupied areas have been tested and approved. Even so, the code assumes that full protection for all areas will be provided as quickly as possible. The installation of many fire protection systems and the associated code alternatives permitted for a given occupancy assume complete building protection and not just in the occupied areas. All partial occupancy conditions are subject to the final approval of the building official. Section 105.3.4 allows the fire code official to issue conditional occupancy permits.

If the building becomes vacant, this section would be applicable again. Here, occupancy is based on a certificate of occupancy. If the vacancy is in a tenant space of an otherwise fully protected building, then the fire protection system must be continued. The other tenants of the building are subject to the necessary continuation of the fire protection system. This is similar to partial occupancy. On the other hand, if a building is vacated completely and the certificate of occupancy is forfeited, then the entire building can be considered as unoccupied, and the fire protection systems can be discontinued. At such time, utilities can be disconnected and the building be declared nonhabitable. This option carries with it the burden of reuse because if the vacant, nonhabitable building is intended to be used again, it is subject to provisions in the IBC that would require the building to be certified as a new structure and may involve significant modifications in order to receive a new certificate of occupancy.

Often, insurance companies will require that automatic sprinkler systems be kept in operation during a vacancy. If such is the case, utilities will likely need to be kept in place in order to keep the system within operating temperature requirements. Buildings in which occupancy is discontinued for an extended period of time may be considered hazardous and require action to remediate the problem, possibly by demolition.

If the system being installed is a nonrequired system, then this section is not applicable and partial occupancy can be granted.

**901.6 Inspection, testing and maintenance.** Fire detection, alarm, and extinguishing systems, mechanical smoke exhaust systems, and smoke and heat vents shall be maintained in an operative condition at all times, and shall be replaced or repaired where defective. Nonrequired *fire protection systems* and equipment shall be inspected, tested and maintained or removed.

- ❖ Adequate maintenance, inspection and periodic testing of all fire protection systems, equipment and devices including equipment and systems related to mechanical smoke exhaust and smoke and heat

vents is necessary so that the systems are ready to perform their intended functions should fire occur.

An inspection consists of a visual check of a system or device to verify that it is in operating condition and free from defects or damage. Indicating valves, gauges and indicator lamps are a few of the features required by the codes to facilitate this activity. Obvious damage and the general condition of the system, particularly the presence of corrosion, both external and internal, must always be noted and recorded. Partially because they are less detailed, inspections are conducted more frequently than tests and maintenance. Because special knowledge and tools are not required, inspections may be performed by any reasonably competent person.

Periodic tests following standardized methods are intended to confirm the results of inspections, determine that all components function properly and that systems meet their original design specifications. Tools, devices or equipment are usually required for these tests.

Because tests are more detailed than inspections, they are usually conducted only once or twice per year in most cases. Some tests, however, may be required as frequently as bimonthly or quarterly (for example, some fire alarm system equipment) or as infrequently as 5-, 6- or 12-year intervals (for example, portable fire-extinguisher hydrostatic tests). Since specialized knowledge and equipment are required, testing is usually done by technicians or specialists trained in the proper conduct of the test methods involved.

Periodic maintenance keeps systems in good working order and may be used to repair damage or defects discovered during inspections or testing. Specialized tools and training are required to perform maintenance. Only properly trained technicians or specialists should perform required periodic maintenance. Most maintenance is required only as needed, but many manufacturers suggest or require regular periodic replacement of parts subject to wear or abuse.

Nonrequired fire protection systems, where installed, require the same level of maintenance as required systems. If required maintenance is not being done, there is no way to determine if the system will function as intended. Therefore, inadequately maintained, nonrequired systems must be removed to avoid creating a false impression of adequate protection.

**901.6.1 Standards.** *Fire protection systems* shall be inspected, tested and maintained in accordance with the referenced standards *listed* in Table 901.6.1.

- ❖ Specific requirements related to inspection practices, testing schedules and maintenance procedures are dependent on the type of fire protection system and its corresponding referenced NFPA standard as indicated in Table 901.6.1.

**TABLE 901.6.1  
FIRE PROTECTION SYSTEM MAINTENANCE STANDARDS**

SYSTEM	STANDARD
Portable fire extinguishers	NFPA 10
Carbon dioxide fire-extinguishing system	NFPA 12
Halon 1301 fire-extinguishing systems	NFPA 12A
Dry-chemical extinguishing systems	NFPA 17
Wet-chemical extinguishing systems	NFPA 17A
Water-based fire protection systems	NFPA 25
Fire alarm systems	NFPA 72
Smoke and heat vents	NFPA 204
Water-mist systems	NFPA 750
Clean-agent extinguishing systems	NFPA 2001

- ❖ This table lists the NFPA referenced standards to be used for the inspection, testing and maintenance criteria for various fire protection systems. Many of the testing and maintenance requirements are included elsewhere in Chapter 9 of the code.

**901.6.2 Records.** Records of all system inspections, tests and maintenance required by the referenced standards shall be maintained.

- ❖ Accurate, up-to-date records are required to document the history of system inspection, testing and maintenance. Record keeping is not intended simply to prove to the fire code official that required inspection, testing and maintenance are being performed, but to assist the owner or his or her agent in performing these functions. A well-kept log helps an owner or technician determine how the system is performing over time and how changes inside and outside of the protected premises are affecting system performance. For example, automatic sprinkler system main drain test results may indicate whether the public water supply is being degraded by development, thereby impairing sprinkler system capabilities. Similarly, a history of accidental alarms at a specific smoke detector may indicate that the device requires cleaning or maintenance.

**901.6.2.1 Records information.** Initial records shall include the name of the installation contractor, type of components installed, manufacturer of the components, location and number of components installed per floor. Records shall also include the manufacturers' operation and maintenance instruction manuals. Such records shall be maintained for the life of the installation.

- ❖ When the fire protection systems are first installed, an accurate inventory must be compiled so that future owners and officials can refer back to the documents for maintenance and operational requirements. Additionally, if a recall is required, the installation inventory will be able to identify if any of the components subject to the recall are installed. By including the installation contractor's information in the list, a resolution of any legal aspects of defective components

can be more readily obtained. Also, if operations or maintenance change during the life of the installation and a public notice is provided, the building owner will have the information necessary to know and apply the new requirements. The requirement to collect and maintain this information is already within many of the standards referenced in the code. This requirement gives the fire code official enforcement language and assists the building owner in understanding the responsibilities associated with having these fire protection systems installed in the building.

**901.7 Systems out of service.** Where a required *fire protection system* is out of service, the fire department and the *fire code official* shall be notified immediately and, where required by the *fire code official*, the building shall be either evacuated or an *approved* fire watch shall be provided for all occupants left unprotected by the shutdown until the *fire protection system* has been returned to service.

Where utilized, fire watches shall be provided with not less than one *approved* means for notification of the fire department and their only duty shall be to perform constant patrols of the protected premises and keep watch for fires.

❖ The protection afforded by a required fire protection system must not be diminished in any existing building except for the purpose of conducting tests, maintenance or repairs. The length of service interruptions must be kept to a minimum. The fire department and the fire code official must be notified of any service interruptions. They must carefully evaluate the continued operation or occupancy of buildings and structures where protection is interrupted. Whenever possible, all unaffected portions of the system should be kept in service. Until protection is restored, hazardous processes or operations should be suspended and alternative special protection should be considered in addition to an approved fire watch.

The code text only addresses when a required system is placed out of service. However, if a system is in place, even though it is not required by the code or the IBC, it would be an appropriate courtesy to inform the fire department of any fire protection system being discontinued or temporarily taken out of service. If the nonrequired system is to be placed out of service for an extended period of time, the fire code official has the authority to address the condition under Section 901.4.5 and require that the system be either placed back into operation or removed so as not to create a false impression of protection.

**901.7.1 Impairment coordinator.** The building *owner* shall assign an impairment coordinator to comply with the requirements of this section. In the absence of a specific designee, the *owner* shall be considered the impairment coordinator.

❖ The impairment coordinator is the person responsible for maintaining the building fire protection systems. The impairment coordinator may be the building owner or other designee, such as the plant manager or building engineer, if he or she is trained to comply with the provisions of Section 901.7.

**901.7.2 Tag required.** A tag shall be used to indicate that a system, or portion thereof, has been removed from service.

❖ When any fire protection system is taken out of service, it must be clearly identified with a visible tag that indicates the conditions of the impairment and who to notify. The tag is intended to alert building occupants and fire department personnel that the system in question is impaired. It must remain visibly in place until full protection is restored.

**901.7.3 Placement of tag.** The tag shall be posted at each fire department connection, system control valve, fire alarm control unit, fire alarm annunciator and *fire command center*, indicating which system, or part thereof, has been removed from service. The *fire code official* shall specify where the tag is to be placed.

❖ This section specifies some of the impaired locations where a tag must be used. Tagging a fire department connection, for example, is intended to alert the responding fire department that a normal operating condition does not exist for the portion of the system beyond the connection. While it is also important to tag system control valves, an impairment tag in the sprinkler riser room may not get noticed until accessed by fire department personnel. The final location of all impairment tags is subject to the approval of the fire code official.

**901.7.4 Preplanned impairment programs.** Preplanned impairments shall be authorized by the impairment coordinator. Before authorization is given, a designated individual shall be responsible for verifying that all of the following procedures have been implemented:

1. The extent and expected duration of the impairment have been determined.
2. The areas or buildings involved have been inspected and the increased risks determined.
3. Recommendations have been submitted to management or the building *owner/manager*.
4. The fire department has been notified.
5. The insurance carrier, the alarm company, the building *owner/manager* and other authorities having jurisdiction have been notified.
6. The supervisors in the areas to be affected have been notified.
7. A tag impairment system has been implemented.
8. Necessary tools and materials have been assembled on the impairment site.

❖ This section specifies the procedures that must be followed in a thorough preplanned impairment program. These procedures must be followed whenever systems are purposely impaired, such as for routine sprinkler system alarm testing. Proper notification of responsible parties eliminates the chance of false alarms, reduces disruption of normal business activities and encourages quick resumption of normal operations.

**901.7.5 Emergency impairments.** Where unplanned impairments occur, appropriate emergency action shall be taken to minimize potential injury and damage. The impairment coordinator shall implement the steps outlined in Section 901.7.4.

❖ Unplanned impairments, of course, go beyond typical testing and maintenance procedures but are also not necessarily indicative of a fire event. For example, an unplanned emergency impairment might occur if a sprinkler head or pipe was found leaking or was accidentally impacted by a fork-lift truck. To reduce water damage and to repair the sprinkler system, the valve controlling the water supply to the affected area would need to be closed, thereby impairing protection to the area protected by that portion of the sprinkler system. The impairment coordinator must follow the procedures in Section 901.7.4 to restore protection in minimum time.

**901.7.6 Restoring systems to service.** When impaired equipment is restored to normal working order, the impairment coordinator shall verify that all of the following procedures have been implemented:

1. Necessary inspections and tests have been conducted to verify that affected systems are operational.
2. Supervisors have been advised that protection is restored.
3. The fire department has been advised that protection is restored.
4. The building *owner*/manager, insurance carrier, alarm company and other involved parties have been advised that protection is restored.
5. The impairment tag has been removed.

❖ Regardless of whether a system is taken out of service for either a planned impairment or for an emergency, this section specifies the procedures to follow when restoring a system to service. By following these procedures, all responsible parties who were informed of the initial impairment will also be made aware that the system is now fully operational. Restoring the system to service assumes the affected part of the system has been corrected and is in proper working condition.

**901.8 Removal of or tampering with equipment.** It shall be unlawful for any person to remove, tamper with or otherwise disturb any fire hydrant, fire detection and alarm system, fire suppression system or other fire appliance required by this code except for the purpose of extinguishing fire, training purposes, recharging or making necessary repairs or where *approved by the fire code official*.

❖ Tampering or otherwise unauthorized altering of any fire protection system or component is illegal. A person who unlawfully tampers with equipment could face potential criminal charges. Tampering could include intentionally pulling a manual fire alarm box when no emergency exists, playing with matches to set off a smoke detector or flowing a city fire hydrant. The use of fire protection systems, equipment and

other fire appliances is limited to those people authorized to conduct repairs and maintenance unless approved by the fire code official.

**901.8.1 Removal of or tampering with appurtenances.** Locks, gates, doors, barricades, chains, enclosures, signs, tags or seals that have been installed by or at the direction of the *fire code official* shall not be removed, unlocked, destroyed, tampered with or otherwise vandalized in any manner.

❖ Tampering with or vandalizing appurtenances that are in place to prevent tampering with the system components is also prohibited. For example, sprinkler system control valves are routinely chained and locked in the open position in addition to being equipped with electronically monitored tamper switches. Gates at fire apparatus roads, authorized by Section 503.6 of the code, must not have the locks changed or operation altered unless approved by the fire code official. Any unauthorized removal or tampering with these types of devices is strictly prohibited.

**901.8.2 Removal of existing occupant-use hose lines.** The *fire code official* is authorized to permit the removal of existing occupant-use hose lines where all of the following conditions exist:

1. Installation is not required by this code or the *International Building Code*.
2. The hose line would not be utilized by trained personnel or the fire department.
3. The remaining outlets are compatible with local fire department fittings.

❖ The current code and the IBC do not require occupant-use hoses in as many locations as were required in previous editions of the codes and referenced standards. There also has been a shift in the philosophy of fire service leaders as to whether occupants should attempt to extinguish the fire via occupant-use hose stations or evacuate the structure. Most of the population is now being taught to evacuate the building, not to fight the fire. This shift is mainly due to the safety risk of having an untrained person attempting to fight a fire with more than a fire extinguisher. Another consideration was the ongoing cost to building owners to comply with maintenance and testing requirements for the hoses and their racks. Many jurisdictions have enacted local legislation or code changes to address this issue, and the addition of this new section updates the code to reflect conventional wisdom on this topic. This section provides safeguards in the form of several conditions for the fire code official to consider in formulating an approval for removal of occupant-use hoses. The first condition makes common sense where a new building of the same characteristics would not be required to have hose stations installed. The second condition assumes that there is not a trained fire brigade on the premises that might be qualified to use the hose stations as first responders

in, for example, an industrial setting. Condition 2 also recognizes that fire departments typically will not use private hose stations for fire attack due to the questionable quality of their maintenance. Condition 3 was included to ensure that any outlets that remain are useable by the fire department by requiring that their threads be compatible with local fire department fire hose fittings, such as American National Fire Hose Connection Screw Thread (NH).

**901.9 Termination of monitoring service.** For fire alarm systems required to be monitored by this code, notice shall be made to the *fire code official* whenever alarm monitoring services are terminated. Notice shall be made in writing, to the *fire code official* by the monitoring service provider being terminated.

❖ This section requires the monitoring service itself to notify the fire code official of service being terminated. Although the ultimate responsibility rests with the building owner, he or she is not cited in this section since if they discontinued the service, they would likely not understand the implications, and if they did would have no incentive to contact the fire code official.

**901.10 Recall of fire protection components.** Any *fire protection system* component regulated by this code that is the subject of a voluntary or mandatory recall under federal law shall be replaced with *approved, listed* components in compliance with the referenced standards of this code. The *fire code official* shall be notified in writing by the building owner when the recalled component parts have been replaced.

❖ This section provides the fire code official with a valuable tool for monitoring recalls. Under this provision, a code section can be cited that will allow the fire code official to enforce the provisions of the recall on systems within the jurisdiction. Product listings and compliance with reference standards are paramount in the effectiveness of fire protection systems. Companies may be under an agreement with federal agencies to “voluntarily” recall certain components or face legal action. While this is technically voluntary, it in no way reduces the need for the recall. To the extent that the company’s livelihood depends on the recall being performed properly, the action is not voluntary. This section allows the fire code official to compel the building owner to comply with the recall and replace the component with one that is not subject to suspicion.

**SECTION 902  
DEFINITIONS**

**902.1 Definitions.** The following terms are defined in Chapter 2:

- ALARM NOTIFICATION APPLIANCE.**
- ALARM SIGNAL.**
- ALARM VERIFICATION FEATURE.**

- ANNUNCIATOR.**
- AUDIBLE ALARM NOTIFICATION APPLIANCE.**
- AUTOMATIC.**
- AUTOMATIC FIRE-EXTINGUISHING SYSTEM.**
- AUTOMATIC SMOKE DETECTION SYSTEM.**
- AUTOMATIC SPRINKLER SYSTEM.**
- AUTOMATIC WATER MIST SYSTEM.**
- AVERAGE AMBIENT SOUND LEVEL.**
- CARBON DIOXIDE EXTINGUISHING SYSTEM.**
- CLEAN AGENT.**
- COMMERCIAL MOTOR VEHICLE.**
- CONSTANTLY ATTENDED LOCATION.**
- DELUGE SYSTEM.**
- DETECTOR, HEAT.**
- DRY-CHEMICAL EXTINGUISHING AGENT.**
- ELEVATOR GROUP.**
- EMERGENCY ALARM SYSTEM.**
- EMERGENCY VOICE/ALARM COMMUNICATIONS.**
- FIRE ALARM BOX, MANUAL.**
- FIRE ALARM CONTROL UNIT.**
- FIRE ALARM SIGNAL.**
- FIRE ALARM SYSTEM.**
- FIRE AREA.**
- FIRE DETECTOR, AUTOMATIC.**
- FIRE PROTECTION SYSTEM.**
- FIRE SAFETY FUNCTIONS.**
- FIXED BASE OPERATOR (FBO).**
- FOAM-EXTINGUISHING SYSTEM.**
- HALOGENATED EXTINGUISHING SYSTEM.**
- IMPAIRMENT COORDINATOR.**
- INITIATING DEVICE.**
- MANUAL FIRE ALARM BOX.**
- MULTIPLE-STATION ALARM DEVICE.**
- MULTIPLE-STATION SMOKE ALARM.**
- NOTIFICATION ZONE.**
- NUISANCE ALARM.**
- PRIVATE GARAGE.**
- RECORD DRAWINGS.**
- SINGLE-STATION SMOKE ALARM.**
- SLEEPING UNIT.**
- SMOKE ALARM.**
- SMOKE DETECTOR.**
- STANDPIPE SYSTEM, CLASSES OF.**  
Class I system.

Class II system.

Class III system.

**STANDPIPE, TYPES OF.**

Automatic dry.

Automatic wet.

Manual dry.

Manual wet.

Semiautomatic dry.

**SUPERVISING STATION.**

**SUPERVISORY SERVICE.**

**SUPERVISORY SIGNAL.**

**SUPERVISORY SIGNAL-INITIATING DEVICE.**

**TIRES, BULK STORAGE OF.**

**TRANSIENT AIRCRAFT.**

**TROUBLE SIGNAL.**

**VISIBLE ALARM NOTIFICATION APPLIANCE.**

**WET-CHEMICAL EXTINGUISHING AGENT.**

**WIRELESS PROTECTION SYSTEM.**

**ZONE.**

**ZONE, NOTIFICATION.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2, in another *International Code*<sup>®</sup> as indicated in Section 201.3 or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

Certain requirements in the code are based on code provisions in the IBC, *International Mechanical Code*<sup>®</sup> (IMC<sup>®</sup>) and *International Plumbing Code*<sup>®</sup> (IPC<sup>®</sup>). A review of definitions included in those codes will aid in the understanding of many of the requirements contained in the code.

## **SECTION 903 AUTOMATIC SPRINKLER SYSTEMS**

**903.1 General.** *Automatic sprinkler systems* shall comply with this section.

❖ This section identifies the conditions requiring an automatic sprinkler system for all occupancies. The need for an automatic sprinkler system may depend on not only the occupancy but also the occupant load, fuel load, height and area of the building as well as fire-fighting capabilities. Section 903.2 addresses all occupancy conditions requiring an automatic sprinkler system. Section 903.3 contains the installation requirements for all sprinkler systems in addition to the requirements of NFPA 13, NFPA 13R and NFPA 13D. The supervision and alarm requirements for sprinkler systems are contained in Section 903.4,

whereas Section 903.5 refers to testing and maintenance requirements for sprinkler systems found in Section 901 and NFPA 25. Section 903.6 addresses existing buildings and references Chapter 11.

Unless specifically allowed by the code or the IBC, residential sprinkler systems installed in accordance with NFPA 13R or NFPA 13D are not recognized for reductions or exceptions permitted by other sections of this code or the IBC. NFPA 13 systems provide the level of protection associated with adequate fire suppression for all occupancies. NFPA 13R and NFPA 13D systems are intended more to provide adequate time for egress but not necessarily for complete suppression of the fire. Commentary Figure 903.2 lists examples of where the various sprinkler thresholds differ in application.

The area values contained in this section are intended to apply to fire areas, which are comprised of all floor areas bounded by fire barriers, fire walls or exterior walls. The minimum required fire-resistance rating of fire barrier assemblies that define a fire area is specified in Table 707.3.10 of the IBC. Because the areas are defined as fire areas, fire barriers, horizontal assemblies, fire walls or exterior walls are the only acceptable means of subdividing a building into smaller areas instead of installing an automatic sprinkler system. Whereas fire barriers and exterior walls define multiple fire areas within a single building, a fire wall defines separate buildings within one structure. Also note that some of the threshold limitations result in a requirement to install an automatic sprinkler system throughout the building while others may require only specific fire areas to be sprinklered.

Another important point is that one fire area may include floor areas in more than one story of a building (see the commentary to the definition of "Fire area" in Section 202).

The application of mixed occupancies and fire areas must be carefully researched. Often the required separation between occupancies for the purposes of applying the separated mixed-use option in Section 508.4 of the IBC will result in a separation that is less than what is required to define the boundaries of a fire area. It is possible to have two different occupancies within a given fire area, treated as separated uses but with code requirements applicable to both occupancies since they are not separated by the rating required for fire areas.

**903.1.1 Alternative protection.** Alternative automatic fire-extinguishing systems complying with Section 904 shall be permitted instead of automatic sprinkler protection where recognized by the applicable standard and *approved* by the *fire code official*.

❖ This section permits the use of an alternative automatic fire-extinguishing system when approved by the fire code official as a means of compliance with the occupancy requirements of Section 903. Although the use of an alternative extinguishing system allowed by Section 904, such as a carbon dioxide

system or clean-agent system, would satisfy the requirements of Section 903.2, it would not be considered an acceptable alternative for the purposes of exceptions, reductions or other code alternatives that would be applicable if an automatic sprinkler system were installed.

**903.2 Where required.** *Approved automatic sprinkler systems* in new buildings and structures shall be provided in the locations described in Sections 903.2.1 through 903.2.12.

**Exception:** Spaces or areas in telecommunications buildings used exclusively for telecommunications equipment, associated electrical power distribution equipment, batteries and standby engines, provided those spaces or areas are equipped throughout with an automatic smoke detection system in accordance with Section 907.2 and are separated from the remainder of the building by not less than 1-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or not less than 2-hour *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.

❖ Sections 903.2.1 through 903.2.12 identify the conditions requiring an automatic sprinkler system (see Commentary Figure 903.2). The type of sprinkler system must be one that is permitted for the specific occupancy condition. An NFPA 13R sprinkler system, for example, may not be installed to satisfy the sprinkler threshold requirements for a mercantile occupancy (see Section 903.2.7). As indicated in Section 903.3.1.2, the use of an NFPA 13R sprinkler system is limited to Group R occupancies not exceeding four stories in height.

There is one exception for those spaces or areas used exclusively for telecommunications equipment. The telecommunications industry has continually stressed the need for the continuity of telephone service, and the ability to maintain this service is of prime importance. This service is a vital link between the community and the various life safety services, including fire, police and emergency medical services. The integrity of this communications service can be jeopardized not only by fire, but also by water, from whatever the source.

It must be emphasized that the exception applies only to those spaces or areas that are used exclusively for telecommunications equipment. Historically, those spaces have a low incidence of fire events. Fires in telecommunications equipment are difficult to start and, if started, grow slowly, thus permitting early detection. Such fires are typically of the smoldering type, do not spread beyond the immediate area and generally self-extinguish.

Note, however, that this exception requires fire resistive separation from other portions of the building and, most importantly, that the building cannot qualify for any code trade-offs for fully sprinklered buildings.

**903.2.1 Group A.** An *automatic sprinkler system* shall be provided throughout buildings and portions thereof used as Group A occupancies as provided in this section. For Group A-1, A-2, A-3 and A-4 occupancies, the *automatic sprinkler*

*system* shall be provided throughout the story where the *fire area* containing the Group A-1, A-2, A-3 or A-4 occupancy is located, and throughout all stories from the Group A occupancy to, and including, the *levels of exit discharge* serving the Group A occupancy. For Group A-5 occupancies, the *automatic sprinkler system* shall be provided in the spaces indicated in Section 903.2.1.5.

❖ Group A occupancies are characterized by a significant number of people who are not familiar with their surroundings. The requirement for a suppression system reflects the additional time needed for egress. The extent of protection is also intended to extend to the occupants of the assembly group from unobserved fires in other building areas located between the story containing the assembly occupancy and all levels of exit discharge serving such occupancies. The only exception to the coverage is for Group A-5 occupancies that are open to the atmosphere. Such occupancies require only certain aspects to be sprinklered, such as concession stands (see commentary, Section 903.2.1.5).

The requirement for sprinklers is based on the location and function of the space. It is not dependent on whether or not the area is provided with exterior walls. IFC Committee Interpretation No. 25-05 to this section discusses this issue and states, in part, that “where no surrounding exterior walls are provided along the perimeter of the building, the building area is used to identify and determine applicable fire area.” Outdoor areas, such as pavilions and patios, may have no walls but will have an occupant load and other factors that identify the assembly occupancy as such. If any of the thresholds are reached requiring sprinkler protection, then sprinkler protection must be provided whether there are exterior walls or not.

**903.2.1.1 Group A-1.** An *automatic sprinkler system* shall be provided for *fire areas* containing Group A-1 occupancies and intervening floors of the building where one of the following conditions exists:

1. The *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. The *fire area* has an *occupant load* of 300 or more.
3. The *fire area* is located on a floor other than a *level of exit discharge* serving such occupancies.
4. The *fire area* contains a multitheater complex.

❖ Group A-1 occupancies are identified as assembly occupancies with fixed seating, such as theaters. In addition to the high occupant load associated with these types of facilities, egress is further complicated by the possibility of low lighting levels customary during performances. The fuel load in these buildings is usually of a type and quantity that would support fairly rapid fire development and sustained duration.

Theaters with stages pose a greater hazard. Sections 410.7 and 410.8 of the IBC require stages to be equipped with an automatic sprinkler system and standpipe system, respectively. The proscenium opening must also be protected. These features com-

pensate for the additional hazards associated with stages in Group A-1 occupancies.

This section lists four conditions that require installing a suppression system in a Group A-1 occupancy. Condition 1 requires that, if any one fire area of Group A-1 exceeds 12,000 square feet (1115 m<sup>2</sup>), the automatic sprinkler system is to be installed throughout the entire story where a Group A-1 occupancy is

located, regardless of whether the building is divided into more than one fire area. However, if all the fire areas are less than 12,000 square feet (1115 m<sup>2</sup>) (and less than the other thresholds) then sprinklers would not be required. Compartmentalization into multiple fire areas in compliance with Chapter 7 of the IBC is deemed an adequate alternative to sprinkler protection.

Occupancy	Threshold	Exception
All occupancies	Buildings with floor level > 55 feet above or below fire department vehicle access and occupant load ≥ 30	Open parking structures (F-2)
Assembly (A-1, A-3, A-4)	Fire area > 12,000 sq. ft. or fire area occupant load > 300 or fire area above/below level of exit discharge Multitheater complex (A-1 only)	None
Assembly (A-2)	Fire area > 5,000 sq. ft. or fire area occupant load ≥ 100 or fire area above/below level of exit discharge	None
Assembly (A-5)	Accessory areas > 1,000 sq. ft.	None
Ambulatory care facility (B)	≥ 4 care recipients incapable of self preservation or any care recipients incapable of self preservation above or below level of exit discharge	None
Educational (E)	Fire area > 12,000 sq. ft. or below level of exit discharge	Each classroom has exterior door at grade
Factory (F-1)	Fire area > 12,000 sq. ft. or fire area located > 3 stories above grade, or combined fire area > 24,000 sq. ft.	None
Mercantile (M)	Woodworking > 2,500 sq. ft. (F-1 only) Manufacture > 2,500 sq. ft. (F1), display and sale > 5,000 sq. ft. (M), storage > 2,500 sq. ft. (S-1) of upholstered furniture or mattresses.	
Storage (S-1)	Bulk storage of tires > 20,000 cu. ft. (S-1 only)	
High-hazard (H-1, H-2, H-3, H-4, H-5)	Sprinklers required	None
Institutional (I-1, I-2, I-3, I-4)	Sprinklers required	Daycare at level of exit discharge and each classroom has exterior exit door.
Residential (R)	Sprinklers required	None
Repair garage (S-1)	Fire area > 12,000 sq. ft. or > 2 stories above grade with fire area 10,000 sq. ft. or repair garage servicing vehicles in basement or servicing commercial motor vehicles in fire area > 5,000 sq. ft.	None
Parking garage (S-1)	Commercial motor vehicles parking area > 5,000 sq. ft.	None
Parking garage (S-2)	Fire area > 12,000 sq. ft. or fire area > 5,000 sq. ft. for storage of commercial motor vehicles; or beneath other groups.	Not if beneath Group R-3
Covered and open malls (914.2.1)	Sprinklers required	Attached open parking structures
High-rises (914.3.1)	Sprinklers required	Open garages; certain telecommunications equipment buildings
Unlimited area buildings (IBC 507)	A-3, A-4, B, F, M, S: 1 story. B, F, M, S: 2 story	One story F-2 or S-2

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>.

a. Thresholds located in Section 903.2 unless noted. See also Table 903.2.11.6 for additional required suppression systems.

**Figure 903.2**  
**SUMMARY OF OCCUPANCY-RELATED AUTOMATIC SPRINKLER THRESHOLDS<sup>a</sup>**

Condition 2 establishes the minimum number of occupants for which an automatic sprinkler system is considered necessary. The determination of the actual occupant load must be based on Section 1004.

Condition 3 accounts for occupant egress delay when traversing a stairway, requiring a sprinkler system regardless of the size of occupant load. In such cases alternative emergency escape elements such as windows may not be available, making the suppression needs all the greater. It is not necessary for the occupant load to exceed 300 on a level other than the level of exit discharge serving such occupancy. Any number of Group A-1 occupants on the alternative level would be cause to apply the requirement for sprinklers. The text does not make reference to “story” but uses the term “floor,” which could include mezzanines and basements.

Condition 4 states that a sprinkler system is required for multiplex theater complexes to account for the delay associated with the notification of adjacent compartmentalized spaces where the occupants may not be immediately aware of an emergency.

Note that as with Group A-2, A-3 and A-4 occupancies, when sprinklers are required they are required throughout the story where the Group A-2 fire area is located and throughout all intervening floors leading to all levels of exit discharge serving the Group A occupancy. See Section 903.2.1.

**903.2.1.2 Group A-2.** An automatic sprinkler system shall be provided for *fire areas* containing Group A-2 occupancies and intervening floors of the building where one of the following conditions exists:

1. The *fire area* exceeds 5,000 square feet (464 m<sup>2</sup>).
  2. The *fire area* has an *occupant load* of 100 or more.
  3. The *fire area* is located on a floor other than a *level of exit discharge* serving such occupancies.
- ❖ Group A-2 assembly occupancies are intended for food or drink consumption, such as banquet halls, nightclubs and restaurants. Occupancies in Group A-2 involve life safety factors, such as a high occupant density, flexible fuel loading, movable furnishings and limited lighting; therefore, they must be protected with an automatic sprinkler system under any of the listed conditions.

In the case of an assembly use, the purpose of the automatic sprinkler system is to provide life safety from fire as well as preserving property. By requiring fire suppression in areas through which the occupants may egress, including the level of exit discharge serving such occupancies, the possibility of unobserved fire development affecting the occupant egress is minimized.

The 5,000-square-foot (464 m<sup>2</sup>) threshold for the automatic sprinkler system reflects the higher degree of life safety hazard associated with Group A-2 occupancies. As alluded to earlier, Group A-2 occupancies could have low lighting levels, loud music, late

hours of operation, dense seating with ill-defined aisles and alcoholic beverage service. These factors in combination could delay fire recognition, confuse occupant response and increase egress time.

Although the calculated occupant load for a 5,000 square-foot (465 m<sup>2</sup>) space at 15 square feet (1.4 m<sup>2</sup>) per occupant would be over 100, the occupant load threshold in Condition 2 is meant to reflect the concern for safety in these higher density occupancies. Although the major reason for establishing the occupant threshold at 100 was due to several recent nightclub incidents, the requirement is not limited to nightclubs or banquet facilities but to all Group A-2 occupancies. Any restaurant with an occupant load greater than 100 would require sprinkler protection as well. This includes fast food facilities with no low lighting or alcohol sales. The similar intent of Condition 3 is addressed in the commentary to Section 903.2.1.1.

Note that as with Group A-1 occupancies, when sprinklers are required they are required throughout the story where the Group A-2 fire area is located and throughout all intervening floors leading to all levels of exit discharge serving the Group A occupancy. See Section 903.2.1.

**903.2.1.3 Group A-3.** An automatic sprinkler system shall be provided for *fire areas* containing Group A-3 occupancies and intervening floors of the building where one of the following conditions exists:

1. The *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
  2. The *fire area* has an *occupant load* of 300 or more.
  3. The *fire area* is located on a floor other than a *level of exit discharge* serving such occupancies.
- ❖ Group A-3 occupancies are assembly occupancies intended for worship, recreation or amusement and other assembly uses not classified elsewhere in Group A, such as churches, museums and libraries. While Group A-3 occupancies could potentially have a high occupant load, they normally do not have the same potential combination of life safety hazards associated with Group A-2 occupancies. As with most assembly occupancies, however, most of the occupants are typically not completely familiar with their surroundings. When any of the three listed conditions are applicable, an automatic sprinkler system is required throughout fire area containing the Group A-3 occupancy, including the entire story where the Group A-3 occupancy is located, and throughout all floors between the Group A occupancy and all exit discharges that serve that occupancy (see commentary, Sections 903.2.1 and 903.2.1.1).

**903.2.1.4 Group A-4.** An automatic sprinkler system shall be provided for *fire areas* containing Group A-4 occupancies and intervening floors of the building where one of the following conditions exists:

1. The *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. The *fire area* has an *occupant load* of 300 or more.

3. The fire area is located on a floor other than a level of exit discharge serving such occupancies.

- ❖ Group A-4 occupancies are assembly uses intended for viewing of indoor sporting events and activities such as arenas, skating rinks and swimming pools. The occupant load density may be high depending on the extent and style of seating, such as bleachers or fixed seats, and the potential for standing-room viewing.

When any of the three listed conditions are applicable, an automatic sprinkler system is required throughout the fire area containing the Group A-4 occupancy, including the entire story where the Group A-4 occupancy is located, and throughout all floors between the Group A occupancy and all exit discharges that serve that occupancy (see commentary, Sections 903.2.1 and 903.2.1.1).

**903.2.1.5 Group A-5.** An automatic sprinkler system shall be provided for Group A-5 occupancies in the following areas: concession stands, retail areas, press boxes and other accessory use areas in excess of 1,000 square feet (93 m<sup>2</sup>).

- ❖ Group A-5 occupancies are assembly uses intended for viewing of outdoor activities. This occupancy classification could include amusement park structures, grandstands and open stadiums. A sprinkler system is not required in the open area of Group A-5 occupancies because the buildings would not accumulate smoke and hot gases. A fire in open areas would also be obvious to all spectators.

Enclosed areas such as retail areas, press boxes and concession stands require sprinklers if they are in excess of 1,000 square feet (93 m<sup>2</sup>). The 1,000-square-foot (93 m<sup>2</sup>) accessory use area is not intended to be an aggregate condition but rather per space. Thus, a press box that is 2,500 square feet (232 m<sup>2</sup>) in area would need to be subdivided into areas less than 1,000 square feet (93 m<sup>2</sup>) each in order to be below the threshold for sprinklers. There is no specific requirement for the separation of these spaces. It is assumed, however, that the separation would be a solid barrier of some type but without a required fire-resistance rating.

The provision is meant to mirror that in Section 1029.6.2.3, which exempts press boxes and storage facilities less than 1,000 square feet (93 m<sup>2</sup>) in area from sprinkler requirements in smoke-protected assembly seating areas.

**903.2.1.6 Assembly occupancies on roofs.** Where an occupied roof has an assembly occupancy with an occupant load exceeding 100 for Group A-2 and 300 for other Group A occupancies, all floors between the occupied roof and the level of exit discharge shall be equipped with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2.

**Exception:** Open parking garages of Type I or Type II construction.

- ❖ Frequently, roof tops are being used and occupied as assembly occupancies. Building owners will provide

an open air roof-top bar or lounge, or other use similar to a Group A-2 occupancy on the roof of a building. A roof does not meet the definition of a fire area. As such, protection of the occupants can be less than what would otherwise be required were the occupancy located on a floor rather than on the roof. In addition, even if a fire occurs within the building itself, it puts these occupants at risk. The provisions requiring sprinklers are based on the type and occupant load of the assembly occupancy located on the roof. The roof occupancy itself is not required to be sprinklered. The reference to Section 903.3.1.2 for NFPA 13R sprinkler systems is included since this use can occur on the roof of multifamily housing facilities.

The exception for open parking garages is consistent with the existing exception for open parking garages under Section 903.2.11.3 for "Buildings 55 feet or more in height." It is becoming more common in urban renewal areas throughout the U.S. that jurisdictions are asking developers to provide additional recreational spaces for their citizens to enjoy within their own communities. Because of the limited space available, it is not uncommon for such recreational spaces to be provided on the roofs of open parking garages. Based on the wording of this section, without the exception Group A-2 recreational spaces greater than 700 square feet in area (based on 7 square feet of area net per occupant) or other Group A occupancies greater than 1,500 square feet in area (based on 15 square feet of area net per occupant) would require the open parking garage below to be sprinklered, possibly with a dry pipe sprinkler system, that is initially a major cost to the project as well as a major on-going maintenance expense. Such an expense would most likely have an adverse effect on developers doing major city urban renewal projects by keeping them from agreeing to provide such amenities for the local jurisdiction.

Additionally, there is considerable data supporting the exception's elimination of automatic sprinkler systems in open parking garages. For example, two reports that evaluated fire behavior in parking garages are:

1. 2006 NFPA Fire Data Report, "Structure and Vehicle Fires in General Vehicle Parking Garages."
2. 2008 Parking Consultants Council Fire Safety Committee Report, "Parking Structure Fire Facts."

These reports provided the following conclusions:

- There was an average of only 660 fires per year in all types of parking garages in the U.S. This represented a mere 0.006 percent of all fires annually.
- There were no fire fatalities in open parking garages constructed of Construction Type I or II and an average of only 2 injuries per year.

- There was no structural damage in 98.7 percent of the fires in parking garages.
- Vehicle fires in parking garages typically do not spread from vehicle to vehicle. Fire spread from vehicle to vehicle occurred in only 7 percent of the incidents.

Automatic sprinkler systems are required in occupancies other than open parking garages to protect the assembly occupancy above the fire and to protect the means of egress. Based on the inherent fire safety provided by open parking garages of Type I or II construction, an automatic sprinkler system is not required when an assembly use is located on the roof.

**903.2.1.7 Multiple fire areas.** An *automatic sprinkler system* shall be provided where multiple fire areas of Group A-1, A-2, A-3 or A-4 occupancies share exit or *exit access* components and the combined *occupant load* of these fire areas is 300 or more.

- ❖ There are two conditions required to trigger the requirements of this section. The first is that exit or exit access components of Group A-1, A-2, A-3 or A-4 fire areas are shared. The second is that the combined occupant load of the fire areas that share these components exceeds 300 persons.

This section addresses the issue of multiple small assembly occupancies placed in a single story building and not triggering a sprinkler system requirement because of the installation of a rated corridor and separation walls. The code now requires that sprinkler systems be added when the convergence of more than 300 persons share an exit. This is consistent with the intent of automatic sprinkler systems being required for life safety and to maintain tenable exiting in a fire event. A fire event that is near an exit is the same whether there are 300 occupants in one room or three rooms with 100 occupants each sharing an exit. This is also consistent with the requirement in the “multitheater complex” for group A-1, which is a requirement for any time two or more theaters are in the same tenancy and does not consider occupant load as a trigger.

This will still allow those single story buildings with multiple tenancies that have separate exits and utilize the fire area separation concept; such as buildings with multiple restaurants with separate entrances and strip-style mall buildings.

**903.2.2 Ambulatory care facilities.** An *automatic sprinkler system* shall be installed throughout the entire floor containing an ambulatory care facility where either of the following conditions exist at any time:

1. Four or more care recipients are incapable of self-preservation, whether rendered incapable by staff or staff has accepted responsibility for care recipients already incapable.
2. One or more care recipients that are incapable of self-preservation are located at other than the level of exit discharge serving such a facility.

In buildings where ambulatory care is provided on levels other than the *level of exit discharge*, an *automatic sprinkler system* shall be installed throughout the entire floor where such care is provided as well as all floors below, and all floors between the level of ambulatory care and the nearest *level of exit discharge*, including the *level of exit discharge*.

- ❖ Ambulatory care facilities are Group B occupancies, which have an enhanced set of requirements that account for the fact that patients may be incapable of self-preservation and require rescue by other occupants or fire personnel. There are several aspects to the enhanced features, including smoke compartments, sprinklers and fire alarms. More specifically, the requirements for sprinklers are based on the presence of four or more care recipients at any given time that are incapable of self-preservation or any number of care recipients that are incapable of self-preservation located on a floor, other than the level of exit discharge, that serves the ambulatory care facility. The sprinkler requirement is limited to the floor area that contains the Group B ambulatory care facility and any floors between the ambulatory care facility and level of exit discharge (see commentary, Section 422 of the IBC).

**903.2.3 Group E.** An *automatic sprinkler system* shall be provided for Group E occupancies as follows:

1. Throughout all Group E *fire areas* greater than 12,000 square feet (1115 m<sup>2</sup>) in area.
2. Throughout every portion of educational buildings below the lowest *level of exit discharge* serving that portion of the building.

**Exception:** An *automatic sprinkler system* is not required in any area below the lowest *level of exit discharge* serving that area where every classroom throughout the building has not fewer than one exterior *exit door* at ground level.

- ❖ Group E occupancies are limited to educational purposes through the 12th grade and day care centers serving children older than 2½ years of age. The 12,000-square-foot (1115 m<sup>2</sup>) fire area threshold for the sprinkler system was established to allow smaller schools and day care centers to be nonsprinklered to minimize the economic impact on these facilities. The 12,000-square-foot (1115 m<sup>2</sup>) threshold is similar to that used for several other occupancies, such as Group M occupancies.

Sprinklers would also be required in portions of the building located below the level of exit discharge serving that occupancy. However, there is an exception that would allow the omission of the automatic sprinkler system for the Group E fire area if there is a direct exit to the exterior from each classroom at ground level. The occupants must be able to go from the classroom directly to the outside without passing through intervening corridors, passageways or interior exit stairways.

**903.2.4 Group F-1.** An automatic sprinkler system shall be provided throughout all buildings containing a Group F-1 occupancy where one of the following conditions exists:

1. A Group F-1 fire area exceeds 12,000 square feet (1115 m<sup>2</sup>).
  2. A Group F-1 fire area is located more than three stories above grade plane.
  3. The combined area of all Group F-1 fire areas on all floors, including any mezzanines, exceeds 24,000 square feet (2230 m<sup>2</sup>).
  4. A Group F-1 occupancy used for the manufacture of upholstered furniture or mattresses exceeds 2,500 square feet (232 m<sup>2</sup>).
- ❖ Group F-1 occupancies must meet several different conditions as to when the fire area or occupancy must be sprinklered. The first three conditions are related to the difficulty of manually suppressing a fire involving a large area. Therefore, occupancies of Group F-1 must be protected throughout with an automatic sprinkler system if the fire area is in excess of 12,000 square feet (1115 m<sup>2</sup>), if the total of all fire areas is in excess of 24,000 square feet (2230 m<sup>2</sup>) or if the fire area is located more than three stories above grade plane. This is one of the few locations in the code where the total floor area of the building is aggregated for application of a code requirement. The stipulated conditions for when an automatic sprinkler system is required also apply to Group M (see Section 903.2.7) and S-1 (see Section 903.2.9) occupancies. Condition 4 for sprinklering a Group F-1 occupancy relates to the requirement for Group F-1 occupancies in excess of 2,500 square feet (232 m<sup>2</sup>) that are used for the manufacture of upholstered furniture or mattresses. Note that this requirement is based simply upon the square footage of the Group F-1 occupancy and is not related to fire areas. Upholstered furniture has the potential for rapid growing and high-heat-release fires. This hazard is increased substantially when there are numerous upholstered furniture or mattresses being manufactured. Such fires put the occupants and emergency responders at risk. This requirement exists regardless of whether the upholstered furniture has passed any fire-retardant tests. See the commentary for Section 903.2.7 for more discussion on the subject of upholstered furniture. See the commentary to Section 903.2.9 for discussion of the formal interpretation and applicability to the code and IBC.

The following examples illustrate how the criteria of this section are intended to be applied:

- If a building contains a single fire area of Group F-1 and the fire area is 13,000 square feet (1208 m<sup>2</sup>), an automatic sprinkler system is required throughout the entire building; however, if this fire area is separated into two fire areas and neither is in excess of 12,000 square feet (1115 m<sup>2</sup>), an automatic fire sprinkler system is not required. To be considered separate fire areas, the areas must be separated by fire barriers or horizontal assemblies having a fire-resistance rating as required in Table 707.3.10.
  - If a 30,000-square-foot (2787 m<sup>2</sup>) Group F-1 building was equally divided into separate fire areas of 10,000 square feet (929 m<sup>2</sup>) each, an automatic sprinkler system would still be required throughout the entire building. Because the aggregate area of all fire areas exceeds 24,000 square feet (2230 m<sup>2</sup>), additional compartmentation will not eliminate the need for an automatic sprinkler system. However, the use of a fire wall to separate the structure into two buildings would reduce the aggregate area of each building to less than 24,000 square feet (2230 m<sup>2</sup>) and each fire area to less than 12,000 square feet (1115 m<sup>2</sup>), which would offset the need for an automatic sprinkler system.
- 903.2.4.1 Woodworking operations.** An automatic sprinkler system shall be provided throughout all Group F-1 occupancy fire areas that contain woodworking operations in excess of 2,500 square feet in area (232 m<sup>2</sup>) that generate finely divided combustible waste or use finely divided combustible materials.
- ❖ Because of the potential amount of combustible dust that could be generated during woodworking operations, an automatic sprinkler system is required throughout a fire area when it contains a woodworking operation that exceeds 2,500 square feet (232 m<sup>2</sup>) in area. Facilities where woodworking operations take place, such as cabinet making, are considered Group F-1 occupancies. The intent of the phrase "finely divided combustible waste" is to describe particle concentrations that are in the explosive range (see Chapter 22 for discussion of dust-producing operations).
- The extent of sprinkler coverage is only intended to be for the Group F-1 occupancy involved in the woodworking activity. If the fire area is larger than 2,500 square feet (232 m<sup>2</sup>) but the woodworking area is less than 2,500 square feet (232 m<sup>2</sup>), sprinklers are not required. It is not the intent to require the installation of sprinklers throughout the building but rather in the fire area where the hazard may be present.
- 903.2.5 Group H.** Automatic sprinkler systems shall be provided in high-hazard occupancies as required in Sections 903.2.5.1 through 903.2.5.3.
- ❖ Group H occupancies are those intended for the manufacturing, processing or storage of hazardous materials that constitute a physical or health hazard. To be considered a Group H occupancy, the amount of hazardous materials is assumed to be in excess of the maximum allowable quantities permitted by Tables 5003.1.1(1) and 5003.1.1(2).
- 903.2.5.1 General.** An automatic sprinkler system shall be installed in Group H occupancies.
- ❖ This section requires an automatic sprinkler system in all Group H occupancies. Even though in some

instances the hazard associated with the occupancy may be one that is not a fire hazard, an automatic sprinkler system is still required to minimize the potential for fire spreading to the high-hazard use; that is, the sprinklers protect the high-hazard area from fire outside the area. This section does not prohibit the use of an alternative automatic fire-extinguishing system in accordance with Section 904. When a water-based system is not compatible with the hazardous materials involved and thus creates a dangerous condition, an alternative fire-extinguishing system should be used. For example, combustible metals, such as magnesium and titanium, have a serious record of involvement with fire and are typically not compatible with water (see commentary, Chapter 59).

Where control areas are used to regulate the quantity of hazardous material within a building, the building is not considered a Group H occupancy. Unless a building would be required by some other code provision to be protected with sprinklers, control areas can be used to control the allowable quantities of hazardous materials in a building so as to not warrant a Group H classification and its mandatory sprinkler requirements.

**903.2.5.2 Group H-5 occupancies.** An automatic sprinkler system shall be installed throughout buildings containing Group H-5 occupancies. The design of the sprinkler system shall be not less than that required under the *International Building Code* for the occupancy hazard classifications in accordance with Table 903.2.5.2.

Where the design area of the sprinkler system consists of a corridor protected by one row of sprinklers, the maximum number of sprinklers required to be calculated is 13.

❖ Group H-5 occupancies are structures that are typically used as semiconductor fabrication facilities and comparable research laboratory facilities that use hazardous production materials (HPM). Many of the materials used in semiconductor fabrication present unique hazards. Many of the materials are toxic, while some are corrosive, water reactive or pyrophoric. Fire protection for these facilities is aimed at preventing incidents from escalating and producing secondary threats beyond a fire, such as the release of corrosive or toxic materials. Because of the nature of Group H-5 facilities, the overall amount of hazardous materials can far exceed the maximum allowable quantities given in Tables 5003.1.1(1) and 5003.1.1(2). Although the amount of HPM material is restricted in fabrication areas, the quantities of HPM in storage rooms normally will be in excess of those allowed by the tables. Additional requirements for Group H-5 facilities are located in Chapter 27 of the code and Section 415.11 of the IBC.

This section also specifies the sprinkler design criteria, based on NFPA 13, for various areas in a Group H-5 occupancy (see commentary, Table 903.2.5.2). When the corridor design area sprinkler option is used, a maximum of 13 sprinklers must be

calculated. This exceeds the requirements of NFPA 13 for typical egress corridors, which require a maximum of either five or seven calculated sprinklers, depending on the extent of protected openings in the corridor. The increased number of calculated corridor sprinklers is based on the additional hazard associated with the movement of hazardous materials in corridors of Group H-5 facilities.

**TABLE 903.2.5.2  
GROUP H-5 SPRINKLER DESIGN CRITERIA**

LOCATION	OCCUPANCY HAZARD CLASSIFICATION
Fabrication areas	Ordinary Hazard Group 2
Service corridors	Ordinary Hazard Group 2
Storage rooms without dispensing	Ordinary Hazard Group 2
Storage rooms with dispensing	Extra Hazard Group 2
Corridors	Ordinary Hazard Group 2

❖ Table 903.2.5.2 designates the appropriate occupancy hazard classification for the various areas within a Group H-5 facility. The listed occupancy hazard classifications correspond to specific sprinkler system design criteria in NFPA 13. Ordinary Hazard Group 2 occupancies, for example, require a minimum design density of 0.20 gpm/ft<sup>2</sup> (8.1 L/min/m<sup>2</sup>) with a minimum design area of 1,500 square feet (139 m<sup>2</sup>). An Extra Hazard Group 2 occupancy, in turn, requires a minimum design density of 0.40 gpm/ft<sup>2</sup> (16.3 L/min/m<sup>2</sup>) with a minimum operating area of 2,500 square feet (232 m<sup>2</sup>). The increased overall sprinkler demand for Extra Hazard Group 2 occupancies is based on the potential use and handling of substantial amounts of hazardous materials, such as flammable or combustible liquids.

**903.2.5.3 Pyroxylin plastics.** An automatic sprinkler system shall be provided in buildings, or portions thereof, where cellulose nitrate film or pyroxylin plastics are manufactured, stored or handled in quantities exceeding 100 pounds (45 kg).

❖ Cellulose nitrate (pyroxylin) plastics pose unusual and substantial fire risks. Pyroxylin plastics are the most dangerous and unstable of all plastic compounds. The chemically bound oxygen in their structure permits them to burn vigorously in the absence of atmospheric oxygen. Although these compounds produce approximately the same amount of energy as paper when they burn, pyroxylin plastics burn at a rate as much as 15 times greater than comparable common combustibles. When burning, these materials release highly flammable and toxic combustion byproducts. Consequently, cellulose nitrate fires are very difficult to control. Although this section specifies a sprinkler threshold quantity of 100 pounds (45.4 kg), the need for additional fire protection should be considered for pyroxylin plastics in any amount.

Although the code includes cellulose nitrate “film” in its requirements, cellulose nitrate motion picture film has not been used in the United States since the 1950s. All motion picture film produced since that

time is what is typically called “safety film.” Consequently, the only application for this section relative to motion picture film is where it may be used in laboratories or storage vaults that are dedicated to film restoration and archives. The protection of these facilities is addressed in Sections 306.2 and 6504.2.

**903.2.6 Group I.** An *automatic sprinkler system* shall be provided throughout buildings with a Group I *fire area*.

**Exceptions:**

1. An *automatic sprinkler system* installed in accordance with Section 903.3.1.2 shall be permitted in Group I-1 Condition 1 facilities.
2. An *automatic sprinkler system* is not required where Group I-4 day care facilities are at the *level of exit discharge* and where every room where care is provided has not fewer than one exterior *exit door*.
3. In buildings where Group I-4 day care is provided on levels other than the *level of exit discharge*, an *automatic sprinkler system* in accordance with Section 903.3.1.1 shall be installed on the entire floor where care is provided, all floors between the level of care and the *level of exit discharge* and all floors below the level of exit discharge other than areas classified as an open parking garage.

❖ The Group I occupancy is divided into four individual occupancy classifications based on the degree of detention, supervision and physical mobility of the occupants. The evacuation difficulties associated with the building occupants creates the need to incorporate a defend-in-place philosophy of fire protection in occupancies of Group I. For this reason, all such occupancies are to be protected with an automatic sprinkler system. Note that this section is applicable to the entire building that contains a Group I occupancy.

Of particular note, this section encompasses all Group I-3 occupancies where more than five persons are detained (see Section 308.5 of the IBC). There has been considerable controversy concerning the use of automatic sprinklers in detention and correctional occupancies. Special design considerations can be taken into account to alleviate the perceived problems with sprinklers in sleeping units. Sprinklers that reduce the likelihood of vandalism as well as the potential to hang oneself are commercially available. Knowledgeable designers can incorporate certain design features to increase reliability and decrease the likelihood of damage to the system.

Group I-4 occupancies would include either adult-only care facilities or occupancies that provide personal care for more than five children, 2½ years of age or younger, on a less than 24-hour basis. Because the degree of assistance and the time needed for egress cannot be gauged, an automatic sprinkler system is required.

There are three exceptions to this section. Exception 1 permits Group I-1 Condition 1 occupancies to be protected throughout with an NFPA 13R system

instead of a NFPA 13 system. This is the lower risk condition for Group I-1 occupancies. Group I-1 Condition 2 occupancies would be required to use an NFPA 13 system.

Exception 2 exempts sprinkler systems completely if the day care center is at the level of exit discharge and every room has at least one exterior exit door. Note that day cares to which this section applies are considered by Section 308.6.1 of the IBC to be Group E occupancies. An automatic sprinkler system would not be required unless dictated by the requirements in Section 903.2.2 (see commentary, Section 308.6.1 of the IBC).

Exception 3 is also related to day cares that are still classified as Group I-4 by nature of the location in the building. In that case, an NFPA 13 system would be required on the floor where the center is located and all floors between and including the level of exit discharge. This is less stringent than the main requirement in Section 903.2.6 that requires the entire building to be sprinklered. As defined in Section 202, a Group I-4 child care facility located at the level of exit discharge and accommodating no more than 100 children, with each child care room having an exit directly to the exterior, would be classified as a Group E occupancy. See also IBC Section 308.6.1.

**903.2.7 Group M.** An *automatic sprinkler system* shall be provided throughout buildings containing a Group M occupancy where one of the following conditions exists:

1. A Group M *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. A Group M *fire area* is located more than three stories above grade plane.
3. The combined area of all Group M *fire areas* on all floors, including any mezzanines, exceeds 24,000 square feet (2230 m<sup>2</sup>).
4. A Group M occupancy used for the display and sale of upholstered furniture or mattresses exceeds 5,000 square feet (464 m<sup>2</sup>).

❖ The sprinkler threshold requirements for Group M occupancies are identical to those of Group F-1 and S-1 occupancies (see commentary, Section 903.2.4). The one exception is that Group M occupancies are provided with an increased area for display of upholstered furniture and mattresses of 5,000 square feet (464 m<sup>2</sup>) versus 2,500 square feet (232 m<sup>2</sup>) required for Group F-1 and S-1 occupancies. As noted in the commentary for Group F-1 occupancies, upholstered furniture and mattresses have the potential for rapidly growing and high-heat-release fires. This hazard is increased substantially when there are numerous upholstered furniture items or mattresses on display. Such fires put the occupants and emergency responders at risk. This requirement exists regardless of whether the upholstered furniture has passed any fire-retardant tests.

The code does not specifically address what constitutes upholstered furniture, but by simple dictionary

definition, upholstered furniture has seats covered with padding, springs, webbing and fabric or leather covers. The code does not make any distinction between levels of padding and upholstery provided on furniture, which was intentional. The proponent's reason statement for code change F135-07/08 stated, in part, that "the American Home Furnishings Alliance (AHFA) and the National Home Furnishings Association (NHFA) have examined proposals for exempting vendors of certain constructions of furniture and concluded that such exemptions would be impractical for local code officials to enforce. This is the case because the internal construction of furniture cannot be established reliably without deconstructing it."

Note that, as with Group F-1 occupancies, the criteria is written such that any Group M occupancy, not the fire area, over 5,000 square feet (464 m<sup>2</sup>) used for the display and sale of upholstered furniture and mattresses shall be sprinklered throughout. This is regardless of the quantity of upholstered furniture and mattresses actually available for purchase. The reason these requirements were placed into the IBC and the code was based on a large fire in Charleston, South Carolina that killed nine fire fighters. The facility was a combination furniture showroom and associated storage area. The building did not provide an automatic sprinkler system. See the commentary to Section 903.2.9 for discussion of a formal interpretation dealing with Group S-1 occupancies and applicability to the code and IBC.

Automatic sprinkler systems for mercantile occupancies are typically designed for an Ordinary Hazard Group 2 classification in accordance with NFPA 13. If high-piled storage (see Section 903.2.7.1) is anticipated; additional levels of fire protection may be required. Also, some merchandise in mercantile occupancies, such as aerosols, rubber tires, paints and certain plastic commodities, even at limited storage heights, are considered beyond the standard Class I through IV commodity classification assumed for mercantile occupancies in NFPA 13 and may warrant additional fire protection.

**903.2.7.1 High-piled storage.** An *automatic sprinkler system* shall be provided as required in Chapter 32 in all buildings of Group M where storage of merchandise is in high-piled or rack storage arrays.

- ❖ Regardless of the size of the Group M fire area, an automatic sprinkler system may be required in a high-piled storage area. High-piled storage includes piled, palletized, bin box, shelf or rack storage of Class I through IV combustibles to a height greater than 12 feet (3658 mm) and certain high-hazard commodities greater than 6 feet (1829 mm). Chapter 23 provides a package of requirements that may include sprinkler protection depending upon the size of the high-piled storage area. The design standard for the sprinkler protection of high-piled storage is NFPA 13. NFPA 13 addresses the many different types and configurations of high-piled storage.

**903.2.8 Group R.** An *automatic sprinkler system* installed in accordance with Section 903.3 shall be provided throughout all buildings with a Group R fire area.

- ❖ This section requires sprinklers in any building that contains a Group R fire area. This includes uses, such as hotels, apartment buildings, group homes and dormitories. There are no minimum criteria and no exceptions.

It should be noted that buildings constructed under the *International Residential Code*<sup>®</sup> (IRC<sup>®</sup>) are not included in Group R and would not, therefore, be subject to these particular requirements. The 2009 IRC required sprinklers in all new townhouses and, beginning January 1, 2011, all one- and two-family dwellings. The IRC is a stand-alone code for the construction of detached one- and two-family dwellings and multiple single-family dwellings (townhouses) no more than three stories in height with a separate means of egress and addresses the requirements for sprinklers in a different way. That is, all of the provisions for new construction that affect those buildings are to be covered exclusively by the IRC and are not to be covered by another *International Code*. Buildings that do not fall within the scope of the IRC would be classified in Group R and be subject to these provisions. This is stated clearly in IFC Committee Interpretation No. 29-03.

With respect to life safety, the need for a sprinkler system is dependent on the occupants' proximity to the fire and the ability to respond to a fire emergency. Group R occupancies could contain occupants who may require assistance to evacuate, such as infants, those with a disability or who may simply be asleep. While the presence of a sprinkler system cannot always protect occupants in residential buildings who are aware of the ignition and either do not respond or respond inappropriately, it can prevent fatalities outside of the area of fire origin regardless of the occupants' response. Section 903.3.2 requires quick-response or residential sprinklers in all Group R occupancies. Full-scale fire tests have demonstrated the ability of quick-response and residential sprinklers to maintain tenability from flaming fires in the room of fire origin.

Where a different occupancy is located in a building with a residential occupancy, the provisions of this section still apply and the entire building is required to be provided with an automatic sprinkler system regardless of the type of mixed-use condition considered. This is consistent with the mixed-use provisions in Chapter 5 of the IBC. The type of sprinkler system permitted in the different types of Group R occupancies is further clarified in Section 903.2.8.1 through 903.2.8.4.

**903.2.8.1 Group R-3.** An *automatic sprinkler system* installed in accordance with Section 903.3.1.3 shall be permitted in Group R-3 occupancies.

- ❖ R-3 occupancies are essentially one- and two-family dwellings that fall outside the scope of the IRC, thus

an NFPA 13D system is appropriate. It should be noted there is no restriction on the use of NFPA 13 or NFPA 13R systems.

**[F] 903.2.8.2 Group R-4 Condition 1.** An *automatic sprinkler system* installed in accordance with Section 903.3.1.3 shall be permitted in Group R-4 Condition 1 occupancies.

❖ Group R-4 Condition 1 is the lesser of the risk categories for Group R-4 occupants. The occupants are more capable of evacuating without assistance; therefore, they are treated no different than a Group R-3 occupancy.

**[F] 903.2.8.3 Group R-4 Condition 2.** An *automatic sprinkler system* installed in accordance with Section 903.3.1.2 shall be permitted in Group R-4 Condition 2 occupancies. Attics shall be protected in accordance with Section 903.2.8.3.1 or 903.2.8.3.2.

❖ In Group R-4 Condition 2 occupancies the occupants need more assistance evacuating a building; therefore, a more robust sprinkler system is required. An NFPA 13R system is required. It should be noted that there are some concerns with NFPA 13R systems not adequately addressing attic spaces as typically NFPA 13R systems focus primarily on the main habitable portion of the building. Specific compliance conditions are provided in Sections 903.2.8.3.1 and 908.2.8.3.2.

**[F] 903.2.8.3.1 Attics used for living purposes, storage or fuel-fired equipment.** Attics used for living purposes, storage or fuel-fired equipment shall be protected throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.2.

❖ This section clarifies that, if the attic is used for living purposes or there are fuel-fired equipment and storage in these areas, full coverage in accordance with NFPA 13R is required.

**[F] 903.2.8.3.2 Attics not used for living purposes, storage or fuel-fired equipment.** Attics not used for living purposes, storage or fuel-fired equipment shall be protected in accordance with one of the following:

1. Attics protected throughout by a heat detector system arranged to activate the building fire alarm system in accordance with Section 907.2.10.
  2. Attics constructed of noncombustible materials.
  3. Attics constructed of fire-retardant-treated wood framing complying with Section 2303.2 of the *International Building Code*.
  4. The *automatic sprinkler system* shall be extended to provide protection throughout the attic space.
- ❖ In attics where people are not expected and storage or fuel-fired equipment is not located, some protection is required on top of what NFPA 13R would require. Four different options of protection are provided. The first is simply to provide more warning time to the occupants if a fire should occur in the attic via a heat detector that activates the fire alarm system. The second is simply to reduce the risk of fire by requiring noncombustible construction materials. The

third, similar to the second, is reducing the fire hazard by using fire-retardant-treated wood. This will slow the growth of a fire should one occur or prevent the start of a fire. The final option is simply to provide sprinkler protection to the attic. If a sprinkler system is provided in the attic, issues such as freezing temperatures need to be addressed.

**[F] 903.2.8.4 Care facilities.** An *automatic sprinkler system* installed in accordance with Section 903.3.1.3 shall be permitted in care facilities with five or fewer individuals in a single-family dwelling.

❖ This section is similar to Sections 903.2.8.1 and 903.2.8.2 and allows the use of an NFPA 13D system in place of an NFPA 13 or 13R system. In this case, it is specific to smaller care facilities with five or fewer residents. Again, while not technically a single-family dwelling, they are very similar in nature based on the type and actual use of the building.

**903.2.9 Group S-1.** An *automatic sprinkler system* shall be provided throughout all buildings containing a Group S-1 occupancy where one of the following conditions exists:

1. A Group S-1 *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. A Group S-1 *fire area* is located more than three stories above grade plane.
3. The combined area of all Group S-1 *fire areas* on all floors, including any mezzanines, exceeds 24,000 square feet (2230 m<sup>2</sup>).
4. A Group S-1 *fire area* used for the storage of commercial motor vehicles where the *fire area* exceeds 5,000 square feet (464 m<sup>2</sup>).
5. A Group S-1 occupancy used for the storage of upholstered furniture or mattresses exceeds 2,500 square feet (232 m<sup>2</sup>).

❖ An automatic sprinkler system must be provided throughout all buildings where the fire area containing a Group S-1 occupancy exceeds 12,000 square feet (1115 m<sup>2</sup>); is more than three stories above grade plane; is a combined fire area, including all floors and mezzanines, exceeding 24,000 square feet (2230 m<sup>2</sup>); or is used for the storage of commercial motor vehicles and exceeds 5,000 square feet (464 m<sup>2</sup>). See the commentary for the definition of "Commercial motor vehicle" in Chapter 2.

The first three sprinkler threshold requirements for Group S-1 occupancies are identical to those of Groups F-1 and M (see commentary, Sections 903.2.4 and 903.2.7). Group S-1 occupancies, such as warehouses and self-storage buildings, are assumed to be used for the storage of combustible materials. While high-piled storage does not change the Group S-1 occupancy classification, sprinkler protection, if required, may have to comply with the additional requirements of Chapter 32. High-piled stock or rack storage in any occupancy must comply with the code and the IBC. The fifth sprinkler threshold is the same as for Group F-1 except that, in this case,

upholstered furniture and mattresses are being stored and not manufactured. Group M has a similar threshold, but is required for larger occupancies containing such items with an area of 5,000 square feet (464 m<sup>2</sup>) versus what is required for Groups S-1 and F-1 occupancies of 2,500 square feet (232 m<sup>2</sup>). See the commentary for Group M and Group F-1 occupancies for more discussion on this issue. Again, it is important to note that the threshold is based upon the square footage of the occupancy and not upon the size of the fire area. A formal interpretation (IFC Interpretation 20-14) has been issued on this section. The formal interpretation addresses self storage warehouses specifically and whether such a facility between 2,500 and 1,2000 square feet would require an automatic sprinkler system. This is based on the fact that upholstered furniture may be stored in such units. The response provided noted that a sprinkler system would be required based on the fact the requirements are focused on the square footage of the occupancy and are not based on fire area or the amount of upholstered furniture or mattresses present.

**903.2.9.1 Repair garages.** An *automatic sprinkler system* shall be provided throughout all buildings used as repair garages in accordance with Section 406.8 of the *International Building Code*, as shown:

1. Buildings having two or more stories above grade plane, including *basements*, with a *fire area* containing a repair garage exceeding 10,000 square feet (929 m<sup>2</sup>).
  2. Buildings not more than one story above grade plane, with a *fire area* containing a repair garage exceeding 12,000 square feet (1115 m<sup>2</sup>).
  3. Buildings with repair garages servicing vehicles parked in *basements*.
  4. A Group S-1 *fire area* used for the repair of commercial motor vehicles where the *fire area* exceeds 5,000 square feet (464 m<sup>2</sup>).
- ❖ Automatic sprinklers may be required in repair garages, depending on the quantity of combustibles present, their location and floor area. In addition, any Group S-1 fire area intended for the repair of commercial motor vehicles that exceeds 5,000 square feet (464 m<sup>2</sup>) would require sprinklers. This is the same criteria as Group S-1 occupancies and Group S-2 enclosed parking garages storing commercial motor vehicles. Repair garages may contain significant quantities of flammable liquids and other combustible materials. These occupancies are typically considered Ordinary Hazard Group 2 occupancies as defined in NFPA 13. Portions of repair garages used for parts cleaning using flammable or combustible liquids may require automatic sprinkler protection. If quantities of hazardous materials exceed the limitations in Chapter 50 for maximum allowable quantities per control area, the repair garage would be reclassified as a Group H occupancy. Note that the term “Commercial motor vehicles” is specially defined in Chapter 2.

**903.2.9.2 Bulk storage of tires.** Buildings and structures where the area for the storage of tires exceeds 20,000 cubic feet (566 m<sup>3</sup>) shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

❖ This section specifies when an automatic sprinkler system is required for the bulk storage of tires based on the volume of the storage area as opposed to a specific number of tires. Even in fully sprinklered buildings, tire fires pose significant problems to fire departments. Tire fires produce thick smoke and are difficult to extinguish by sprinklers alone. NFPA 13 contains specific fire protection requirements for the storage of rubber tires.

Whether the volume of tires is divided into different fire areas or not is irrelevant to the application of this section. If the total for all areas where tires are stored is great enough that the resultant storage volume exceeds 20,000 cubic feet (566 m<sup>3</sup>), the building must be sprinklered throughout. See the commentary to Section 202 definition of “Tires, bulk storage of” for further information.

**903.2.10 Group S-2 enclosed parking garages.** An *automatic sprinkler system* shall be provided throughout buildings classified as enclosed parking garages in accordance with Section 406.6 of the *International Building Code* where either of the following conditions exists:

1. Where the *fire area* of the enclosed parking garage exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. Where the enclosed parking garage is located beneath other groups.

**Exception:** Enclosed parking garages located beneath Group R-3 occupancies.

❖ Fire records have shown that fires in parking structures typically fully involve only a single automobile with minor damage to adjacent vehicles. An enclosed parking garage, however, does not allow the dissipation of smoke and hot gases as readily as an open parking structure, which is also considered a Group S-2 occupancy. If the enclosed parking garage has a fire area greater than 12,000 square feet (1115 m<sup>2</sup>) or is located beneath another occupancy group, the enclosed parking garage must be protected with an automatic sprinkler system. This requirement that the enclosed parking garage located beneath other occupancy groups is required to be sprinklered is based on the potential for a fire to develop undetected, which would endanger the occupants of the other occupancy. The 12,000 square foot (1115 m<sup>2</sup>) threshold is similar to other occupancies such as Groups M and S-1.

It should be noted that while open parking garages are considered a Group S-2 occupancy, they are not required by the provisions of this section to be equipped with an automatic sprinkler system.

The exception exempts enclosed garages in buildings where the garages are located below a Group R-3 occupancy. The exception is essentially moot since the code requires all buildings with a Group R occupancy to be sprinklered throughout. Because the entire

building with the residential occupancy is required to be sprinklered according to Sections 903.2.8, the garage would be sprinklered as well. It should be noted that if the Group R-3 was protected with an NFPA 13D system that the enclosed parking garage would not require sprinklers.

**903.2.10.1 Commercial parking garages.** An *automatic sprinkler system* shall be provided throughout buildings used for storage of commercial motor vehicles where the *fire area* exceeds 5,000 square feet (464 m<sup>2</sup>).

❖ Because of the larger-sized vehicles involved in commercial parking structures, those housing commercial motor vehicles, as defined in Section 202, a more stringent sprinkler threshold is required. Bus garages may also be located adjacent to passenger terminals (Group A-3) that have a substantial occupant load. Commercial parking requires only a single vehicle in order to be classified as commercial parking.

The criterion for sprinkler protection is based on the size of the fire area and not the size of the commercial parking. If the commercial parking involves only 1,000 square feet (93 m<sup>2</sup>) but the fire area exceeds 5,000 square feet (464 m<sup>2</sup>), sprinkler protection is required.

**903.2.11 Specific buildings areas and hazards.** In all occupancies other than Group U, an *automatic sprinkler system* shall be installed for building design or hazards in the locations set forth in Sections 903.2.11.1 through 903.2.11.6.

❖ Sections 903.2.11.1 through 903.2.11.2 specify certain conditions under which an automatic sprinkler system is required, even in otherwise nonsprinklered buildings. As indicated, the listed conditions in the noted sections are applicable to all occupancies except Group U. Most structures that qualify as Group U do not typically have the type of conditions stipulated in Sections 903.2.11.1 through 903.2.11.1.3.

**903.2.11.1 Stories without openings.** An *automatic sprinkler system* shall be installed throughout all stories, including *basements*, of all buildings where the floor area exceeds 1,500 square feet (139.4 m<sup>2</sup>) and where there is not provided not fewer than one of the following types of *exterior wall* openings:

1. Openings below grade that lead directly to ground level by an exterior *stairway* complying with Section 1009 or an outside ramp complying with Section 1010. Openings shall be located in each 50 linear feet (15 240 mm), or fraction thereof, of *exterior wall* in the story on at least one side. The required openings shall be distributed such that the lineal distance between adjacent openings does not exceed 50 feet (15 240 mm).
2. Openings entirely above the adjoining ground level totaling not less than 20 square feet (1.86 m<sup>2</sup>) in each 50 linear feet (15 240 mm), or fraction thereof, of *exterior wall* in the story on at least one side. The required openings shall be distributed such that the lineal distance between adjacent openings does not exceed 50 feet (15 240 mm). The height of the bottom of the clear

opening shall not exceed 44 inches (1118 mm) measured from the floor.

❖ Because of both the lack of openings in exterior walls for access by the fire department for fire fighting and rescue and the problems associated with venting the products of combustion during fire suppression operations, all stories which includes any basements of buildings that do not have adequate openings as defined in this section must be equipped with an automatic sprinkler system. This section applies to stories without sufficient exterior openings where the floor area exceeds 1,500 square feet (139 m<sup>2</sup>) and where the building is not otherwise required to be fully sprinklered. The requirement for an automatic sprinkler system in this section applies only to the affected area and does not mandate sprinkler protection throughout the entire building.

Stories without openings, as defined in this section, are stories that do not have at least 20 square feet (1.9 m<sup>2</sup>) of opening leading directly to ground level in each 50 lineal feet (15 240 mm) or fraction thereof on at least one side. Since exterior doors will provide openings of 20 square feet (1.9 m<sup>2</sup>), or slightly less in some occupancies, exterior stairways and ramps in each 50 lineal feet (15 240 mm) are considered acceptable.

This section specifically states that the required openings be distributed such that the lineal distance between adjacent openings does not exceed 50 feet (15 240 mm). If the openings in the exterior wall are located without regard to the location of the adjacent openings, it is possible that segments of the exterior wall will not have the required access to the interior of the building for fire-fighting purposes. Any arrangement of required stairways, ramps or openings that results in a portion of the wall 50 feet (15 240 mm) or more in length with no openings to the exterior does not meet the intent of the code that access be provided in each 50 lineal feet (15 240 mm) (see Commentary Figure 903.2.11.1).

There is a further restriction on openings that are entirely above grade. More specifically, to support fire fighting operations, the openings need to be accessible and usable. Therefore, Item 2 specifies that the maximum sill height be 44 inches (1117.6 mm) above the floor. This height is consistent with the height provided for emergency escape and rescue windows in Section 1030.3.

One application of this section has been addressed in the *International Code Interpretations* and deals with automotive service shops that have below-grade service areas where employees perform oil changes and other minor maintenance services. The below-grade areas are typically open to the grade-level service bays via openings providing access to the underside of the vehicles without requiring the vehicle to be lifted into the air. Inasmuch as the below-grade space has no openings directly to the exterior, the question was asked if it would be regulated as a windowless story and thus be required to be equipped with an automatic

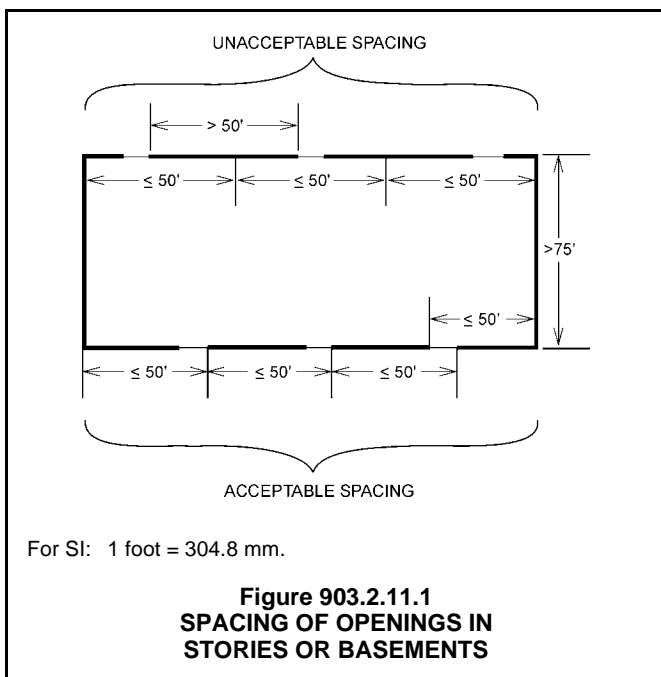
fire suppression system in accordance with Section 903.2.11.1.

The answer to that question is no. Due to the openness between the adjacent service levels, the below-grade area would be more appropriately regulated similar to a mezzanine rather than a story. A mezzanine is not regulated as a separate story but rather as part of the same story that it serves. Therefore, if the below-grade service level is in compliance with the applicable provisions of Section 505 of the IBC, the windowless story provisions of Section 903.2.11.1 would be evaluated based on the exterior wall openings of the main level and not the service mezzanine below. The direct interconnections provided between the two adjacent floor levels by multiple service openings provide access to the lower service area for fire-fighting and rescue operations. As such, it would not be regulated as a windowless story.

The requirement to sprinkler the basement is independent of mixed-use conditions. Whether the basement is separated or nonseparated is irrelevant to the need for sprinkler protection, nor does the requirement to provide sprinklers in the basement imply that sprinklers must be provided elsewhere. This requirement is applicable to the basement or any story without openings irrespective of other code provisions.

These provisions are also not based upon the size of a fire area but rather upon the size of the basement. Thus, subdividing the basement into multiple fire areas would have no effect on the requirement. However, one benefit of the multiple fire areas could be that each fire area could have a separate limited area sprinkler system with less than 20 sprinklers.

**903.2.11.1.1 Opening dimensions and access.** Openings shall have a minimum dimension of not less than 30 inches (762 mm). Such openings shall be accessible to the fire department from the exterior and shall not be obstructed in a



manner such that fire fighting or rescue cannot be accomplished from the exterior.

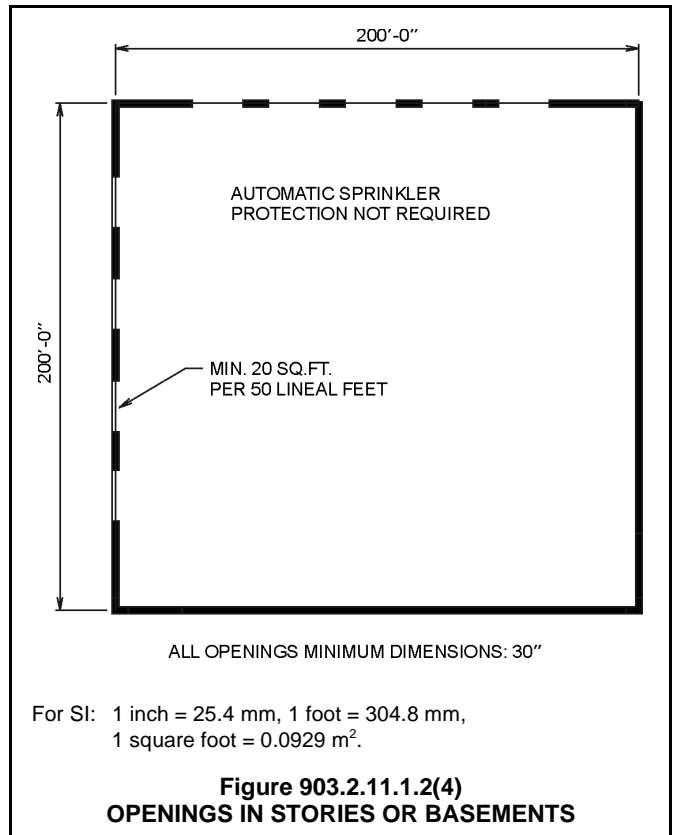
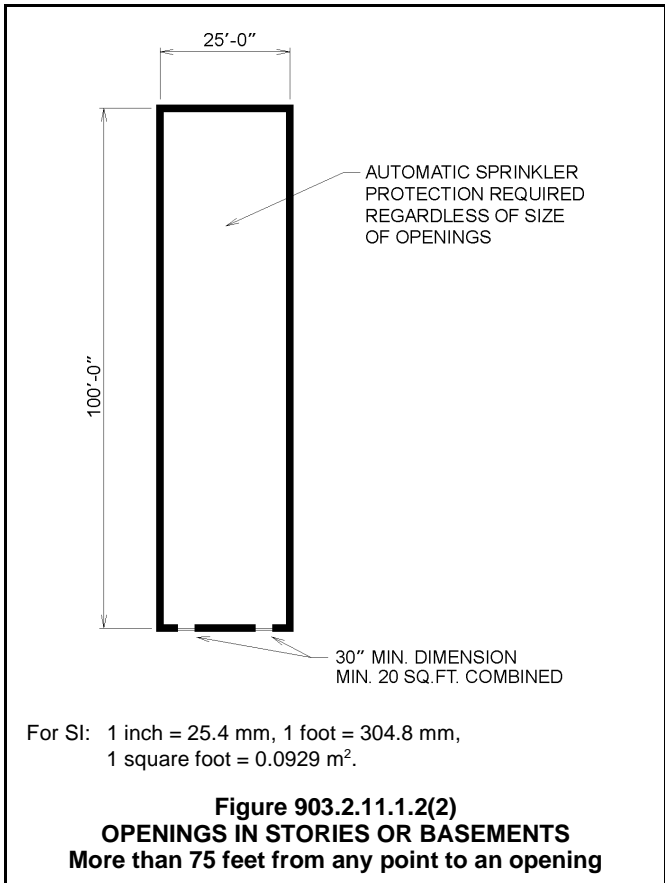
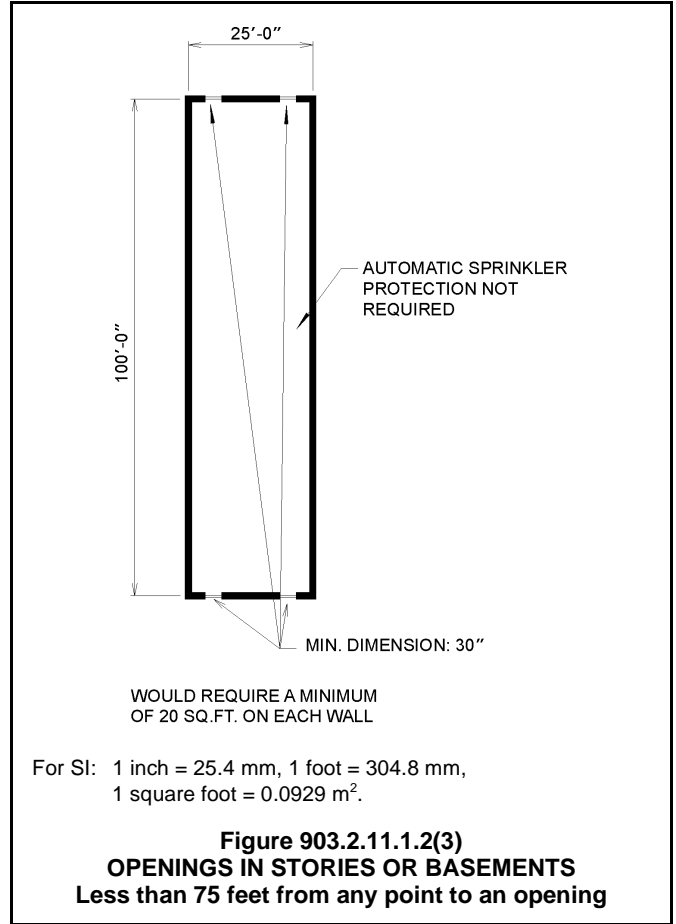
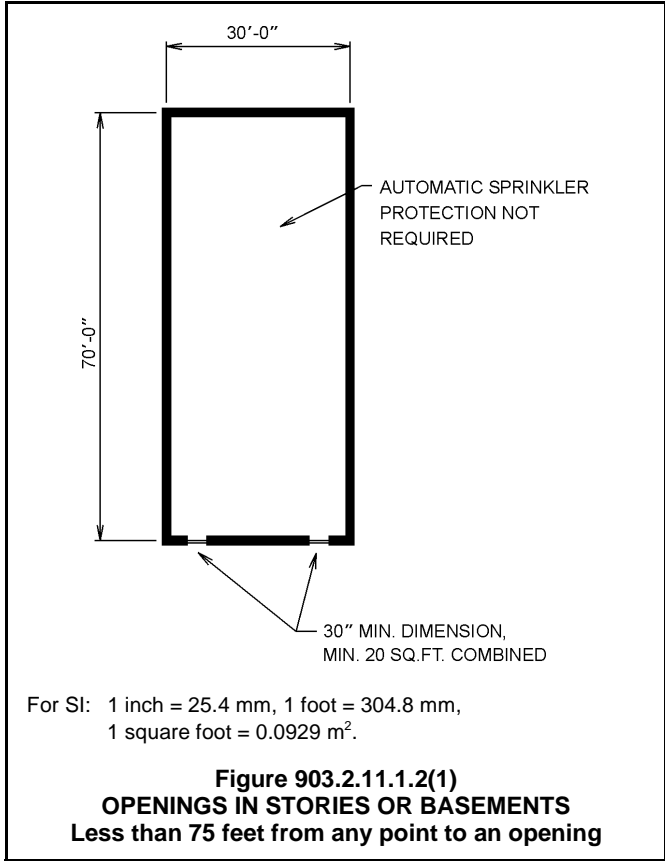
- ❖ To qualify, an opening must not be less than 30 inches (762 mm) in least dimension and must be accessible to the fire department from the exterior. The minimum opening dimension gives fire department personnel access to the interior of the story or basement for fire-fighting and rescue operations and provides openings that are large enough to vent the products of combustion.

**903.2.11.1.2 Openings on one side only.** Where openings in a story are provided on only one side and the opposite wall of such story is more than 75 feet (22 860 mm) from such openings, the story shall be equipped throughout with an *approved automatic sprinkler system* or openings as specified above shall be provided on not fewer than two sides of the story.

- ❖ If openings are provided on only one side, an automatic sprinkler system would still be required if the opposite wall of the story is more than 75 feet (22 860 mm) from existing openings. An alternative to providing the automatic sprinkler system would be to design openings on at least two sides of the exterior of the building. As long as the story being considered is not a basement, the openings on two sides can be greater than 75 feet (22 860 mm) from any portion of the floor. In basements, if any portion is more than 75 feet (22 860 mm) from the openings, the entire basement must be equipped with an automatic sprinkler system, as indicated in Section 903.2.11.1.3. Providing openings on more than one wall allows cross ventilation to vent the products of combustion [see Commentary Figures 903.2.11.1.2(1-4)].

**903.2.11.1.3 Basements.** Where any portion of a *basement* is located more than 75 feet (22 860 mm) from openings required by Section 903.2.11.1, or where walls, partitions or other obstructions are installed that restrict the application of water from hose streams, the *basement* shall be equipped throughout with an *approved automatic sprinkler system*.

- ❖ The 75-foot (22 860 mm) distance is intended to be measured in the line of travel—not in a straight line perpendicular to the wall. Where obstructions, such as walls or other partitions, are present in a basement, the walls and partitions enclosing any room or space must have openings that provide an equivalent degree of fire department access to that provided by the openings prescribed in Section 903.2.11.1 for exterior walls. When obstructions, such as walls or partitions are installed in the basement, the ability to apply hose streams through these openings and reach the basement area is reduced or eliminated. The configuration and clear-opening requirements become useless when an interior wall or other obstruction is placed inside the basement. In that case, it is reasonable to require automatic fire sprinklers to provide adequate protection in the basement. If an equivalent degree of fire department access to all portions of the floor area is not provided, the basement would require an automatic sprinkler system.



**903.2.11.2 Rubbish and linen chutes.** An *automatic sprinkler system* shall be installed at the top of rubbish and linen chutes and in their terminal rooms. Chutes shall have additional sprinkler heads installed at alternate floors and at the lowest intake. Where a rubbish chute extends through a building more than one floor below the lowest intake, the extension shall have sprinklers installed that are recessed from the drop area of the chute and protected from freezing in accordance with Section 903.3.1.1. Such sprinklers shall be installed at alternate floors beginning with the second level below the last intake and ending with the floor above the discharge. Chute sprinklers shall be accessible for servicing.

❖ Gravity rubbish (waste) and linen chutes can present a significant hazard to building occupants if they are not properly installed and protected. Generally, these systems are installed in high-occupancy buildings where the occupants will be sleeping or are incapable of self-rescue such as in Group I, R-1 and R-2 occupancies. Secondly, for occupant convenience, openings to the chutes are commonly provided in areas accessible to the public and, in older buildings, the chute opening may be located in an exit access corridor. In comparison to other building shafts, gravity rubbish and linen chutes always contain fuel. As bags of waste debris or linen fall through the chute, they can deposit fluids such as waste cooking oil which adheres to the shaft surface. This waste material and other debris provide fuel that can support and accelerate vertical fire spread. The greatest accumulation of fuel will be in the termination room; however, a significant amount of fuel that covers the interior surface area of the chute will be found in the sections of chutes closest to the collection or termination room. Therefore, it is important that the automatic sprinklers be properly placed and protected so they are available in the event of a fire in the termination room and to protect waste compaction equipment where such equipment is installed.

Installation of gravity chutes for rubbish or linen requires compliance with the IBC, Chapter 6 of NFPA 82 and the code. Under the IBC and NFPA 82, Chapter 6, permanent rubbish and linen chutes are constructed inside of a fire-resistance-rated shaft assembly with a minimum 1-hour fire-resistance rating in buildings less than four stories in height; in buildings four or more stories in height, the fire-resistance rating is increased to 2 hours by Section 713.4 of the IBC. The design of the shaft system and its openings must also comply with the requirements in Sections 713.11 and 713.13 of the IBC, which requires the termination room receiving the discharged material to be separated from the building by a fire-resistance rating equivalent to that of the shaft that it serves.

Section 713.13.6 of the IBC requires the installation of an automatic sprinkler system in rubbish and linen chutes to comply with the requirements of Section 903.2.11.2. Section 903.2.11.2 correlates with the requirements in Chapter 21 of NFPA 13. Chapter 22 of NFPA 13 contains the special occupancy requirements for all buildings, including gravity waste and linen

chutes. The provisions align the IBC and the code requirements with those in NFPA 82 and NFPA 13.

A critical term in this section is “extension.” The word was selected to address chutes installed in buildings of pedestal construction or other designs in which the fire-resistant construction shaft and chute pass through a less hazardous occupancy, such as a Group S-2 parking garage, or other floors that do not have access to the shaft. In these areas, chute openings are generally not provided. As a result, this section now contains a specific provision that may impose a requirement for sprinklers in the portion of the chute that serves as an extension beyond the last intake and the termination room or discharge area.

Because objects will be falling through the chute, the code requires the chute sprinklers to be recessed and protected from impact. Sprinklers are not required at every story housing a chute. The code requires automatic sprinklers at the top of the chute and at its termination. In addition, sprinkler heads are required at alternate floors within the chute with a head being installed at the floor level with the lowest intake point into the chute. Previously, these additional sprinkler heads were only required where the shaft extended through three or more floors. These revisions, plus the previously discussed requirements for extensions, may result in additional sprinkler heads within some shafts as compared to the previous requirements.

Sprinklers in chutes that are in locations subject to freezing require freeze protection in accordance with the requirements of Section 903.3.1.1 and, therefore, the NFPA 13 standard. This can be accomplished using a dry-pendant sprinkler or constructing a dry-pipe sprinkler system.

**903.2.11.3 Buildings 55 feet or more in height.** An *automatic sprinkler system* shall be installed throughout buildings that have one or more stories with an *occupant load* of 30 or more located 55 feet (16 764 mm) or more above the lowest level of fire department vehicle access, measured to the finished floor.

**Exceptions:**

1. Open parking structures.
2. Occupancies in Group F-2.

❖ Because of the difficulties associated with manual suppression of a fire in mid-rise buildings in excess of 55 feet (16 764 mm) above the lowest level of fire department vehicle access, an automatic sprinkler system is required throughout the building regardless of occupancy. Buildings that qualify for a sprinkler system under this section are not necessarily high-rise buildings as defined in Section 202 and are focused also on those with occupants located on the upper floors. These provisions apply only to buildings with occupied floors with an occupant load of 30 or more located on stories 55 feet (16 764 mm) or greater from fire department vehicle access. The 55 feet (16 764 mm) is measured to the finished floor (see Commentary Figure 903.2.11.3).

The listed exceptions are occupancies that, based on height only, do not require an automatic sprinkler system. Open parking structures are also exempt from the high-rise provisions of Section 403 of the IBC. Although an automatic sprinkler system is not required in open parking structures, a sprinkler system may still be needed, depending on the building construction type and the area and number of parking tiers (see Table 406.3.5 of the IBC).

**903.2.11.4 Ducts conveying hazardous exhausts.** Where required by the *International Mechanical Code*, automatic sprinklers shall be provided in ducts conveying hazardous exhaust or flammable or combustible materials.

**Exception:** Ducts where the largest cross-sectional diameter of the duct is less than 10 inches (254 mm).

❖ Section 510 of the IMC addresses the requirements for hazardous exhaust systems. To protect against the spread of fire within a hazardous exhaust system and to prevent a duct fire from involving the building, an automatic sprinkler system must be installed to protect the exhaust duct system. Where materials conveyed in the ducts are not compatible with water, alternative extinguishing agents should be used. The fire suppression requirement is intended to apply to exhaust systems having an actual fire hazard. An automatic sprinkler system in the duct would be of little value for an exhaust system that conveys only nonflammable or noncombustible materials, fumes, vapors or gases.

The exception recognizes the reduced hazard associated with smaller ducts and the impracticality of installing sprinkler protection. Another exception in the IMC indicates that laboratory hoods that meet specific provisions of the IMC are not required to be suppressed. Because the IMC is more specific in this

regard, it should be consulted for the proper application of the exception.

**903.2.11.5 Commercial cooking operations.** An *automatic sprinkler system* shall be installed in commercial kitchen exhaust hood and duct systems where an *automatic sprinkler system* is used to comply with Section 904.

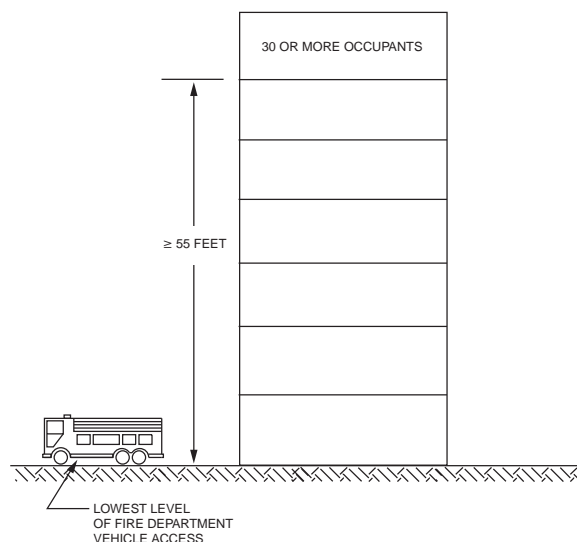
❖ An automatic suppression system is required for commercial kitchen exhaust hood and duct systems where required by Section 609 or by the IMC to have a Type I hood. Type I hoods are required for commercial cooking equipment that produces grease-laden vapors or smoke. Section 904.12 recognizes that alternative extinguishing systems other than an automatic sprinkler system may be used. Where an automatic sprinkler system is used for commercial cooking operations, it must comply with the requirements identified in Section 904.11.4.

**903.2.11.6 Other required suppression systems.** In addition to the requirements of Section 903.2, the provisions indicated in Table 903.2.11.6 require the installation of a fire suppression system for certain buildings and areas.

❖ In addition to Section 903.2, requirements for automatic fire suppression systems are also found elsewhere in the code as indicated in Table 903.2.11.6.

**TABLE 903.2.11.6.** See page 9-26.

❖ Table 903.2.11.6 identifies other sections of the code that require an automatic fire suppression system based on the specific occupancy or use because of the unique hazards of such use or occupancy. The table does not identify the various sections of the code that contain design alternatives based on the use of an automatic fire suppression system, typically an automatic sprinkler system.



For SI: 1 foot = 304.8 mm.

**Figure 903.2.11.3**  
**SPRINKLER REQUIREMENTS: OCCUPANTS 55 FEET OR GREATER FROM FIRE DEPARTMENT VEHICLE ACCESS**

**TABLE 903.2.11.6  
ADDITIONAL REQUIRED FIRE SUPPRESSION SYSTEMS**

SECTION	SUBJECT
914.2.1	Covered and open mall buildings
914.3.1	High-rise buildings
914.4.1	Atriums
914.5.1	Underground structures
914.6.1	Stages
914.7.1	Special amusement buildings
914.8.2	Airport traffic control towers
914.8.3, 914.8.6	Aircraft hangars
914.9	Flammable finishes
914.10	Drying rooms
914.11.1	Ambulatory care facilities
1029.6.2.3	Smoke-protected assembly seating
1103.5.1	Pyroxylin plastic storage in existing buildings
1103.5.2	Existing Group I-2 occupancies
1103.5.3	Existing Group I-2 Condition 2 occupancies
1103.5.4	Pyroxylin plastics
2108.2	Dry cleaning plants
2108.3	Dry cleaning machines
2309.3.2.6.2	Hydrogen motor fuel-dispensing area canopies
2404.2	Spray finishing in Group A, E, I or R
2404.4	Spray booths and spray rooms
2405.2	Dip-tank rooms in Group A, I or R
2405.4.1	Dip tanks
2405.9.4	Hardening and tempering tanks
2703.10	HPM facilities
2703.10.1.1	HPM work station exhaust
2703.10.2	HPM gas cabinets and exhausted enclosures
2703.10.3	HPM exit access corridor
2703.10.4	HPM exhaust ducts
2703.10.4.1	HPM noncombustible ducts
2703.10.4.2	HPM combustible ducts
2807.3	Lumber production conveyor enclosures
2808.7	Recycling facility conveyor enclosures
3006.1	Class A and B ovens
3006.2	Class C and D ovens
Table 3206.2	Storage fire protection
3206.4	Storage
5003.8.4.1	Gas rooms
5003.8.5.3	Exhausted enclosures
5004.5	Indoor storage of hazardous materials
5005.1.8	Indoor dispensing of hazardous materials
5104.4.1	Aerosol warehouses

(continued)

**TABLE 903.2.11.6—continued  
ADDITIONAL REQUIRED FIRE SUPPRESSION SYSTEMS**

SECTION	SUBJECT
5106.3.2	Aerosol display and merchandising areas
5204.5	Storage of more than 1,000 cubic feet of loose combustible fibers
5306.2.1	Exterior medical gas storage room
5306.2.2	Interior medical gas storage room
5306.2.3	Medical gas storage cabinet
5606.5.2.1	Storage of smokeless propellant
5606.5.2.3	Storage of small arms primers
5704.3.7.5.1	Flammable and combustible liquid storage rooms
5704.3.8.4	Flammable and combustible liquid storage warehouses
5705.3.7.3	Flammable and combustible liquid Group H-2 or H-3 areas
6004.1.2	Gas cabinets for highly toxic and toxic gas
6004.1.3	Exhausted enclosures for highly toxic and toxic gas
6004.2.2.6	Gas rooms for highly toxic and toxic gas
6004.3.3	Outdoor storage for highly toxic and toxic gas
6504.1.1	Pyroxylin plastic storage cabinets
6504.1.3	Pyroxylin plastic storage vaults
6504.2	Pyroxylin plastic storage and manufacturing

For SI: 1 cubic foot = 0.023 m<sup>3</sup>.

**903.2.12 During construction.** *Automatic sprinkler systems* required during construction, *alteration* and demolition operations shall be provided in accordance with Section 3313.

❖ Chapter 14 of the code and Chapter 33 of the IBC address fire safety requirements during construction, alteration or demolition work. Working sprinkler systems should remain operative at all times unless it is absolutely necessary to shut down the system because of the proposed work. All sprinkler system impairments should be rectified as quickly as possible unless specific prior approval has been obtained from the fire code official. Buildings with a required sprinkler system should not be occupied unless the sprinkler system has been installed and tested consistent with Section 901.5.1. If the system must be placed out of service, the requirements of Section 901.7 are necessary to address the temporary impairment to the fire protection system.

**903.3 Installation requirements.** *Automatic sprinkler systems* shall be designed and installed in accordance with Sections 903.3.1 through 903.3.8.

❖ Specific design, installation and testing criteria are given for automatic sprinkler systems in the sections and subsections that follow, as well as an indication of the applicability of a nationally recognized standard in the area. The information required to complete a thorough review of an automatic sprinkler system is listed in Commentary Figure 903.3.

**1. Information required on shop drawings includes:**

- Name of owner and occupant
- Location, including street address
- Point of compass
- Graphic indication of scale
- Ceiling construction
- Full-height cross section
- Location of fire walls
- Location of partitions
- Occupancy of each area or room
- Location and size of blind spaces and closets
- Any questionable small enclosures in which no sprinklers are to be installed
- Size of city main in street, pressure and whether dead end or circulation and, if dead end, direction and distance to nearest circulating main, city main test results
- Other source of water supply, with pressure or elevation
- Make, type and orifice size of sprinkler
- Temperature rating and location of high-temperature sprinklers
- Limitations on extended coverage sprinklers or other special sprinkler types
- Number of sprinklers on each riser and on each system by floors and total area by each system on each floor
- Make, type, model and size of alarm or dry pipe valve
- Make, type, model and size of preaction or deluge valve
- Type and location of alarm bells
- Backflow prevention method and details
- Total number of sprinklers on each dry pipe system or preaction deluge system
- Approximate capacity in gallons or each dry pipe system
- Setting for pressure-reducing valves
- Pipe size, type, and schedule of wall thickness
- Cutting lengths of pipe (or center-to-center dimensions)
- Type of fittings, riser nipples and size, and all welds and bends
- Type and location of hangers, inserts and sleeves
- Calculations of loads and details for sway bracing
- All control valves, checks, drain pipes, flushing, and test pipes
- Size and location of standpipe risers and hose outlets
- Small hand-hose equipment
- Underground pipe size, length, location, weight, material, point of connection to city main; the type of valves, meters and valve pits; and the depth that top of the pipe is laid below grade
- Size and location of hydrants along with hose-houses
- Size and location of fire department connections
- When the equipment is to be installed as an addition to an old group of sprinklers without additional feed from the yard system, enough of the old system shall be indicated on the plans to show the total number of sprinklers to be supplied and to make all connections clear
- Information to be provided on the hydraulic nameplate
- Name, address and phone number of contractor and sprinkler designer
- Hydraulic reference points shall be shown by a number and/or letter designation and shall correspond with comparable reference points shown on the hydraulic calculation sheets
- System design criteria showing the minimum rate of water application (density), the design area of water application and the water required for hose streams both inside and outside
- Actual calculated requirements showing the total quantity of water and the pressure required at a common reference point for each system
- Elevation data showing elevations of sprinklers, junction points and supply or reference points
- Protected wall openings if room design method is used

**2. Information required on calculations includes:**

- Location
  - Name of owner and occupant
  - Building identification
  - Description of hazard
  - Name and address of contractor and designer
  - Name of approving agency
- 3. System design requirements include:**
- Design area of water application
  - Minimum rate of water application (density)
  - Area of sprinkler coverage
  - Hazard or commodity classification
  - Building height
  - Storage height
  - Storage method
  - Total water requirements, as calculated, including allowance for hose demand water supply information and allowance for in-rack sprinklers
  - Location and elevation static and residual test gauge with relation to the riser reference point
  - Size and location of hydrants used for flow test data
  - Flow location
  - Static pressure, psi
  - Residual pressure, psi
  - Flow, gpm
  - Date
  - Time
  - Test conducted by whom
  - Sketch to accompany gridded system calculations to indicate flow quantities and directions for lines with sprinklers operated in the remote area

**4. Additional information necessary for complete review includes:**

- Sprinkler description and discharge constant (K-value)
- Hydraulic reference points
- Flow, gpm
- Pipe diameter (actual internal diameter)
- Pipe length
- Equivalent pipe length for fittings and components
- Friction loss in psi per foot of pipe
- Total friction loss between reference points
- Elevation difference between reference points
- Required pressure in psi at each reference point
- Velocity pressures and normal pressure if included in calculations
- Notes to indicate starting points, reference to other sheets or clarification of data
- Information on antifreeze solution (type and quantity)
- Water treatment system information including reason for treatment and program details

**5. Included with the submittal must be a graph sheet showing water supply curves and system requirements including:**

- Hose demand plotted on semilogarithmic graph paper so as to present a graphic summary of the complete hydraulic calculations
- Sprinkler system demand including in-rack sprinklers (if applicable)

**Figure 903.3**  
**SAMPLE SPRINKLER SYSTEM DRAWING AND DATA SUBMITTALS**

**903.3.1 Standards.** Sprinkler systems shall be designed and installed in accordance with Section 903.3.1.1, unless otherwise permitted by Sections 903.3.1.2 and 903.3.1.3 and other chapters of this code, as applicable.

❖ Automatic sprinkler systems are to be installed to comply with the code and NFPA 13, 13R or 13D. As provided for in Section 102.7.1, where differences occur between the code and NFPA 13, 13R or 13D, the code applies. The fire code official also has the authority to approve the type of sprinkler system to be installed. See Commentary Figure 903.3.1 for typical design parameters for each type of sprinkler system.

This section also provides a pointer to other sections of the code that might provide more specific or detailed sprinkler requirements such as those found in Chapters 23 and 24 of the code.

**903.3.1.1 NFPA 13 sprinkler systems.** Where the provisions of this code require that a building or portion thereof be equipped throughout with an *automatic sprinkler system* in accordance with this section, sprinklers shall be installed throughout in accordance with NFPA 13 except as provided in Sections 903.3.1.1.1 and 903.3.1.1.2.

❖ NFPA 13 contains the minimum requirements for the design and installation of automatic water sprinkler systems and exposure protection sprinkler systems. The requirements contained in the standard include the character and adequacy of the water supply and the selection of sprinklers, piping, valves and all of the materials and accessories. The standard does not include detailed requirements for installation of private fire service mains and their appurtenances; installation of fire pumps or construction and installation of gravity and pressure tanks and towers.

NFPA 13 defines seven classifications or types of water sprinkler systems: wet pipe (see Commentary Figure 903.3.1.1); dry pipe; preaction or deluge; combined dry pipe and preaction; antifreeze systems; sprinkler systems that are designed for a special purpose and outside sprinklers for exposure protection. While numerous variables must be considered in selecting the proper type of sprinkler system, the wet-pipe sprinkler system is recognized as the most effective and efficient. The wet-pipe system is also the

most reliable type of sprinkler system, because water under pressure is available at the sprinkler. Therefore, wet-pipe sprinkler systems are recommended wherever possible.

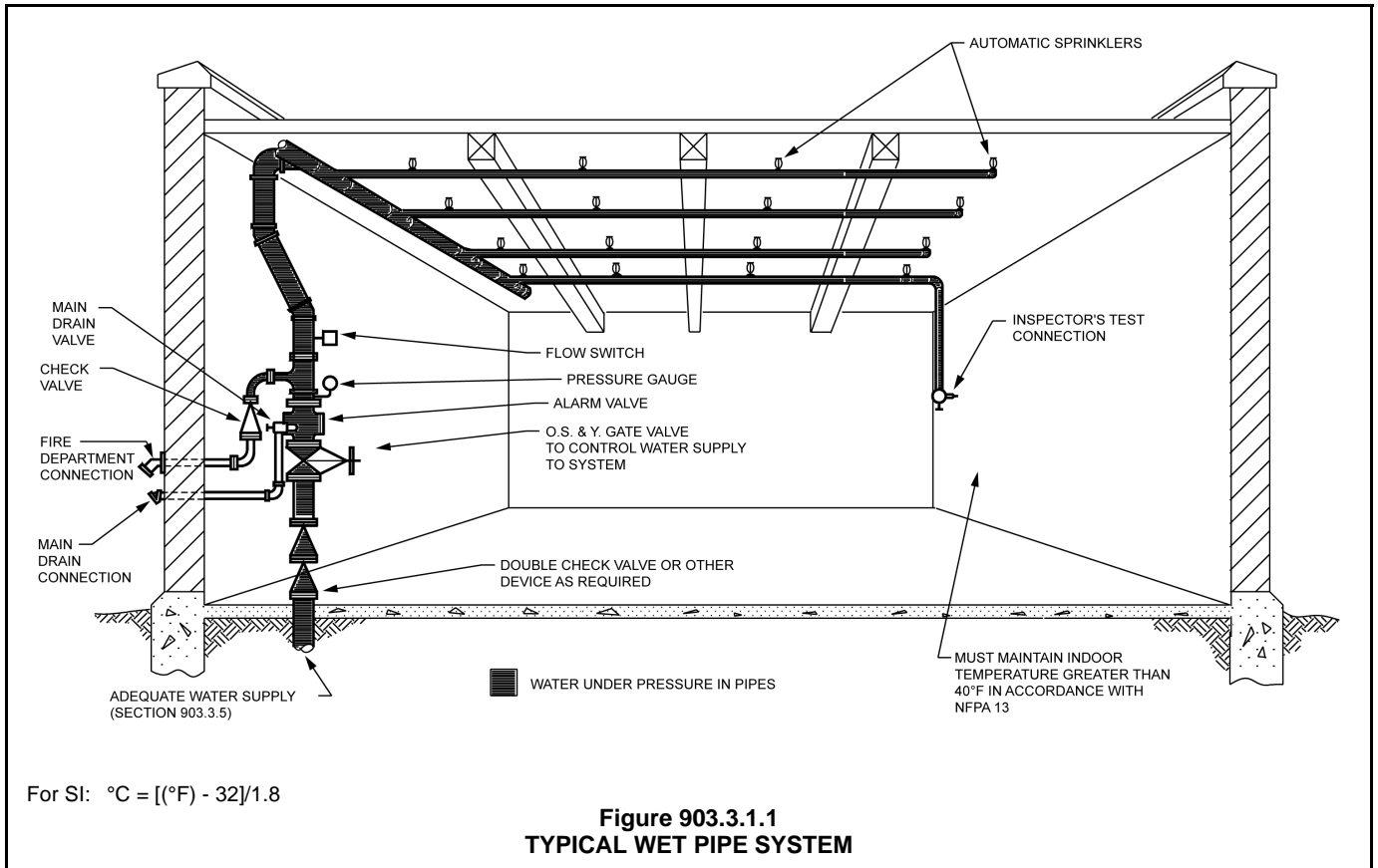
The extent of coverage and distribution of sprinklers is based on the NFPA 13 standard. Numerous conditions exist in the standard where sprinklers are specifically required and also where they may or may not be located. Once it is determined that the sprinkler system is to be in accordance with NFPA 13, that standard must be reviewed for installation details. For example, exterior spaces such as combustible canopies are required to be equipped with sprinklers according to Section 8.15.7 of NFPA 13 where the canopy extends for a distance of 4 feet (1219 mm) or more. A 3-foot (914 mm) combustible canopy would not require sprinklers nor would a 6-foot (1829 mm) canopy constructed of noncombustible materials, provided there is no combustible storage under the canopy.

Because installation is required to be in accordance with NFPA 13, if the standard allows for the omission of sprinklers in any location, then the building is still considered as being sprinklered throughout. For example, Section 8.15.8.1.1 of NFPA 13 allows sprinklers to be omitted from bathrooms in dwelling units in hotels and motels. If sprinklers are not provided in the bathrooms due to the conditions stipulated in NFPA 13, the building would still be considered as sprinklered throughout in accordance with the code, NFPA 13 and the IBC.

Exceptions for the use of NFPA 13R and 13D systems are addressed throughout the code when exceptions based upon the use of sprinklers are provided. More specifically, if the use of these other standards is appropriate, it will be noted within the exception. For a building to be considered “equipped throughout” with an NFPA 13 sprinkler system, complete protection must be provided in accordance with the referenced standard, subject to the exempt locations indicated in Section 903.3.1.1.1. See Commentary Figure 904.2.1 for examples of requirements modified through the use of sprinkler systems.

	NFPA 13	NFPA 13R	NFPA 13D
Extent of protection	Equip throughout (Section 903.3.1.1)	Occupied spaces (Section 903.3.1.2)	Occupied spaces (Section 903.3.1.3)
Scope	All occupancies	Low-rise residential	One- and two-family dwellings
Sprinkler design	Density/area concept	4-head design	2-head design
Sprinklers	All types	Residential only	Residential only
Duration	30 minutes (minimum)	30 minutes	10 minutes
Advantages	Property and life protection	Life safety/tenability	Life safety/tenability

**Figure 903.3.1**  
**NFPA 13, NFPA 13R, NFPA 13D SYSTEMS**



**903.3.1.1.1 Exempt locations.** Automatic sprinklers shall not be required in the following rooms or areas where such rooms or areas are protected with an *approved* automatic fire detection system in accordance with Section 907.2 that will respond to visible or invisible particles of combustion. Sprinklers shall not be omitted from a room merely because it is damp, of fire-resistance-rated construction or contains electrical equipment.

1. A room where the application of water, or flame and water, constitutes a serious life or fire hazard.
2. A room or space where sprinklers are considered undesirable because of the nature of the contents, where *approved* by the *fire code official*.
3. Generator and transformer rooms separated from the remainder of the building by walls and floor/ceiling or roof/ceiling assemblies having a *fire-resistance rating* of not less than 2 hours.
4. Rooms or areas that are of noncombustible construction with wholly noncombustible contents.
5. Fire service access elevator machine rooms and machinery spaces.
6. Machine rooms, machinery spaces, control rooms and control spaces associated with occupant evacuation elevators designed in accordance with Section 3008 of the *International Building Code*.

❖ This section allows the omission of sprinkler protection in certain locations if an approved automatic fire detection system is installed. Buildings in compliance with one of the five listed conditions would still be considered fully sprinklered throughout in compliance with the code and NFPA 13 and thus would be eligible for all applicable code alternatives, exceptions or reductions. Elimination of the sprinkler system in a sensitive area is subject to the approval of the fire code official.

Condition 1 addresses restrictions where the application of water could create a hazardous condition. For example, sprinkler protection is to be avoided where it is not compatible with certain stored materials (i.e., some water-reactive hazardous materials such as calcium carbide). Combustible metals, such as magnesium and aluminum, may burn so intensely that the use of water to attempt fire control will only intensify the reaction.

It is not the intent of Condition 2 to omit sprinklers solely because of a potential for water damage. A desire to not sprinkler a certain area (such as a computer room or operating room) does not fall within the limitations of the exception unless there is something unique about the space that would result in water being incompatible. A computer room can be adequately protected using an automatic sprinkler system or an alternative gaseous suppression agent system or a combination of these systems. The intent of Condition 2 is to consider whether or not the contents would react adversely to the application of water. It is important to note that the fire code official

must approve the use of this item. Note also that with respect to computer rooms, NFPA 75—*Protection of Information Technology Equipment* (not a referenced standard), recognizes automatic sprinklers as the primary fire protection of computer rooms.

Condition 3 recognizes the low fuel load and low occupancy hazards associated with generator and transformer rooms and, therefore, allows the omission of sprinkler protection if the rooms are separated from adjacent areas by 2-hour fire-resistance-rated construction. This condition assumes the room is not used for any combustible storage. This condition is similar to Section 8.15.11.3 of NFPA 13, which exempts electrical equipment rooms from sprinkler protection, provided the room is dedicated to the use of dry-type electrical equipment, is constructed as a 2-hour fire-resistance-rated enclosure and is not used for combustible storage.

Condition 4 requires the construction of the room or area, as well as the contents, to be noncombustible. An example would be an area in an unprotected steel frame building (Type IIB construction) used for steel or concrete block storage. Neither involves any significant combustible packaging or sources of ignition, and few combustibles are present (see Commentary Figure 903.3.1).

Condition 5 addresses the concern for elevator machine rooms and machinery spaces associated with fire service access elevators as required for buildings with occupied floors greater than 120 feet (36.58 m) from the lowest level of fire department access by Sections 403.6.1 and 3007 of the IBC. These elevators need to work during fire situations and their operation cannot be threatened by the activation of a sprinkler in a machine room or space that may affect the operation of the elevator. Fire service access elevators are required to be continuously monitored at the fire command center in accordance with Section 3007.7 of the IBC.

Condition 6, similar to Condition 5, exempts sprinklers from the machine rooms and machinery spaces, control rooms and control spaces for occupant evacuation elevators. Like fire service access elevators, these elevators need to work during fire situations and their operation cannot be threatened by the activation of a sprinkler in a machine room or machinery spaces. Such elevators are required to be monitored at the fire command center in accordance with Section 3008.7 of the IBC.

**903.3.1.1.2 Bathrooms.** In Group R occupancies, other than Group R-4 occupancies, sprinklers shall not be required in bathrooms that do not exceed 55 square feet (5 m<sup>2</sup>) in area and are located within individual *dwelling units* or *sleeping units*, provided that walls and ceilings, including the walls and ceilings behind a shower enclosure or tub, are of noncombustible or limited-combustible materials with a 15-minute thermal barrier rating.

❖ This provision was added to the code to reinstate an exception of NFPA 13 that had been in existence

since 1976 but deleted for all but dwelling units in motels and hotels (NFPA Section 8.15.8.1.1) from the 2013 edition of NFPA 13.

Although reinstating the small bathroom exception will have a limited impact on new construction because many modern bathrooms exceed the 55-square-foot area limit in the exception to accommodate wheelchair access, the more important consequence will be removing an unnecessary cost increase for building owners who choose to retrofit existing properties with small bathrooms that were built before it was common to provide wheelchair access. Codes and standards should not erect any unnecessary barriers to retrofitting sprinklers into existing properties, such as existing high-rise buildings.

In the 1976 edition of the Life Safety Code (NFPA 101), to encourage cost-effective fire protection systems for apartment buildings, Section 11-3.8.3.4.1 provided an exception to permit bathrooms that did not exceed 55-square-foot within individual dwelling units to omit sprinklers when the apartment building was sprinklered in accordance with NFPA 13. The basis of the 55-square-foot area is that this area accommodates a “typical” small bathroom that contains a standard tub, a toilet and a sink and nothing more. This exception was later duplicated from NFPA 101 into the 1991 edition of NFPA 13 with the understanding that the next edition of NFPA 101 (1994) could delete the exception, since NFPA 13 would have it covered. NFPA 101-1994 then, as planned, deleted the exception.

The history of apartment unit bathroom fires is statistically minimal. According to the recent NFPA *Home Structure Fire Report*, January 2009, Table 9B, “Reported Apartment Structure Fires by Area of Origin 2003-2006 Annual Averages”, out of 113,000 fires/year, only 1600 (1 percent) are in bathrooms. Given that there are more than 35 years of experience with the bathroom sprinkler exception being in place (since it was put into NFPA 101 in 1976), it would certainly be reasonable to expect anecdotal or statistical experience to indicate the existence of a problem, if there were one.

**903.3.1.2 NFPA 13R sprinkler systems.** *Automatic sprinkler systems* in Group R occupancies up to and including four stories in height in buildings not exceeding 60 feet (18 288 mm) in height above grade plane shall be permitted to be installed throughout in accordance with NFPA 13R.

The number of stories of Group R occupancies constructed in accordance with Sections 510.2 and 510.4 of the *International Building Code* shall be measured from the horizontal assembly creating separate buildings.

❖ NFPA 13R contains design and installation requirements for a sprinkler system to aid in the detection and control of fires in low-rise (four stories or less) residential occupancies.

Sprinkler systems designed in accordance with NFPA 13R are intended to prevent flashover (total

involvement) in the room of fire origin and to improve the chance for occupants to escape or be evacuated. The design criteria in NFPA 13R are similar to those in NFPA 13 except that sprinklers may be omitted from areas in which fatal fires in residential occupancies do not typically originate (bathrooms, closets, attics, porches, garages and concealed spaces).

A common question is whether a mixed occupancy building which contains a Group R occupancy could still use NFPA 13R for the design. If one of the mixed-use occupancies would require a sprinkler system throughout the building in accordance with NFPA 13, then a 13R system would not be allowed. If, however, the only reason a sprinkler system is being installed is because there is a Group R fire area, then a NFPA 13R system would be an appropriate design choice. The areas that are not classified as Group R would require protection in accordance with NFPA 13.

It must be noted that although the building would be considered sprinklered throughout in accordance with NFPA 13R, not all of the code sprinkler alternatives could be applied. Any alternative that requires the installation of an NFPA 13 system would not be applicable if a portion of the building utilizes an NFPA 13R system.

The code provisions that allow for an increase in building height according to Section 504.3 of the IBC do not compound this section. NFPA 13R is applicable to buildings that are up to four stories in height and 60 feet in height above grade plane. If the design of a residential building intends to take advantage of the sprinkler height increase so that the building is five stories or more, the sprinkler system must be an NFPA 13 system. Because this section limits the height to four stories, four stories is the maximum height for a building that can utilize an NFPA 13R system. This is consistent with the scoping provisions in the NFPA 13R standard.

The limitation of four stories in height is to be measured with respect to the established grade plane, which is consistent with IFC Interpretation No. 43-03. As such, a basement would not be considered a story above grade for purposes of determining the applicability of this section.

The second paragraph recognizes the application of the requirements of Sections 510.2 and 510.4 of the IBC which are essentially exceptions to the height and area requirements. This exception is based on providing a horizontal fire separation similar to the concept of a fire wall to create separate buildings. This establishes that the height in stories can be measured from the horizontal assembly instead of from grade plane. The height in feet would still be limited to being measured from grade plane. Such buildings are often referred to as “pedestal buildings.”

**903.3.1.2.1 Balconies and decks.** Sprinkler protection shall be provided for exterior balconies, decks and ground floor patios of *dwelling units* and *sleeping units* where the building is of Type V construction, provided there is a roof or deck above. Sidewall sprinklers that are used to protect such areas

shall be permitted to be located such that their deflectors are within 1 inch (25 mm) to 6 inches (152 mm) below the structural members and a maximum distance of 14 inches (356 mm) below the deck of the exterior balconies and decks that are constructed of open wood joist construction.

❖ Balconies, decks and patios in buildings of Type V construction and used for Group R occupancies are required to have sprinkler protection when there is a roof or deck above. This is in addition to the requirements of NFPA 13R, which primarily addresses the life safety of occupants and not property protection. The intent is to address hazards such as grilling and similar activities. Since NFPA 13R does not require such coverage, there is potential that a fire on a balcony could grow much too large for the system within the building to handle. The concern is that a potential exterior balcony fire could spread to unprotected floor/ceiling assemblies and attic spaces and result in major property damage. Section 308.1.4 specifically addresses restrictions on open flame cooking devices used on combustible balconies.

Regardless of whether the exterior walking surface is attached to the building and called a balcony or is a freestanding structure such as a deck or patio the concern for fire ignition in the area adjacent to the exterior wall is the same. Sidewall sprinklers should be selected based on the area of coverage and climate. If the potential for freezing exists, a dry sidewall sprinkler should be used. Where the overhanging deck or balcony is extensive, an extended coverage sprinkler should be selected.

**903.3.1.2.2 Open-ended corridors.** Sprinkler protection shall be provided in *open-ended corridors* and associated *exterior stairways* and *ramps* as specified in Section 1027.6, Exception 3.

❖ This section is simply emphasizing the fact that, since there is no separation from the exterior exit stairways, sprinklers would be required when using an NFPA 13R system. Section 1027.6, Exception 3 allows the separation between the open-ended corridor and exterior exit stairway to be omitted, but only where several conditions are met. The primary condition is that the corridor be sprinklered. A definition of “Open-ended corridor” is provided in Chapter 2. See Commentary Figure 903.3.1.2.2 for an example of an open-ended corridor.

**903.3.1.3 NFPA 13D sprinkler systems.** *Automatic sprinkler systems* installed in one- and two-family dwellings; Group R-3; Group R-4 Condition 1 and townhouses shall be permitted to be installed throughout in accordance with NFPA 13D.

❖ NFPA 13D contains design and installation requirements for a sprinkler system to aid in the detection and control of fires in one- and two-family dwellings, mobile homes and townhouses. This section also specifically allows the use of an NFPA 13D system for occupancies classified as Group R-3 and Group R-4 Condition 1. Group R-3 are one- and two-family

dwellings that fall outside the scope of the IRC and also those buildings housing small congregate living facilities and boarding houses. These facilities operate very similar to a single-family home and the level of the ability of the occupants is such that little assistance is needed for self-evacuation. This is consistent with the NFPA 13D requirements and is also consistent with FHA court cases based on nondiscrimination for group homes.

Similar to NFPA 13R, sprinkler systems designed in accordance with NFPA 13D are intended to prevent flashover (total involvement) in the room of fire origin and to improve the chance for occupants to escape or be evacuated. Although the allowable omission of sprinklers in certain areas of the dwelling unit in NFPA 13D is similar to that in NFPA 13R, the water supply requirements are less restrictive. NFPA 13D uses a two-head sprinkler design with a 10-minute duration requirement, while NFPA 13R uses a four-head sprinkler design with a 30-minute duration requirement. The decreased water supply requirement emphasizes the main intent of NFPA 13D to control the fire and maintain tenability during evacuation of the residence.

**903.3.2 Quick-response and residential sprinklers.** Where *automatic sprinkler systems* are required by this code, quick-response or residential automatic sprinklers shall be installed



**Figure 903.3.1.2.2  
OPEN-ENDED CORRIDOR**

in all of the following areas in accordance with Section 903.3.1 and their listings:

1. Throughout all spaces within a smoke compartment containing care recipient *sleeping units* in Group I-2 in accordance with the *International Building Code*.
  2. Throughout all spaces within a smoke compartment containing treatment rooms in ambulatory care facilities.
  3. *Dwelling units* and *sleeping units* in Group I-1 and R occupancies.
  4. Light-hazard occupancies as defined in NFPA 13.
- ❖ Quick-response and residential sprinklers are similar in nature. They use a lighter material for the operating mechanism, thus reducing the heat lag in the element. The faster the heat can be absorbed, the sooner the sprinkler will begin to discharge water. Quick-response sprinklers have shown that they operate up to 25 percent faster than traditional sprinklers and create conditions in the room of origin that significantly increase the tenability of the environment. In tests performed by Factory Mutual (FM) for the Federal Emergency Management Agency (FEMA), the gas temperature in the room of origin was 550°F (288°C) with quick-response sprinklers, while it was 1,470°F (799°C) for conventional sprinklers at the time of sprinkler activation. More importantly, while the carbon monoxide (CO) level was 1,860 ppm for conventional sprinklers, the CO level when tested with quick-response sprinklers was only around 350 ppm. Comparatively, the National Institute of Occupational Safety and Health (NIOSH) considers the IDLH (immediately dangerous to life and health) level of CO to be 1,200 ppm. Thus, quick-response sprinklers have been shown to add significantly to the life safety effects of standard sprinkler systems.

Condition 1 requires the use of approved quick-response or residential sprinklers in smoke compartments containing care recipient sleeping units in Group I-2 occupancies. Even though properly operating standard sprinklers are effective, the extent of fire growth and smoke production that can occur before sprinkler activation creates the need for early warning to enable faster response by care providers and initiation of egress that is critical in occupancies containing persons incapable of self-preservation. The faster response time associated with quick-response or residential sprinklers increases the probability that the sprinklers will actuate before the care recipient's life would be threatened by a fire in his or her room.

Condition 2 requires the use of approved quick-response or residential sprinklers in smoke compartments containing treatment rooms in ambulatory care facilities. The justification is the same as that for Condition 1. When there is a potential for care recipients to be incapable of self-preservation, the use of residential sprinkler or quick-response sprinklers are critical.

Because of the kind of occupants sleeping in Group

R and I-1 occupancies, as indicated in Condition 3, a faster responding type of sprinkler is desirable. Similar to the first condition, because occupants will be sleeping, the use of quick-response sprinklers creates additional safety by reducing sprinkler response time, thereby increasing the time available for egress and allowing for the time necessary for occupants to wake up and recognize the emergency event.

Condition 4 recognizes light-hazard occupancies in accordance with NFPA 13. These could include restaurants, schools, office buildings, places of religious worship and similar occupancies where the fire load and potential heat release of combustible contents are low.

**903.3.3 Obstructed locations.** Automatic sprinklers shall be installed with due regard to obstructions that will delay activation or obstruct the water distribution pattern. Automatic sprinklers shall be installed in or under covered kiosks, displays, booths, concession stands or equipment that exceeds 4 feet (1219 mm) in width. Not less than a 3-foot (914 mm) clearance shall be maintained between automatic sprinklers and the top of piles of *combustible fibers*.

**Exception:** Kitchen equipment under exhaust hoods protected with a fire-extinguishing system in accordance with Section 904.

❖ To provide adequate sprinkler coverage, sprinkler protection must be extended under any obstruction that exceeds 4 feet (1219 mm) in width. Large air ducts are another common obstruction where sprinklers are routinely extended beneath the duct. The 3-foot (914 mm) storage clearance requirement for combustible fibers is caused by their potential high heat release. Most storage conditions require only a minimum 18-inch (457 mm) storage clearance to combustibles, depending on the type of sprinklers used and their actual storage conditions.

The exception recognizes that an alternative extinguishing system is permitted for commercial cooking systems in place of sprinkler protection for exhaust hoods that may be more than 4 feet (1219 mm) wide.

The application of this section is more critical to the ongoing use of the space. The obstruction conditions, therefore, should have already been addressed during plan review and installation inspection. This section gives the fire official and building owner adequate information to avoid the most typical obstruction-related issues in terms of proper sprinkler coverage.

**903.3.4 Actuation.** *Automatic sprinkler systems* shall be automatically actuated unless specifically provided for in this code.

❖ The intent of this section is to eliminate the need for occupant intervention during a fire. As such, it is assumed that it will not be necessary for a person to manually open a valve or perform some other physical activity in order to allow the sprinkler system to activate.

Wet-pipe and dry-pipe sprinkler systems, for exam-

ple, are essentially fail-safe systems in the sense that, if the system is in proper operating condition, it will operate once a sprinkler fuses. Dry systems have an inherent time lag for water to reach the sprinkler; therefore, the response is not as fast as for a wet-pipe system. Other types of sprinkler systems, such as preaction and deluge, rely on the actuation of a detection system to operate the sprinkler valve.

**903.3.5 Water supplies.** Water supplies for *automatic sprinkler systems* shall comply with this section and the standards referenced in Section 903.3.1. The potable water supply shall be protected against backflow in accordance with the requirements of this section and the *International Plumbing Code*. For connections to public waterworks systems, the water supply test used for design of fire protection systems shall be adjusted to account for seasonal and daily pressure fluctuations based on information from the water supply authority and as approved by the *fire code official*.

❖ To be effective, all sprinkler systems must have an adequate supply of water. The criteria for an acceptable water supply are contained in the standards referenced in Section 903.3.1. For example, NFPA 13 contains criteria for different types of water supplies as well as the methods to determine the pressure, flow capabilities and capacity necessary to get the intended performance from a sprinkler system. An acceptable water supply could consist of a reliable municipal supply, a gravity tank or a fire pump with a pressure tank or a combination of these.

This section also establishes the requirements for protecting the potable water system against a nonpotable source, such as stagnant water retained within the sprinkler piping. As stated in Section 608.16.4 of the IPC, an approved double check valve device or reduced pressure principle backflow preventer is required.

The other issue addressed by this section is fluctuations in water pressure. Information on pressure fluctuation is necessary to not only ensure that the minimum required pressure will be available for the automatic sprinkler system, but also to ensure that high pressures do not exceed the limitations of the sprinkler system. If the water pressure on a sprinkler system exceeds 100 psi, changes in the hanging methods are required. Also, if a fire pump is provided, it might be possible to exceed 175 psi, which is typically considered the maximum working pressure for a sprinkler system. These are just additional reasons why it is critical to account for pressure fluctuations in the water supply. Obviously, fire flows can be affected by this, as well as other water-based fire protection systems, such as standpipes, which require a minimum 100 psi at the roof of high-rise buildings and such may not be available due to pressure fluctuations. With regards to gathering of data, this requirement is simply intended to make sure that pressure fluctuations are addressed in accordance with the water supply authority to the extent that such informa-

tion is available. Further authority is provided to the fire code official to accept other documentation.

**903.3.5.1 Domestic services.** Where the domestic service provides the water supply for the *automatic sprinkler system*, the supply shall be in accordance with this section.

❖ This section establishes the scope of domestic services for residential combination services. Essentially, compliance with Section 903.3.5 is required.

**903.3.5.2 Residential combination services.** A single combination water supply shall be allowed provided that the domestic demand is added to the sprinkler demand as required by NFPA 13R.

❖ NFPA 13R permits a common supply main to a building to serve both the sprinkler system and domestic services if the domestic demand is added to the sprinkler demand. NFPA 13R systems do not provide the same level of property protection as NFPA 13 systems.

**903.3.6 Hose threads.** Fire hose threads and fittings used in connection with *automatic sprinkler systems* shall be as prescribed by the *fire code official*.

❖ The threads on connections and fittings that the fire department will use to connect a hose must be compatible with the fire department threads.

Design documents must specify the type of thread to be used in order to be compatible with the local fire department equipment after consultation and coordination with the fire code official. The criteria typically apply to fire department connections for sprinkler and standpipe systems, standpipe hose connections, yard hydrants and wall hydrants.

The majority of fire departments in the United States use the American National Fire Hose Connection Screw Thread also commonly known as the national standard thread (NST) and NS. NFPA 1963 gives the screw thread dimensions and the thread size of threaded connections, with nominal sizes ranging from  $\frac{3}{4}$  inch (19 mm) to 6 inches (152 mm) for the NS thread. Although efforts to standardize fire hose threads began after the Boston conflagration in 1872, there are still many different screw threads, some of which give the appearance of compatibility with the NH thread. While NFPA 1963 may be used as a guide, the code does not require that any particular standard be used. Rather, it is important that the fire code official be consulted for the appropriate thread selection. The intent is that the threads match those of the local department identically so that adapters are not required within the fire department's own district.

**903.3.7 Fire department connections.** Fire department connections for *automatic sprinkler systems* shall be installed in accordance with Section 912.

❖ Section 912, to which this section points, provides a comprehensive set of requirements for fire department connections (FDCs), reducing the opportunity

for any of its requirements to be overlooked. See the commentary to Section 912.

**903.3.8 Limited area sprinkler systems.** Limited area sprinkler systems shall be in accordance with the standards listed in Section 903.3.1 except as provided in Sections 903.3.8.1 through 903.3.8.5.

❖ The use of limited area sprinkler systems is restricted to cases in which the code requires a limited number of sprinklers to protect a specific hazard or area and not a complete automatic sprinkler system. For example, limited area sprinkler systems may be used to protect areas including, but not limited to, stages; storage and workshop areas; painting rooms; trash rooms and chutes; furnace rooms; kitchens and hazardous exhaust systems and incidental uses as regulated in Section 1105.3 of the code and Section 509 of the IBC.

**903.3.8.1 Number of sprinklers.** Limited area sprinkler systems shall not exceed six sprinklers in any single fire area.

❖ In the 2015 edition of the code, the number of sprinklers allowed on a limited area sprinkler system in a fire area has been reduced to only six. In previous editions, up to 19 sprinklers were allowed. This reduced number will limit the type of applications for such systems. In the past, 19 sprinklers may have been able to address an entire building, depending on the system design, more easily allowing the use of the domestic water supply.

**903.3.8.2 Occupancy hazard classification.** Only areas classified by NFPA 13 as Light Hazard or Ordinary Hazard Group 1 shall be permitted to be protected by limited area sprinkler systems.

❖ The use of limited area systems is restricted to only the two lowest hazard occupancy classifications in accordance with NFPA 13. Such systems are fairly limited and can only contain six sprinklers per fire area; because of this, the types of hazards should be limited.

**903.3.8.3 Piping arrangement.** Where a limited area sprinkler system is installed in a building with an automatic wet standpipe system, sprinklers shall be supplied by the standpipe system. Where a limited area sprinkler system is installed in a building without an automatic wet standpipe system, water shall be permitted to be supplied by the plumbing system provided that the plumbing system is capable of simultaneously supplying domestic and sprinkler demands.

❖ Two options are provided for how water to the limited area sprinkler system is to be supplied. If the building contains automatic wet standpipes, then the system must be supplied by the standpipe system. If there is no standpipe system available, connection to the domestic water supply is permitted. The water supply must be analyzed to determine if it is sufficient to supply simultaneously both domestic usage and the sprinkler system demand. This will mean looking at peak water use throughout the day. See Section 903.3.5 and the IPC.

**903.3.8.4 Supervision.** Control valves shall not be installed between the water supply and sprinklers unless the valves are of an *approved* indicating type that are supervised or secured in the open position.

❖ No shutoff valves are permitted in the sprinkler system piping unless the valves are specifically approved and are either supervised or secured in the open position. These restrictions increase the likelihood that the sprinkler system will be operational should a fire occur. Valve supervision or securing a valve in the open position are considered equally reliable by this section.

**903.3.8.5 Calculations.** Hydraulic calculations in accordance with NFPA 13 shall be provided to demonstrate that the available water flow and pressure are adequate to supply all sprinklers installed in any single *fire area* with discharge densities corresponding to the hazard classification.

❖ Hydraulic calculations are required to be in accordance with NFPA 13 to demonstrate that the water system is adequate to supply the sprinkler demand in any particular fire area.

**903.4 Sprinkler system supervision and alarms.** Valves controlling the water supply for *automatic sprinkler systems*, pumps, tanks, water levels and temperatures, critical air pressures and waterflow switches on all sprinkler systems shall be electrically supervised by a *listed* fire alarm control unit.

**Exceptions:**

1. *Automatic sprinkler systems* protecting one- and two-family *dwellings*.
  2. Limited area sprinkler systems in accordance with Section 903.3.8.
  3. *Automatic sprinkler systems* installed in accordance with NFPA 13R where a common supply main is used to supply both domestic water and the *automatic sprinkler system*, and a separate shutoff valve for the *automatic sprinkler system* is not provided.
  4. Jockey pump control valves that are sealed or locked in the open position.
  5. Control valves to commercial kitchen hoods, paint spray booths or dip tanks that are sealed or locked in the open position.
  6. Valves controlling the fuel supply to fire pump engines that are sealed or locked in the open position.
  7. Trim valves to pressure switches in dry, preaction and deluge sprinkler systems that are sealed or locked in the open position.
- ❖ The reliability data on automatic sprinkler systems clearly indicate that a closed valve is the leading cause of sprinkler system failure. There are also a number of other critical elements that contribute to successful sprinkler system operation, including, but not limited to, pumps, water tanks and air pressure maintenance devices; therefore, this section requires that the various critical elements that contribute to an

available water supply and to the function of the sprinkler system be electrically supervised.

Automatic sprinkler systems in one- and two-family dwellings are typically designed to comply with NFPA 13D, which does not require electrical supervision (see Exception 1).

Limited area sprinkler systems are generally supervised by their connection to the domestic water service, although the use of a supervised indicating valve is permitted. Compliance with Section 903.3.8 means that the alarm provisions of this section are not applicable to limited area systems. Consequently, limited area sprinkler systems do not require local alarms or supervision. Again, electrical supervision is required only if a control valve is installed between the riser control valve and the sprinkler system piping.

Similar to limited area sprinkler systems, electrical supervision is not required for NFPA 13R residential combination services when a shutoff valve is not installed (see Exception 3). NFPA 13R sprinkler systems are supervised in that the only way to shut off the sprinkler system is to also shut off the domestic water supply.

The valves discussed in Exceptions 4 through 7 can be sealed or locked in the open position because they do not control the sprinkler system water supply.

**903.4.1 Monitoring.** Alarm, supervisory and trouble signals shall be distinctly different and shall be automatically transmitted to an *approved* supervising station or, where *approved* by the *fire code official*, shall sound an audible signal at a constantly attended location.

**Exceptions:**

1. Underground key or hub valves in roadway boxes provided by the municipality or public utility are not required to be monitored.
  2. Backflow prevention device test valves located in limited area sprinkler system supply piping shall be locked in the open position. In occupancies required to be equipped with a fire alarm system, the backflow preventer valves shall be electrically supervised by a tamper switch installed in accordance with NFPA 72 and separately annunciated.
- ❖ Automatic sprinkler systems must be supervised as a means of determining that the system is operational. A valve supervisory switch operating as a normally open or normally closed switch is usually used. NFPA 72 does not permit valve supervisory switches to be connected to the same zone circuit as the waterflow switch unless it is specifically arranged to actuate a signal that is distinctive from the circuit trouble condition signal.
- Required sprinkler systems are to be monitored by an approved supervising service to comply with NFPA 72. Types of supervising stations recognized in NFPA 72 include central stations, remote supervising stations or proprietary supervising stations.
- A central station is an independent off-site facility

operated and maintained by personnel whose primary business is to furnish, maintain, record and supervise a signaling system. A proprietary system is similar to a central station system; however, a proprietary system is typically an on-site facility monitoring a number of buildings on the same site for the same owner. A remote station system has an alarm signal that is transmitted to a remote location acceptable to the authority having jurisdiction and that is attended 24 hours a day. The receiving equipment is usually located at a fire station, police station, regional emergency communications center or telephone answering service. An alternative use to the three previous supervising methods is an audible signal that can be transmitted to a constantly attended location approved by the fire code official.

Exception 1 recognizes that underground key or hub valves in roadway boxes are not normally supervised or required to be supervised by this section or NFPA 13.

Exception 2 acknowledges that local water utilities and environmental authorities in many instances require, by local ordinances, that backflow prevention devices be installed in limited-area sprinkler system piping. To make the testing and maintenance of backflow prevention devices easier, test valves are installed on each side of the device. These valves are typically indicating-type valves and can function as shutoff valves for the sprinkler system and, therefore, require some level of supervision.

Because these infrequently used valves may be the only feature of protection requiring supervision in occupancies not otherwise required to be equipped with a fire alarm system, Exception 2 permits these valves to be locked in the open position; however, if the occupancy is protected by a fire alarm system, these valves must be equipped with approved valve supervisory devices connected to the fire alarm control panel on a separate (supervisory) zone so that the supervisory signal is transmitted to the designated receiving station. Installation and testing of backflow preventers in sprinkler systems are regulated in Sections 312.10 (testing) and 608.16.4 (devices) of the IPC.

**903.4.2 Alarms.** An approved audible device, located on the exterior of the building in an *approved* location, shall be connected to each *automatic sprinkler system*. Such sprinkler waterflow alarm devices shall be activated by water flow equivalent to the flow of a single sprinkler of the smallest orifice size installed in the system. Where a fire alarm system is installed, actuation of the *automatic sprinkler system* shall actuate the building fire alarm system.

❖ The audible alarm, sometimes referred to as the “outside ringer” or “water-motor gong,” sounds when the sprinkler system has activated. The alarm device may be electrically operated or it may be a true water-motor gong operated by a paddle-wheel-type attachment to the sprinkler system riser that responds to the flow of water in the piping. Though no longer the

alarm device of choice, water-motor gongs do have the advantage of not being subject to power failures within or outside the protected building (see Sections 6.9 and 8.17 of NFPA 13 for further information on these devices). The alarm must be installed on the exterior of the building in a location approved by the fire code official. This location is often in close proximity to the fire department connection (FDC), serving a collateral function of helping the responding fire apparatus engineer more promptly locate the FDC.

The alarm is not intended to be an evacuation alarm. The requirement is also not intended to be an indirect requirement for a fire alarm system. Unless a fire alarm system is required by some other code provision, only the exterior alarm device is required. However, when a fire alarm system is installed, the sprinkler system must be interconnected with the fire alarm system so that when the sprinkler system actuates, it sounds the evacuation alarms required for the fire alarm system.

The primary purpose of the exterior alarm is to notify people outside the building that the sprinkler system is in operation. Originally, it was to act as a supplemental alert so that passersby could notify the fire department of the condition. However, because the code now requires electronic supervision of sprinkler systems, that function is mostly moot. The exterior notification now primarily serves the function of alerting the arriving fire department of which building or sprinkler system is in operation before staging fire-fighting activities for the building.

**903.4.3 Floor control valves.** *Approved* supervised indicating control valves shall be provided at the point of connection to the riser on each floor in high-rise buildings.

- ❖ In high-rise buildings, sprinkler control valves with supervisory initiating devices must be installed at the point of connection to the riser on each floor. Sprinkler control valves on each floor are intended to permit servicing activated systems without impairing the water supply to large portions of the building.

**903.5 Testing and maintenance.** Sprinkler systems shall be tested and maintained in accordance with Section 901.

- ❖ Section 901 contains requirements for the testing and maintenance of sprinkler systems. Acceptance tests are necessary to verify that the system performs as intended by design and by the code. Periodic testing and maintenance are essential to verify that the level of protection designed into the building will be operational whenever a fire occurs. Water-based extinguishing systems must be tested and maintained as required by NFPA 25.

The time schedule for testing and maintenance is included in the various standards referenced in Section 901 and listed in Table 901.6.1. Such maintenance includes annual visual inspection of seismic bracing, periodic lubrication of valves and quarterly testing of water flow alarm devices. An ongoing program for such maintenance and testing should be

established and reports prepared and maintained as noted in Section 901.6.2.

**903.6 Where required in existing buildings and structures.** An *automatic sprinkler system* shall be provided in existing buildings and structures where required in Chapter 11.

- ❖ Chapter 11 of this code, specifically Section 1103.5, requires sprinklers for existing buildings used for the manufacture and storage of pyroxylin plastics, in certain Group A-2 occupancies and in existing Group I-2 occupancies. See the commentary for Sections 1103.5.1 through 1103.5.4 for more detail on the retroactive sprinkler requirements.

## SECTION 904 ALTERNATIVE AUTOMATIC FIRE-EXTINGUISHING SYSTEMS

**904.1 General.** Automatic fire-extinguishing systems, other than *automatic sprinkler systems*, shall be designed, installed, inspected, tested and maintained in accordance with the provisions of this section and the applicable referenced standards.

- ❖ Section 904 covers alternative fire-extinguishing systems that use extinguishing agents other than water. Alternative automatic fire-extinguishing systems include wet-chemical, dry-chemical, foam, carbon dioxide, halon and clean-agent suppression systems. In addition to the provisions of Section 904, the indicated referenced standards include specific installation, maintenance and testing requirements for all systems.

**904.1.1 Certification of service personnel for fire-extinguishing equipment.** Service personnel providing or conducting maintenance on automatic fire-extinguishing systems, other than *automatic sprinkler systems*, shall possess a valid certificate issued by an *approved* governmental agency, or other *approved* organization for the type of system and work performed.

- ❖ Maintenance of fire protection systems and devices are minimum Chapter 9 requirements. Fire protection systems, like other technologies, have advanced new designs which require a clear understanding of their construction and maintenance. To ensure that systems and devices are properly maintained, the code now requires individuals performing these activities be certified. Certification must be issued by an approved organization or governmental agency.

These provisions align the code with NFPA standards governing the design, construction, inspection and maintenance of alternative automatic fire-extinguishing systems and portable fire extinguishers. The personnel qualification requirements specified by the applicable NFPA standards for the various alternative automatic fire-extinguishing systems are summarized in Commentary Figure 904.1.1.

Several organizations offer certifications that will

confirm to code officials that individuals are qualified to perform maintenance on alternative automatic fire extinguishing systems and portable fire extinguishers. The International Code Council® (ICC®), in conjunction with the National Association of Fire Equipment Distributors, offers certifications to individuals who service and inspect portable fire extinguishers and pre-engineered alternative fire-extinguishing systems protecting commercial kitchen hoods or industrial equipment such as spray booths. The National Institute for Certification in Engineering Technologies (NICET) offers four progressive levels of certification for individuals who design, erect and inspect special hazard suppression systems. Special hazard suppression systems include all of the various systems recognized in Section 904 and Commentary Figure 904.1.1. Finally, most manufacturers of these systems offer corporate certifications to individuals who will design, install and inspect them. Such certifications are beneficial to code officials because they confirm the individuals are qualified to install or maintain fire protection equipment produced by a specific manufacturer.

**904.2 Where permitted.** Automatic fire-extinguishing systems installed as an alternative to the required *automatic sprinkler systems* of Section 903 shall be *approved* by the *fire code official*.

❖ One of the main considerations in selecting an extinguishing agent should be the compatibility of the agent with the hazard. The fire code official is responsible for approving an alternative extinguishing agent. The approval should be based on the compatibility of the agent with the hazard and the potential effectiveness of the agent to suppress a fire involving the hazards present.

**904.2.1 Restriction on using automatic sprinkler system exceptions or reductions.** Automatic fire-extinguishing systems shall not be considered alternatives for the purposes of exceptions or reductions allowed for *automatic sprinkler systems* or by other requirements of this code.

❖ Although Section 904.2 allows the use of alternative fire extinguishing systems with specific approval, this section prohibits the use of such systems to allow reductions or exceptions allowed for automatic sprinkler systems throughout the IBC. Therefore, the building will not be considered as equipped throughout with an automatic sprinkler system when using systems such as automatic water mist or other alternative systems (see Commentary Figure 904.2.1).

**904.2.2 Commercial hood and duct systems.** Each required commercial kitchen exhaust hood and duct system required by Section 609 to have a Type I hood shall be protected with an *approved* automatic fire-extinguishing system installed in accordance with this code.

❖ This section requires an effective suppression system to combat fire on the cooking surfaces of grease-producing appliances and within the hood and exhaust system of a commercial kitchen installation. Type I hoods, including the duct system, must be protected with an approved automatic fire-extinguishing system because they are used for handling grease-laden vapors or smoke, whereas Type II hoods handle fumes, steam, heat and odors. Type I hoods are typically required for commercial food heat-processing equipment, such as deep fryers, griddles, charbroilers, broilers and open burner stoves and ranges. For additional guidance on the requirements for Type I

NFPA STANDARD NUMBER & EDITION	SUBJECT	SECTION	PERSONNEL QUALIFICATION REQUIREMENT
12, 2011	Carbon dioxide	4.4.1.1	Specifications for carbon dioxide fire-extinguishing systems shall be prepared under the supervision of a person fully experienced and qualified in the design of carbon dioxide extinguishing systems and with the advice of the authority having jurisdiction.
12A, 2009	Halon 1301	5.1.2.1	Plans and calculations shall be submitted for approval to the authority having jurisdiction before installation begins. Their preparation shall be entrusted only to persons fully experienced and qualified in the design of Halon 1301 extinguishing systems.
17, 2013	Dry chemical	1.6	Only trained persons shall be considered competent to design or layout, install and service dry-chemical systems.
17A, 2013	Wet chemical	1.7	Only trained persons shall be considered competent to design or lay out, install, and service wet chemical systems.
2001, 2012	Clean agent	7.6.1	All persons who could be expected to inspect, test, maintain, or operate fire-extinguishing systems shall be thoroughly trained and kept thoroughly trained in the functions the persons are expected to perform.

**Figure 904.1.1**  
**PERSONNEL QUALIFICATION REQUIREMENTS BY TYPE OF FIRE-EXTINGUISHING AGENT**

CODE SECTION <sup>a</sup>	MODIFICATION	NFPA 13	NPFA 13R	NFPA 13D
<b>Increases</b>				
504.3 and Table 504.3	Height increase in feet	yes	yes	no
504.4 and Table 504.4	Height increase in number of stories	yes	yes	no
506.2 and Table 506.2	Area increase	yes	yes	no
1005.3.1, 1005.3.2 <sup>b</sup>	Egress width	yes	yes	no
Table 1017.2 <sup>b</sup>	Travel distance	yes	yes	no
<b>Rating Reductions</b>				
Table 508.4	Separated occupancies	yes	no	no
708.3	Fire partitions (dwelling units, sleeping units)	yes	no	no
Table 1020.1 <sup>b</sup>	Corridor walls	yes	yes	no
<b>Miscellaneous</b>				
Tables 307.1(1), 307.1(2)	Hazardous material increase	yes	no	no
404.2	Atriums	yes	no	no
507.4, 507.5	Unlimited area buildings	yes	no	no
Table 705.8	Allowable area of openings	yes	no	no
705.8.5	Vertical separation of openings	yes	yes	no
718.3.2	Residential floor/ceiling draftstopping	yes	yes <sup>c</sup>	no
718.3.3	Nonresidential draftstopping	yes	no	no
718.4.2	Groups R-1, R-2 attic draftstopping	yes	yes <sup>c</sup>	no
718.4.3	Other group draftstopping	yes	no	no
Table 803.9	Interior finish	yes	yes	no
804.4.2	Floor finish	yes	yes	no
907.2.1 – 907.2.10 <sup>b</sup>	Manual fire alarm system	yes (A, B, E, F, M)	yes (R-1, R-2)	no
1009.2.1 <sup>b</sup>	Accessible egress	yes	yes	no
1028.1 <sup>b</sup>	Exit discharge	yes	yes	no
1406.3	Balconies	yes	yes <sup>c, d</sup>	yes <sup>c</sup>

- a. Section numbers refer to sections in the code.
- b. Section numbers in Chapters 9 and 10 apply to both the IFC and the code.
- c. Sprinkler protection must be extended to the affected areas.
- d. For additional balcony requirements, see Section 903.3.1.2.1.

**FIGURE 904.2.1  
SELECTED EXAMPLES OF REQUIREMENTS MODIFIED THROUGH USE OF AUTOMATIC SPRINKLER SYSTEMS**

and II hoods, see the commentary to Section 507 of the IMC.

**904.3 Installation.** Automatic fire-extinguishing systems shall be installed in accordance with this section.

- ❖ The installation of automatic fire-extinguishing systems must comply with the requirements of Sections 904.3.1 through 904.3.5 in addition to the installation criteria contained in the referenced standard for the proposed type of alternative extinguishing system.

**904.3.1 Electrical wiring.** Electrical wiring shall be in accordance with NFPA 70.

- ❖ NFPA 70 regulates the design and installation of electrical systems and equipment. All electrical work must also be in compliance with any specific electrical classifications and conditions contained in the referenced standards for each type of system.

Section 605 of the code and Chapter 27 of the IBC contain provisions that also reference NFPA 70. Those sections also contain additional information that must be applied when addressing electrical issues.

**904.3.2 Actuation.** Automatic fire-extinguishing systems shall be automatically actuated and provided with a manual means of actuation in accordance with Section 904.11.1. Where more than one hazard could be simultaneously involved in fire due to their proximity, all hazards shall be protected by a single system designed to protect all hazards that could become involved.

**Exception:** Multiple systems shall be permitted to be installed if they are designed to operate simultaneously.

- ❖ Section 904.3.2 requires alternative fire-extinguishing systems to be designed for automatic activation. Activation commonly occurs when a heat-, fire- or smoke-detection system operates. In Type I commercial kitchen hoods, Section 904.12 requires a manual and automatic means of activating the fire-extinguishing system. Designing a fire-extinguishing system to only operate upon manual actuation is prohibited by the IBC and many of the NFPA fire protection system standards.

The requirements for fire-extinguishing system actuation correlate with the requirements of NFPA 17 and NFPA 17A. The requirement prescribes that when a hazard is protected by two or more fire-extinguishing systems, all of the systems must be designed to operate simultaneously. The reason for the revision is that a typical alternative automatic fire-extinguishing system has a limited amount of fire-extinguishing agent. The amount of agent that is available is based on the area or volume of the hazard and the fire behavior of the fuel. Because the amount of agent is limited, the simultaneous operation of all the fire-extinguishing systems ensures that enough agent is applied to extinguish the fire and prevent its spread from the area of origin.

It is fairly common for a single hazard to be protected by two or more alternative automatic fire-extinguishing systems. For example, protection of a spray

booth used for the application of flammable finishes using dry chemical commonly requires two or three alternative automatic fire-extinguishing systems. The reason is that many dry-chemical and all wet-chemical systems are preengineered systems. Utilizing listed nozzles, preengineered systems are designed and constructed based on the manufacturer's installation requirements. Because these systems are assembled using listed nozzles and extinguishing agents, one system may not be able to protect the spraying space and exhaust plenum. As a result, two or more systems may be required as a provision of an extinguishing system's listing to protect certain hazards.

Another example is commercial kitchen cooking operations. Consider a flat grill broiler and a deep-fat fryer located beneath the same Type I hood. It is quite common for each of these commercial cooking appliances to be protected by separate automatic fire-extinguishing systems. Based on the revision to Section 904.3.2, both extinguishing systems must simultaneously operate in the event a fire involves either of the example appliances (see commentary, Section 904.12.1).

**904.3.3 System interlocking.** Automatic equipment interlocks with fuel shutoffs, ventilation controls, door closers, window shutters, conveyor openings, smoke and heat vents and other features necessary for proper operation of the fire-extinguishing system shall be provided as required by the design and installation standard utilized for the hazard.

- ❖ Shutting off fuel supplies will eliminate potential ignition sources in the protected area. Automatic door and window closers and dampers for forced-air ventilation systems are intended to maintain the desired concentration level of the extinguishing agent in the protected area. See the commentary for Section 904.12.2 for information on system interconnections in commercial cooking fire-extinguishing systems.

**904.3.4 Alarms and warning signs.** Where alarms are required to indicate the operation of automatic fire-extinguishing systems, distinctive audible, visible alarms and warning signs shall be provided to warn of pending agent discharge. Where exposure to automatic-extinguishing agents poses a hazard to persons and a delay is required to ensure the evacuation of occupants before agent discharge, a separate warning signal shall be provided to alert occupants once agent discharge has begun. Audible signals shall be in accordance with Section 907.5.2.

- ❖ Safeguards are necessary to prevent injury or death to personnel in areas where the atmosphere will be made hazardous by oxygen depletion due to agent discharge in a confined space. The "where alarms are required" phrase is referring to requirements that will be found in the referenced installation standards indicated in Sections 904.5 through 904.12, as applicable. Predischage alarms that will operate on fire detection system activation must be installed within and at entrances to the affected areas.

Where required by the appropriate installation stan-

ard(s), an extinguishing agent discharge delay feature shall also be provided to allow evacuation of personnel prior to agent discharge. Warning and instructional signs are also to be posted, preferably at the entrances to and within the protected area. See Section 4.5.6.1 of NFPA 12 for additional information on carbon dioxide system alarms, Section 4.3.5 of NFPA 12A for additional information on Halon system alarms and Section 4.3.5 of NFPA 2001 for additional information on clean agent system alarms.

**904.3.5 Monitoring.** Where a building fire alarm system is installed, automatic fire-extinguishing systems shall be monitored by the building fire alarm system in accordance with NFPA 72.

❖ Automatic fire-extinguishing systems need not be electrically supervised unless the building is equipped with a fire alarm system. This section recognizes the fact that a fire alarm system is not required in all buildings. However, because most alternative fire-extinguishing systems require the space to be evacuated before the system is discharged, they are equipped with evacuation alarms. Interconnection of the fire-extinguishing system evacuation alarm with the building evacuation alarm results in an increased level of hazard notification for the occupants in addition to the electrical supervision of the fire-extinguishing system.

**904.4 Inspection and testing.** Automatic fire-extinguishing systems shall be inspected and tested in accordance with the provisions of this section prior to acceptance.

❖ The completed installation must be tested and inspected to determine that the system has been installed in compliance with the code and will function as required. Full-scale acceptance tests must be conducted as required by the applicable referenced standard.

**904.4.1 Inspection.** Prior to conducting final acceptance tests, all of the following items shall be inspected:

1. Hazard specification for consistency with design hazard.
2. Type, location and spacing of automatic- and manual-initiating devices.
3. Size, placement and position of nozzles or discharge orifices.
4. Location and identification of audible and visible alarm devices.
5. Identification of devices with proper designations.
6. Operating instructions.

❖ This section identifies those items that need to be verified or visually inspected prior to the final acceptance tests. All equipment should be listed, approved and installed in accordance with the manufacturer's recommendations

**904.4.2 Alarm testing.** Notification appliances, connections to fire alarm systems and connections to *approved* supervising stations shall be tested in accordance with this section and Section 907 to verify proper operation.

❖ Components of fire-extinguishing systems related to alarm devices and their supervision must be tested before the system is approved. Alarm devices must be tested to satisfy the requirements of NFPA 72.

**904.4.2.1 Audible and visible signals.** The audibility and visibility of notification appliances signaling agent discharge or system operation, where required, shall be verified.

❖ This section requires verification upon completion of the system installation of the audibility and visibility of notification appliances in the area affected by the extinguishing agent discharge of the alternative automatic fire-extinguishing system.

**904.4.3 Monitor testing.** Connections to protected premises and supervising station fire alarm systems shall be tested to verify proper identification and retransmission of alarms from automatic fire-extinguishing systems.

❖ Where monitoring of fire-extinguishing systems is required, such as by Section 904.3.5, all connections related to the supervision of the system must be tested to verify they are in proper working order.

**904.5 Wet-chemical systems.** Wet-chemical extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 17A and their listing. Records of inspections and testing shall be maintained.

❖ NFPA 17A contains minimum requirements for the design, installation, operation, testing and maintenance of wet-chemical preengineered extinguishing systems. Equipment that is typically protected with wet-chemical extinguishing systems includes restaurant, commercial and institutional hoods; plenums; ducts and associated cooking equipment. Strict compliance with the manufacturer's installation instructions is vital for a viable installation.

Wet-chemical solutions used in extinguishing systems are relatively harmless and there is usually no lasting significant effect on a person's skin, respiratory system or clothing. These solutions may produce a mild, temporary irritation but the symptoms will usually disappear when contact is eliminated.

This section also specifically requires that records be maintained of inspections and testing to increase the effectiveness of such systems. Without records of such inspections and testing, it is more difficult to determine if the systems will be effective when activated and when future inspection and testing is necessary.

**904.5.1 System test.** Systems shall be inspected and tested for proper operation at six-month intervals. Tests shall include a check of the detection system, alarms and releasing devices, including manual stations and other associated equipment. Extinguishing system units shall be weighed and the required amount of agent verified. Stored pressure-type

units shall be checked for the required pressure. The cartridge of cartridge-operated units shall be weighed and replaced at intervals indicated by the manufacturer.

- ❖ This section specifies the frequency for inspection and testing of wet-chemical extinguishing systems. The system and its essential components must be inspected and checked every six months to determine that the system is in full operating condition.

**904.5.2 Fusible link maintenance.** Fixed temperature-sensing elements shall be maintained to ensure proper operation of the system.

- ❖ Wet-chemical extinguishing systems are commonly used to protect commercial cooking equipment. The fusible metal alloy sensing elements are subject to the accumulation of grease or other contaminants that could affect the operation of the fusible link. The sensing elements must be inspected routinely and replaced as needed.

**904.6 Dry-chemical systems.** Dry-chemical extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 17 and their listing. Records of inspections and testing shall be maintained.

- ❖ NFPA 17 contains the minimum requirements for the design, installation, testing, inspection, approval, operation and maintenance of dry-chemical extinguishing systems.

The fire code official has the authority to approve the type of dry-chemical extinguishing system to be used. NFPA 17 identifies three types of dry-chemical extinguishing systems: total flooding, local application and hand hose-line systems. Only total flooding and local application systems are considered automatic extinguishing systems.

The types of hazards and equipment that can be protected with dry-chemical extinguishing systems include: flammable and combustible liquids and combustible gases; combustible solids, which melt when involved in a fire; electrical hazards, such as transformers or oil circuit breakers; textile operations subject to flash surface fires; ordinary combustibles such as wood, paper or cloth and restaurant and commercial hoods, ducts and associated cooking appliance hazards, such as deep fat fryers and some plastics, depending on the type of material and configuration.

Total flooding dry-chemical extinguishing systems are used only where there is a permanent enclosure about the hazard that is adequate to enable the required concentration to be built up. The total area of uncloseable openings must not exceed 15 percent of the total area of the sides, top and bottom of the enclosure. Consideration must be given to eliminating the probable sources of re-ignition within the enclosure because the extinguishing action of dry-chemical systems is transient.

Local application of dry-chemical extinguishing systems is to be used for extinguishing fires where the hazard is not enclosed or where the enclosure does not conform to the requirements for total flood-

ing systems. Local application systems have successfully protected hazards involving flammable or combustible liquids, gases and shallow solids, such as paint deposits.

NFPA 17 also discusses preengineered dry-chemical systems consisting of components designed to be installed in accordance with pretested limitations as tested and labeled by a testing agency. Preengineered systems must be installed within the limitations that have been established by the testing agency and may include total flooding, local application or a combination of both types of systems.

The type of dry chemical used in the extinguishing system is a function of the hazard to be protected. The type of dry chemical used in a system should not be changed unless it has been proven changeable by a testing laboratory, is recommended by the manufacturer of the equipment and is acceptable to the fire code official for the hazard being protected. Additional guidance on the use of various dry-chemical agents can be found in NFPA 17.

This section also specifically requires that records be maintained of inspections and testing to increase the effectiveness of such systems. Without records of such inspections and testing, it is more difficult to determine if the systems will be effective when activated and when future inspection and testing is necessary.

**904.6.1 System test.** Systems shall be inspected and tested for proper operation at six-month intervals. Tests shall include a check of the detection system, alarms and releasing devices, including manual stations and other associated equipment. Extinguishing system units shall be weighed, and the required amount of agent verified. Stored pressure-type units shall be checked for the required pressure. The cartridge of cartridge-operated units shall be weighed and replaced at intervals indicated by the manufacturer.

- ❖ This section specifies the frequency for inspection and testing of dry-chemical extinguishing systems. The system and its essential components must be inspected and checked every six months to determine that the system is in full operating condition.

**904.6.2 Fusible link maintenance.** Fixed temperature-sensing elements shall be maintained to ensure proper operation of the system.

- ❖ Dry-chemical extinguishing systems are commonly used to protect commercial cooking systems and other hazardous use conditions. In these applications the fusible metal alloy sensing elements are subject to the accumulation of grease or other contaminants that could affect the operation of the fusible link. The sensing elements must be inspected routinely and replaced as needed.

**904.7 Foam systems.** Foam-extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 11 and NFPA 16 and their listing. Records of inspections and testing shall be maintained.

- ❖ NFPA 11 covers the characteristics of foam-producing materials used for fire protection and the requirements for design, installation, operation, testing and maintenance of equipment and systems, including those used in combination with other fire-extinguishing agents. The minimum requirements are covered for flammable and combustible liquid hazards in local areas within buildings, storage tanks and indoor and outdoor processing areas.

Low-expansion foam is defined as an aggregation of air-filled bubbles resulting from the mechanical expansion of a foam solution by air with a foam-to-solution volume ratio of less than 20:1. It is most often used to protect flammable and combustible liquid hazards. Also, low-expansion foam may be used for heat radiation protection. Combined-agent systems involve the application of low-expansion foam to a hazard simultaneously or sequentially with dry-chemical powder.

NFPA 11 gives minimum requirements for the installation, design, operation, testing and maintenance of medium- and high-expansion foam systems. Medium-expansion foam is defined as an aggregation of air-filled bubbles resulting from the mechanical expansion of a foam solution by air or other gases with a foam-to-solution volume ratio of 20:1 to 200:1. High-expansion foam has a foam-to-solution volume ratio of 200:1 to approximately 1,000:1.

Medium-expansion foam may be used on solid fuel and liquid fuel fires where some degree of in-depth coverage is necessary (for example, for the total flooding of small, enclosed or partially enclosed volumes, such as engine test cells, transformer rooms, etc.). High-expansion foam is most suitable for filling volumes in which fires exit at various levels. For example, high-expansion foam can be used effectively against high-rack storage fires in enclosures such as in underground passages, where it may be dangerous to send personnel to control fires involving liquefied natural gas (LNG) and liquefied petroleum gas (LP-gas), and to provide vapor dispersion control for LNG and ammonia spills. High-expansion foam is particularly suited for indoor fires in confined spaces, since it is highly susceptible to wind and lack-of-confinement effects.

NFPA 16 contains the minimum requirements for open-head deluge-type foam-water sprinkler systems and foam-water spray systems. The systems are especially applicable to the protection of most flammable liquid hazards and have been used successfully to protect aircraft hangars and truck loading racks.

This section also specifically requires that records be maintained of inspections and testing to increase the effectiveness of such systems. Without records of such inspections and testing it is more difficult to determine if the systems will be effective when acti-

vated and when future inspection and testing is necessary.

**904.7.1 System test.** Foam-extinguishing systems shall be inspected and tested at intervals in accordance with NFPA 25.

- ❖ Although Section 904.7.1 references NFPA 25 as the standard for the inspection and testing of foam-extinguishing systems, NFPA 25 is limited to water-based extinguishing systems. NFPA 25 technically addresses only foam-water sprinkler systems as specified in NFPA 16. NFPA 11 should be consulted for inspection and testing intervals for low-, medium- and high-expansion foam systems.

As with other alternative fire-extinguishing systems, the inspection and testing of foam systems is necessary to determine that the system is fully operational. In addition to general maintenance of equipment, the condition of the foam concentrate and its storage tanks or containers should be inspected at least once a year to verify adequate quality. The desired concentration of the foam concentrate in a stagnant storage situation may deteriorate over time.

**904.8 Carbon dioxide systems.** Carbon dioxide extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 12 and their listing. Records of inspections and testing shall be maintained.

- ❖ NFPA 12 provides minimum requirements for the design, installation, testing, inspection, approval, operation and maintenance of carbon dioxide extinguishing systems.

Carbon dioxide extinguishing systems are useful in extinguishing fires in specific hazards or equipment in occupancies where an inert electrically nonconductive medium is essential or desirable and where cleanup of other extinguishing agents, such as dry-chemical residue, presents a problem. Carbon dioxide systems have satisfactorily protected the following: flammable liquids; electrical hazards, such as transformers, oil switches, rotating equipment and electronic equipment; engines using gasoline and other flammable liquid fuels; ordinary combustibles, such as paper, wood and textiles and hazardous solids.

The fire code official has the authority to approve the type of carbon dioxide system to be installed. NFPA 12 defines four types of carbon dioxide systems: total flooding, local application, hand hose lines and standpipe and mobile supply systems. Only total flooding and local application systems are automatic suppression systems.

Total-flooding systems may be used where there is a permanent enclosure around the hazard that is adequate to allow the required concentration to be built up and maintained for the required period of time, which varies for different hazards. Examples of hazards that have been successfully protected by total flooding systems include rooms, vaults,

enclosed machines, ducts, ovens and containers and their contents.

Local application systems may be used for extinguishing surface fires in flammable liquids, gases and shallow solids where the hazard is not enclosed or the enclosure does not conform to the requirements for a total-flooding system. Examples of hazards that have been successfully protected by local application systems include dip tanks, quench tanks, spray booths, oil-filled electric transformers and vapor vents.

This section also specifically requires that records be maintained of inspections and testing to increase the effectiveness of such systems. Without records of such inspections and testing it is more difficult to determine if the systems will be effective when activated and when future inspection and testing is necessary.

**904.8.1 System test.** Systems shall be inspected and tested for proper operation at 12-month intervals.

- ❖ To determine adequate operation, carbon dioxide systems must be inspected and tested at least once a year.

**904.8.2 High-pressure cylinders.** High-pressure cylinders shall be weighed and the date of the last hydrostatic test shall be verified at six-month intervals. Where a container shows a loss in original content of more than 10 percent, the cylinder shall be refilled or replaced.

- ❖ Because of the potential of unobserved leaking high-pressure cylinders, they need to be weighed semi-annually to verify the concentration level is always within at least 10 percent of the original content.

**904.8.3 Low-pressure containers.** The liquid-level gauges of low-pressure containers shall be observed at one-week intervals. Where a container shows a content loss of more than 10 percent, the container shall be refilled to maintain the minimum gas requirements.

- ❖ A weekly visual observation of the liquid level gauges of low-pressure containers is required to verify that there has been no significant leakage.

**904.8.4 System hoses.** System hoses shall be examined at 12-month intervals for damage. Damaged hoses shall be replaced or tested. At five-year intervals, all hoses shall be tested.

- ❖ The maintenance of system hoses is essential to ensuring the reliability of their use in an emergency. Although system hoses need to be visually checked on an annual basis only, a complete pressure test as indicated in Section 904.8.4.1 must be performed every five years.

**904.8.4.1 Test procedure.** Hoses shall be tested at not less than 2,500 pounds per square inch (psi) (17 238 kPa) for high-pressure systems and at not less than 900 psi (6206 kPa) for low-pressure systems.

- ❖ Every five years, system hoses for both high-pressure/low-pressure systems must be pressure tested to verify they are still in proper operating condition. The test typically involves filling the hose with water.

The hose is then pressurized at the desired test pressure for at least 1 minute to observe any potential distortions or leakage in the hose. All hose assemblies that do not pass the test should be marked, destroyed and replaced with new hose assemblies. Hose assemblies that pass the test should be marked, dated and returned to service.

**904.8.5 Auxiliary equipment.** Auxiliary and supplementary components, such as switches, door and window releases, interconnected valves, damper releases and supplementary alarms, shall be manually operated at 12-month intervals to ensure that such components are in proper operating condition.

- ❖ The effectiveness of the carbon dioxide extinguishing system is also dependent upon the operation of its auxiliary components. These components must also be manually operated at least once a year.

**904.9 Halon systems.** Halogenated extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 12A and their listing. Records of inspections and testing shall be maintained.

- ❖ NFPA 12A contains minimum requirements for the design, installation, testing, inspection, approval, operation and maintenance of Halon 1301 extinguishing systems. Halon 1301 fire-extinguishing systems are useful in specific hazards, equipment or occupancies where an electrically nonconductive medium is essential or desirable and where cleanup of other extinguishing agents presents a problem.

Halon 1301 systems have satisfactorily protected gaseous and liquid flammable materials; electrical hazards, such as transformers, oil switches and rotating equipment; engines using gasoline and other flammable fuels; ordinary combustibles, such as paper, wood and textiles and hazardous solids. Halon 1301 systems have also satisfactorily protected electronic computers, data processing equipment and control rooms.

The fire code official has the authority to approve the type of halogenated extinguishing system to be installed. NFPA 12A defines two types of halogenated extinguishing systems: total flooding and local application. Total-flooding systems may be used where there is a fixed enclosure around the hazard that is adequate to enable the required halon concentration to be built up and maintained for the required period of time to enable the effective extinguishing of the fire. Total-flooding systems may provide fire protection for rooms, vaults, enclosed machines, ovens, containers, storage tanks and bins.

Local application systems are used where there is not a fixed enclosure around the hazard or where the fixed enclosure around the hazard is not adequate to enable an extinguishing concentration to be built up and maintained in the space. Hazards that may be successfully protected by local application systems include dip tanks, quench tanks, spray booths, oil-filled electric transformers and vapor vents.

Two other considerations in selecting the proper

extinguishing system are ambient temperature and the personnel hazards associated with the agent. The ambient temperature of the enclosure for a total-flooding system must be above 70°F (21°C) for halon 1301 systems. Special consideration must also be given to the use of halon systems when the temperatures are in excess of 900°F (482°C) because halon will readily decompose at such temperatures and the products of decomposition can be extremely irritating if inhaled, even in small amounts.

Halon 1301 total-flooding systems must not be used in concentrations greater than 10 percent in normally occupied areas. Where personnel cannot vacate the area within 1 minute, Halon 1301 total-flooding systems must not be used in normally occupied areas with concentrations greater than 7 percent. Halon 1301 total-flooding systems may be used with concentrations of up to 15 percent if the area is not normally occupied and the area can be evacuated within 30 seconds.

Therefore, the supply of halon is limited and new supplies of halogenated extinguishing agents will not be available in the future. Existing supplies of halon can, however, continue to be used in existing, undischarged systems or to recharge discharged systems. This newfound need for halon supplies has given rise to new industries geared to the ranking, recycling and reclamation of existing halon supplies. Alternative “clean agent” extinguishing agents have been developed to replace halogenated agents (see Section 904.10).

This section also specifically requires that records be maintained of inspections and testing to increase the effectiveness of such systems. Without records of such inspections and testing it is more difficult to determine if the systems will be effective when activated and when future inspection and testing is necessary.

**904.9.1 System test.** Systems shall be inspected and tested for proper operation at 12-month intervals.

- ❖ To determine proper operation, Halon systems must be inspected and tested at least once a year.

**904.9.2 Containers.** The extinguishing agent quantity and pressure of containers shall be checked at six-month intervals. Where a container shows a loss in original weight of more than 5 percent or a loss in original pressure (adjusted for temperature) of more than 10 percent, the container shall be refilled or replaced. The weight and pressure of the container shall be recorded on a tag attached to the container.

- ❖ Because of the potential for unobserved leakage of the Halon containers, they must be checked at least semi-annually to verify the original weight and pressure are within the designated tolerances. When necessary, containers must be refilled or replaced when the desired levels are not maintained. The containers

should also be checked for evidence of corrosion or mechanical damage.

**904.9.3 System hoses.** System hoses shall be examined at 12-month intervals for damage. Damaged hoses shall be replaced or tested. At five-year intervals, all hoses shall be tested.

- ❖ Maintenance of system hoses is essential to ensuring the reliability of their use in an emergency. System hoses need to be visually checked annually. A complete pressure test as indicated in Section 904.9.3.1 must be performed every five years.

**904.9.3.1 Test procedure.** For Halon 1301 systems, hoses shall be tested at not less than 1,500 psi (10 343 kPa) for 600 psi (4137 kPa) charging pressure systems and not less than 900 psi (6206 kPa) for 360 psi (2482 kPa) charging pressure systems. For Halon 1211 hand-hose line systems, hoses shall be tested at 2,500 psi (17 238 kPa) for high-pressure systems and 900 psi (6206 kPa) for low-pressure systems.

- ❖ Every five years, system hoses must be pressure tested to verify they are still in proper operating condition. This section specifies the test pressure for the various types of Halon systems. The pressure test is intended to check for any potential distortion or leaking in the hose (see commentary, Section 904.8.4.1).

**904.9.4 Auxiliary equipment.** Auxiliary and supplementary components, such as switches, door and window releases, interconnected valves, damper releases and supplementary alarms, shall be manually operated at 12-month intervals to ensure such components are in proper operating condition.

- ❖ The effectiveness of halogenated extinguishing systems is also dependent upon the operation of its auxiliary components. These components must be manually operated at least once a year.

**904.10 Clean-agent systems.** Clean-agent fire-extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 2001 and their listing. Records of inspections and testing shall be maintained.

- ❖ NFPA 2001 contains minimum requirements for the design, installation, testing, inspection and operation of clean-agent fire-extinguishing systems. A clean agent is an electrically nonconducting suppression agent that is volatile or gaseous at discharge and does not leave a residue on evaporation. Clean-agent fire-extinguishing systems are installed in locations that are enclosed and have openings in the protected area that can be sealed on activation of the alarm to provide effective clean-agent concentrations. A clean-agent fire-extinguishing system should not be installed in locations that cannot be sealed unless testing has shown that adequate concentrations can be developed and maintained.

The two categories of clean agents are halocarbon compounds and inert gas agents. Halocarbon compounds include bromine, carbon, chlorine, fluorine,

hydrogen and iodine. Halocarbon compounds suppress fire by a combination of breaking the chemical chain reaction of the fire, reducing the oxygen supporting the fire and reducing the ambient temperature of the fire origin to reduce the propagation of the fire. Inert gas agents contain primary components consisting of helium, neon, argon or a combination of these. Inert gases work by reducing the oxygen concentration around the fire origin to a level that does not support combustion.

Clean-agent fire-extinguishing systems were developed in response to the demise of halon as an acceptable fire-extinguishing agent because of its harmful effect on the environment. Although the original hope for a halon substitute was that these new clean agents could be directly and proportionally substituted for halon agents in existing systems (drop in replacements), research has shown that clean agents are less efficient in extinguishing fires than are the halons they were intended to replace and require approximately 60 percent more agent by weight and volume in storage to do the same job. Additionally, the physical and chemical characteristics of clean agents differ sufficiently from halon to require different nozzles in addition to the need for larger storage vessels. Existing piping systems should be salvaged for use with clean agents only if they are carefully evaluated and determined to be hydraulically compatible with the flow characteristics of the new agent.

This section also relies on strict adherence to the system manufacturer's design and installation instructions for code compliance. As with many of the alternative fire suppression systems covered in this chapter, clean-agent systems are, for the most part, subjected by their manufacturers to a testing and listing program conducted by an approved testing agency. In such testing and listing programs, the clean agent is listed for use with specific equipment and equipment is listed for use with specific clean agents. The resultant listings include reference to the manufacturer's installation manuals, thereby giving the fire code official another valuable resource for reviewing and approving clean-agent systems.

Although clean agents have found a limited market for local application uses, such as a replacement for Halon 1211 in portable fire extinguishers, their primary application is in total-flooding systems and they are available in both engineered and preengineered configurations.

Engineered clean-agent systems are specifically designed for protection of a particular hazard, whereas preengineered systems are designed to operate within predetermined limitations up to the noted maximums, thus allowing broader applicability to a variety of hazard applications.

Total flooding systems are used where there is a fixed enclosure around the hazard that is adequate to enable the required clean-agent concentration to

build up and be maintained within the space long enough to extinguish the fire. Such applications can include vaults, ovens, containers, tanks, computer rooms, paint lockers or enclosed machinery. In selecting the clean agent to be used in a given application, careful consideration must be given to whether the protected area is a normally occupied space, because different agents have different levels of concentration at which they may be a health hazard to occupants of the area.

The fire code official has the authority to approve the type of clean-agent system to be installed and should become familiar with the unique characteristics and hazards of clean-agent extinguishing systems using all available resources on the subject.

This section also specifically requires that records be maintained of inspections and testing to increase the effectiveness of such systems. Without records of such inspections and testing it is more difficult to determine if the systems will be effective when activated and when future inspection and testing is necessary.

**904.10.1 System test.** Systems shall be inspected and tested for proper operation at 12-month intervals.

❖ To determine proper operation, all clean-agent systems must be inspected and tested at least once a year.

**904.10.2 Containers.** The extinguishing agent quantity and pressure of the containers shall be checked at six-month intervals. Where a container shows a loss in original weight of more than 5 percent or a loss in original pressure, adjusted for temperature, of more than 10 percent, the container shall be refilled or replaced. The weight and pressure of the container shall be recorded on a tag attached to the container.

❖ Because of the potential for unobserved leakage of the clean-agent containers, they must be checked at least semi-annually to verify the original weight and pressure are within the designated tolerances. When necessary, containers must be refilled or replaced when the desired levels are not maintained.

**904.10.3 System hoses.** System hoses shall be examined at 12-month intervals for damage. Damaged hoses shall be replaced or tested. All hoses shall be tested at five-year intervals.

❖ The maintenance of system hoses is essential to ensuring their reliability in an emergency. System hoses must be visually checked annually. A complete pressure test must be performed every five years.

**904.11 Automatic water mist systems.** *Automatic water mist systems* shall be permitted in applications that are consistent with the applicable listing or approvals and shall comply with Sections 904.11.1 through 904.11.3.

❖ This section provides the ability to use automatic water mist systems in specific applications. These installations are required to be consistent with the list-



**Figure 904.11**  
**WATER MIST NOZZLE DISCHARGE**

ings or approvals to which such systems have been tested. See Commentary Figure 904.11.

**904.11.1 Design and installation requirements.** *Automatic water mist systems* shall be designed and installed in accordance with Sections 904.11.1.1 through 904.11.1.4.

❖ The subsections to follow provide the various installation and design requirements related to water mist systems. This relates to the systems themselves and the provisions for a reliable water supply.

**904.11.1.1 General.** *Automatic water mist systems* shall be designed and installed in accordance with NFPA 750 and the manufacturer's instructions.

❖ This section simply provides reference to the subsections with the detailed requirements related to the design and installation of water mist systems.

**904.11.1.2 Actuation.** *Automatic water mist systems* shall be automatically actuated.

❖ If a water mist system is used, it is required to be automatically activated.

**904.11.1.3 Water supply protection.** Connections to a potable water supply shall be protected against backflow in accordance with the *International Plumbing Code*.

❖ The water supply quality is more critical with automatic water mist systems than automatic sprinkler systems. Backflow prevention is required, as it would be for water supply for automatic sprinkler systems.

**904.11.1.4 Secondary water supply.** Where a secondary water supply is required for an *automatic sprinkler system*, an *automatic water mist system* shall be provided with an *approved* secondary water supply.

❖ Since these systems work to protect buildings and spaces in a fashion similar to a sprinkler system and

possibly as an alternative to automatic sprinkler systems, the water supply must be appropriate. If an automatic sprinkler system is required to have a secondary water supply in accordance with Section 403.3.3 of the IBC, then the water mist system must also provide an approved secondary water supply.

**904.11.2 Water mist system supervision and alarms.** Supervision and alarms shall be provided as required for *automatic sprinkler systems* in accordance with Section 903.4.

❖ This section plays a similar role to an automatic sprinkler system with regard to supervision and alarms. It is critical to make sure valves are open. In addition, an alarm to notify of an activation must be provided as it is for a sprinkler system. Note that this is not intended to be an occupant notification system. See the commentary for Section 903.4.

**904.11.2.1 Monitoring.** Monitoring shall be provided as required for *automatic sprinkler systems* in accordance with Section 903.4.1.

❖ See the commentary to Sections 903.4.1 and 904.11.2.

**904.11.2.2 Alarms.** Alarms shall be provided as required for *automatic sprinkler systems* in accordance with Section 903.4.2.

❖ Again, this is not intended as occupant notification but instead is simply to alert someone that the system has activated. See commentary for Sections 903.4.2 and 904.11.2.

**904.11.2.3 Floor control valves.** Floor control valves shall be provided as required for *automatic sprinkler systems* in accordance with Section 903.4.3.

❖ See the commentary to Section 903.4.3.

**904.11.3 Testing and maintenance.** *Automatic water mist systems* shall be tested and maintained in accordance with Section 901.6.

❖ Testing and maintenance is critical to the long term viability of automatic water mist systems. See the commentary to Section 901.6.

**904.12 Commercial cooking systems.** The automatic fire-extinguishing system for commercial cooking systems shall be of a type recognized for protection of commercial cooking equipment and exhaust systems of the type and arrangement protected. Preengineered automatic dry- and wet-chemical extinguishing systems shall be tested in accordance with UL 300 and *listed* and *labeled* for the intended application. Other types of automatic fire-extinguishing systems shall be *listed* and *labeled* for specific use as protection for commercial cooking operations. The system shall be installed in accordance with this code, its listing and the manufacturer's installation instructions. Automatic fire-extinguishing systems of the following types shall be installed in accordance with the referenced standard indicated, as follows:

1. Carbon dioxide extinguishing systems, NFPA 12.
2. *Automatic sprinkler systems*, NFPA 13.

3. Foam-water sprinkler system or foam-water spray systems, NFPA 16.
4. Dry-chemical extinguishing systems, NFPA 17.
5. Wet-chemical extinguishing systems, NFPA 17A.

**Exception:** Factory-built commercial cooking recirculating systems that are tested in accordance with UL 710B and *listed, labeled* and installed in accordance with Section 304.1 of the *International Mechanical Code*.

- ❖ The history of commercial kitchen exhaust systems shows that the mixture of flammable grease and effluents carried by such systems and the potential for the cooking equipment to act as an ignition source contribute to a higher level of hazard for kitchen exhaust systems than is normally found in many other exhaust systems. Furthermore, fire in a grease exhaust duct can produce temperatures of 2,000°F (1093°C) or more and heat radiating from the duct can ignite nearby combustibles. As a result, the code requires exhaust systems serving grease-producing equipment to include fire suppression to protect the cooking surfaces, hood, filters and exhaust duct to confine a fire to the hood and duct system, thus reducing the likelihood of it spreading to the structure.

In addition to the general requirements of this section, five industry standards are referenced for the installation of fire-extinguishing systems protecting commercial food heat-processing equipment and kitchen exhaust systems. Design professionals should specify and design fire-extinguishing systems to comply with these referenced standards. Only the installation of fire-extinguishing systems is regulated by these references. Where preengineered automatic dry- and wet-chemical extinguishing systems are installed, they must be listed and labeled for the specific cooking operation and tested in accordance with UL 300. Design and construction requirements for the specific types of fire-extinguishing systems are found in the respective sections of the referenced standards.

Regulatory requirements for the approval and installation of fire-extinguishing systems are the same as the approval required for all mechanical equipment and appliances. This section, therefore, requires extinguishing systems to be listed and labeled by an approved agency and installed in accordance with their listing and the manufacturer's installation instructions.

The exception allows factory-built commercial cooking recirculating systems to be installed if they have been tested and listed in accordance with UL 710B. It is important that they be installed in accordance with the manufacturer's installation instructions so that the listing requirements are met. An improper installation could result in hazardous vapors being discharged back into the kitchen.

Commercial cooking recirculating systems consist of an electric cooking appliance and an integral or matched packaged hood assembly. The hood assembly consists of a fan, collection hood, grease

filter, fire damper, fire-extinguishing system and air filter, such as an electrostatic precipitator. These systems are tested for fire safety and emissions. The grease vapor (condensable particulate matter) in the effluent at the system discharge is not allowed to exceed a concentration of 5.0 mg/m<sup>3</sup>. Recirculating systems are not used with fuel-fired appliances because the filtering systems do not remove combustion products. Kitchens require ventilation in accordance with Chapter 4 of the IMC.

Although the provisions in Section 904.12 address many of the specifics for commercial kitchens, additional information regarding commercial cooking suppression systems is located in Sections 904.2 and 904.3. This information is supplemental to that and should be considered together in developing the design for commercial cooking suppression systems.

A question that is often asked about this section is whether it requires existing commercial cooking preengineered fire extinguishing systems to comply with UL 300. Generally, neither this section nor the retroactivity provisions contained in the referenced NFPA standards indicate that retroactive application is intended. The application of this section is subject to the applicability provisions of Section 102.1 of the code. As such, where an existing, previously approved, listed preengineered fire extinguishing system installed for the protection of commercial cooking operations has been, and continues to be, maintained in accordance with the manufacturer's installation and maintenance requirements and the applicable NFPA standard referenced on the extinguishing system unit and continues to comply with Sections 609.3.4, 901.4 and 901.6, no change to the system would be required. In the event, however, that a system can no longer comply with the provisions noted above, or if the changes described in Section 904.12.6.1 have taken place, it would then need to be brought into compliance with the applicable provisions of Section 904.12 and the referenced standards. Note that some extinguishing system manufacturers no longer provide service support, either directly or through their authorized agents, for certain older-model systems (e.g., replacement parts, etc.). Continuing manufacturer maintenance and service support of existing systems would be a key element in the determination of whether a system continues to meet the above requirements and should be investigated on a case-by-case basis with the respective system manufacturer (see Section 904.12.6.2).

Another question that is often asked is whether the requirements of this section apply to grease-producing appliances installed in a mobile commercial vending cart or catering truck. This section is not a "where required" section but, rather, contains "how-to" criteria once it is determined that a hood and a commercial kitchen hood and duct fire suppression system is required. Where a hood and duct fire suppression system is required depends on the type of cooking

operation being conducted and the type of hood that is required to be installed, as indicated in Section 609.2 of the code. That section is specific in requiring a Type I hood above all commercial cooking appliances as they are defined in Chapter 2. That definition limits the term to only appliances used in a commercial food service establishment and goes on to define such establishments as "...any building or portion thereof used for the preparation and serving of food." Accordingly, a typical food vendor's cart, catering truck with on-board cooking, or any other mobile or temporary food concessions, would not be included in that definition and as such, would be outside the scope of Section 101.2 of the IMC, or Section 609.2 or this section of the code.

**904.12.1 Manual system operation.** A manual actuation device shall be located at or near a *means of egress* from the cooking area not less than 10 feet (3048 mm) and not more than 20 feet (6096 mm) from the kitchen exhaust system. The manual actuation device shall be installed not more than 48 inches (1200 mm) nor less than 42 inches (1067 mm) above the floor and shall clearly identify the hazard protected. The manual actuation shall require a maximum force of 40 pounds (178 N) and a maximum movement of 14 inches (356 mm) to actuate the fire suppression system.

**Exception:** *Automatic sprinkler systems* shall not be required to be equipped with manual actuation means.

- ❖ The manual device, usually a pull station, mechanically activates the suppression system. The typical system uses a mechanical circuit of cables under tension to hold the system in the armed (cocked) mode. Melting of a fusible link or actuation of a manual pull station causes the cable to lose tension, which, in turn, starts the discharge of the suppression agent. The manual actuation device must be readily and easily usable by the building occupants; therefore, the device must not require excessive force or range of movement to cause actuation.

In order to allow the actuation device to be used most effectively, the specified mounting height is intended to be consistent with the NFPA 17A standards and be handicapped accessible. This includes the requirement to identify the actuation device with the hazard protected. Where multiple kitchen appliances are provided, properly identifying which device relates to which appliance is very important. Required signage should be readily visible in the hazard area and capable of conveying information quickly and concisely.

Manual actuation is not required for automatic sprinkler systems because the typical system design will employ closed heads and wet system piping. A manual actuation valve would serve no purpose because sprinkler heads are already supplied with pressurized water and will discharge water only when the individual fusible elements open the heads.

**904.12.2 System interconnection.** The actuation of the fire extinguishing system shall automatically shut down the fuel or electrical power supply to the cooking equipment. The fuel and electrical supply reset shall be manual.

- ❖ The actuation of any fire suppression system must automatically shut off all sources of fuel or power to all cooking equipment located beneath the exhaust hood protected by the suppression system. This requirement is intended to shut off all heat sources that could reignite or intensify a fire. Shutting off a fuel and power supply to cooking appliances will eliminate an ignition source and allow the cooking surfaces to cool down. This shutdown is accomplished with mechanical or electrical interconnections between the suppression system and a shutoff valve or switch located on the fuel or electrical supply.

Common fuel shutoff valves include mechanical-type gas valves and electrical solenoid-type gas valves. Contactor-type switches or shunt-trip circuit breakers can be used for electrically heated appliances. The fuel or electric source must not be automatically restored after the suppression system has been actuated.

Chemical-type fire-extinguishing systems discharge for only a limited time and can discharge only once before recharge and reset; therefore, precautions must be taken to prevent a fire from reigniting. After a fire is detected and the initial suppressant discharge begins, the fuel and power supply will be locked out, thereby preventing the operation of the appliances until all systems are again ready for operation. Fuel and power supply shutoff must be manually restored by resetting a mechanical linkage or holding (latching)-type circuit.

**904.12.3 Carbon dioxide systems.** Where carbon dioxide systems are used, there shall be a nozzle at the top of the ventilating duct. Additional nozzles that are symmetrically arranged to give uniform distribution shall be installed within vertical ducts exceeding 20 feet (6096 mm) and horizontal ducts exceeding 50 feet (15 240 mm). Dampers shall be installed at either the top or the bottom of the duct and shall be arranged to operate automatically upon activation of the fire-extinguishing system. Where the damper is installed at the top of the duct, the top nozzle shall be immediately below the damper. Automatic carbon dioxide fire-extinguishing systems shall be sufficiently sized to protect all hazards venting through a common duct simultaneously.

- ❖ This section states specific design requirements for nozzle locations, dampers and ducts for carbon dioxide extinguishing systems that may be used to protect commercial cooking systems. These requirements are intended to supersede similar, more general provisions in NFPA 12. Because carbon dioxide (CO<sub>2</sub>) is a gaseous suppressant, dampers are required in the ductwork to define the atmosphere where the fire event would be. A specific concentration of CO<sub>2</sub> is

necessary and dampers are required to define and contain the suppressant. The discharge cools exposed surfaces in addition to depriving the fire of oxygen. Although not mentioned specifically in this section, the applicable provisions of NFPA 12 should also be applied because the system is a CO<sub>2</sub> system as referenced in Section 904.8.

**904.12.3.1 Ventilation system.** Commercial-type cooking equipment protected by an automatic carbon dioxide extinguishing system shall be arranged to shut off the ventilation system upon activation.

- ❖ Shutting down the ventilation system upon activation of the CO<sub>2</sub> extinguishing system maintains the desired concentration of carbon dioxide to suppress the fire. Leakage of gas from the protected area should be kept to a minimum. Where leakage is anticipated, additional quantities of carbon dioxide must be provided to compensate for any losses.

**904.12.4 Special provisions for automatic sprinkler systems.** *Automatic sprinkler systems* protecting commercial-type cooking equipment shall be supplied from a separate, readily accessible, indicating-type control valve that is identified.

- ❖ This section requires a separate control valve in the water line to the sprinklers protecting the cooking and ventilating system. The additional valve allows the flexibility to shut off the system for repairs or for cleanups after sprinkler discharge without taking the entire system out of service.

**904.12.4.1 Listed sprinklers.** Sprinklers used for the protection of fryers shall be tested in accordance with UL 199E, *listed* for that application and installed in accordance with their listing.

- ❖ Sprinklers specifically listed for such use must be used when protecting deep-fat fryers. These specially listed sprinklers use finer water droplets than standard spray sprinklers. The water spray lowers the temperature below a point where the fire can sustain itself and reduces the possibility of expanding the fire. UL 199E addresses these special sprinklers and includes performance tests for deep-fat fryer extinguishment and also deep-fat fryer cooking temperature splash. The selection of inappropriate sprinklers for deep-fat fryer protection can increase the hazards during water application rather than suppressing the fire.

**904.12.5 Portable fire extinguishers for commercial cooking equipment.** Portable fire extinguishers shall be provided within a 30-foot (9144 mm) distance of travel from commercial-type cooking equipment. Cooking equipment involving solid fuels or vegetable or animal oils and fats shall be protected by a Class K rated portable extinguisher in accordance with Section 904.12.5.1 or 904.12.5.2, as applicable.

- ❖ To combat a fire in its incipient stage, access to a manual means of extinguishment is critical. Although a 30-foot (9144 mm) maximum travel distance is specified, the location of the extinguisher should be a

safe distance from the cooking equipment so that it will not become involved in the fire. Only Class K-rated extinguishers that have been tested on commercial cooking appliances can be used.

**904.12.5.1 Portable fire extinguishers for solid fuel cooking appliances.** Solid fuel cooking appliances, whether or not under a hood, with fireboxes 5 cubic feet (0.14 m<sup>3</sup>) or less in volume shall have a minimum 2.5-gallon (9 L) or two 1.5-gallon (6 L) Class K wet-chemical portable fire extinguishers located in accordance with Section 904.12.5.

- ❖ The fuels used in solid fuel-fired cooking appliances present significantly more potential burning surface area than the flat surface of a grill or deep fat fryer. This surface area is also often shielded by other solid fuel elements. As a result, a large extinguisher or two moderate-sized extinguishers are required. The 2<sup>1</sup>/<sub>2</sub>-gallon (9 L) extinguisher roughly equates to a 2A rating. The K-rating is necessary rather than using a water-based agent because the discharge from water-based extinguishers is usually in the form of a straight stream rather than a less concentrated, flooding type of coverage. A straight stream can dislodge the burning solid fuel material and possibly spread the burning coals to other areas where they could pose both a secondary fire risk, as well as a life safety hazard. The same travel distance to an extinguisher is required for solid fuel extinguishers as for deep fat fryer extinguishers so that manual suppression can be provided if necessary in a reasonable time. See the commentary to Section 904.12.5.2 for further discussion of Class K extinguishers.

**904.12.5.2 Class K portable fire extinguishers for deep fat fryers.** Where hazard areas include deep fat fryers, listed Class K portable fire extinguishers shall be provided as follows:

1. For up to four fryers having a maximum cooking medium capacity of 80 pounds (36.3 kg) each: one Class K portable fire extinguisher of a minimum 1.5-gallon (6 L) capacity.
2. For every additional group of four fryers having a maximum cooking medium capacity of 80 pounds (36.3 kg) each: one additional Class K portable fire extinguisher of a minimum 1.5-gallon (6 L) capacity shall be provided.
3. For individual fryers exceeding 6 square feet (0.55 m<sup>2</sup>) in surface area: Class K portable fire extinguishers shall be installed in accordance with the extinguisher manufacturer's recommendations.

- ❖ In recent years, commercial cooking operations have begun to use improved, more efficient deep fat fryer-type cooking appliances and more healthful, unsaturated cooking oils that require a much higher cooking temperature than the former saturated oils. The Class K extinguishing agent and extinguishers were developed to deal with this new hazard. Class K extinguishers use a wet-chemical, potassium acetate-based agent that has proven to be more effective in

fighting these fires and provides a cooling effect for the deep fat fryer hazard. Though primarily intended for cooking fires, many Class K extinguishers can also be effectively used on Class A, B and C hazards.

Class K fire extinguishers do not have letter ratings similar to other types of extinguishers. The capacity of the Class K extinguisher becomes the effective rating. Based on the extinguishing capability of a moderate sized Class K extinguisher the maximum quantity of typical fat frying medium can be determined. This quantity is determined by weight based on the typical deep fat fryer. A fryer capacity of 80 pounds (36 kg) can provide a surface area between 4½ to 6 square feet (0.42 to 0.56 m<sup>2</sup>), depending on the manufacturer. When the surface area exceeds 6 square feet (0.56 m<sup>2</sup>), guidelines for Class K extinguishers are no longer applicable. Consequently, for the larger surface area fryers the size of Class K extinguisher should be based on the manufacturer's recommendations. Although not specifically indicated in the code text, the understanding is that if the weight capacity of the fryer exceeds 80 pounds (36 kg) but the surface area is less than 6 square feet (0.56 m<sup>2</sup>), the manufacturer's recommendations should be applied for those conditions as well.

**904.12.6 Operations and maintenance.** Automatic fire-extinguishing systems protecting commercial cooking systems shall be maintained in accordance with Sections 904.12.6.1 through 904.12.6.3.

- ❖ Most fires in commercial kitchens involve the cooking appliance and exhaust system in some way. Proper operation of the system in accordance with the IMC, as well as routine maintenance can reduce the hazards related to the collection and removal of smoke and grease-laden vapors.

**904.12.6.1 Existing automatic fire-extinguishing systems.** Where changes in the cooking media, positioning of cooking equipment or replacement of cooking equipment occur in existing commercial cooking systems, the automatic fire-extinguishing system shall be required to comply with the applicable provisions of Sections 904.12 through 904.12.4.

- ❖ The provisions of Section 904.12 have long required new commercial cooking system preengineered fire extinguishing systems to be tested in accordance with UL 300 and listed and labeled for that use. The question has often arisen, however, as to whether or how those provisions should be applied to existing systems. This section provides guidance and adds clarity as to when existing automatic fire extinguishing systems protecting commercial cooking operations need to be modified, upgraded or replaced to meet UL 300 requirements. These provisions are thought to be consistent with provisions adopted by some states and local jurisdictions on this topic.

**904.12.6.2 Extinguishing system service.** Automatic fire-extinguishing systems shall be serviced at least every six

months and after activation of the system. Inspection shall be by qualified individuals, and a certificate of inspection shall be forwarded to the *fire code official* upon completion.

- ❖ Range hood fire-extinguishing systems must be inspected and serviced at regular intervals to determine that they are ready to perform the intended function. Obviously, service is required after the suppression system discharges. The extent of service and maintenance depends on the type of fire-extinguishing system installed. The NFPA standard corresponding to the installed extinguishing agent should be consulted for additional service requirements (see commentary, Section 904.12).

**904.12.6.3 Fusible link and sprinkler head replacement.** Fusible links and automatic sprinkler heads shall be replaced at least annually, and other protection devices shall be serviced or replaced in accordance with the manufacturer's instructions.

**Exception:** Frangible bulbs are not required to be replaced annually.

- ❖ Because of the potential accumulation of grease or other contaminants that could adversely affect proper operation, fusible links and automatic sprinkler heads must be replaced at least annually. The sensing elements of the fusible link devices as well as the sprinkler heads must be routinely visually inspected and replaced as needed, at least annually.

The exception allows frangible bulb-type sprinklers to not be replaced as long as the annual examination shows no accumulation of grease or other contaminants.

**904.13 Domestic cooking systems in Group I-2 Condition 1.** In Group I-2 Condition 1 occupancies where cooking facilities are installed in accordance with Section 407.2.6 of the *International Building Code*, the domestic cooking hood provided over the cooktop or range shall be equipped with an automatic fire-extinguishing system of a type recognized for protection of domestic cooking equipment. Preengineered automatic extinguishing systems shall be tested in accordance with UL 300A and listed and labeled for the intended application. The system shall be installed in accordance with this code, its listing and the manufacturer's instructions.

- ❖ As nursing homes move away from institutional models, it is critical to have a functioning kitchen that can serve as the "hearth of the home." Instead of a large, centralized, institutional kitchen where all meals are prepared and delivered to a central dining room or the resident's room, the new "household model" nursing home uses decentralized kitchens and small dining areas to create the feeling and focus of home. For persons with dementia, it is particularly important to have spaces that look familiar, like the kitchen in their former home, to increase their understanding and ability to function at their highest level. This section addresses the fire protection system needs for these

kitchens. Note that these occupancies already contain quick response sprinklers. This section provides the requirements for the hood fire extinguishing system needed for the cooking hood located over the cook top or range. That system is required to be in compliance with UL 300A.

**904.13.1 Manual system operation and interconnection.** Manual actuation and system interconnection for the hood suppression system shall be in accordance with Sections 904.12.1 and 904.12.2, respectively.

- ❖ To manually activate such systems, the requirements of Sections 904.12.1 and 904.12.2 would apply. This provides for the location of the manual shut down and also directs what equipment and power needs to automatically shut down. See the commentary to Sections 904.12.1 and 904.12.2.

**904.13.2 Portable fire extinguishers for domestic cooking equipment in Group I-2 Condition 1.** A portable fire extinguisher complying with Section 906 shall be installed within a 30-foot (9144 mm) distance of travel from domestic cooking appliances.

- ❖ This requirement for a portable fire extinguisher relates to the added safety of allowing a residential-type kitchen in nursing homes. This provides another line of defense and the location is focused on the distance from the cooking appliances.

## SECTION 905 STANDPIPE SYSTEMS

**905.1 General.** Standpipe systems shall be provided in new buildings and structures in accordance with Sections 905.2 through 905.10. In buildings used for *high-piled combustible storage*, fire protection shall be in accordance with Chapter 32.

- ❖ Standpipe systems are required in buildings to provide a quick, convenient water source for fire department use where hose lines would otherwise be impractical, such as in high-rise buildings. Standpipe systems can also be used prior to deployment of hose lines from fire department apparatus. The requirements for standpipes are based on practical requirements of typical fire-fighting operations and the nationally recognized standard NFPA 14.

The threads on connections to which the fire department may connect a hose must be compatible with the fire department hose threads (see commentary, Section 903.3.6). Chapter 32 requires a Class I standpipe system in exit passageways of buildings used for high-piled storage. Note that if a building containing high-piled storage does not contain an exit passageway then standpipes would not be required. High-piled storage involves the solid piled, bin box, palletized or rack storage of Class I through IV commodities over 12 feet (3658 mm) high. High-hazard commodities stored higher than 6 feet (1829 mm) are also considered high piled.

**905.2 Installation standard.** Standpipe systems shall be installed in accordance with this section and NFPA 14. Fire department connections for standpipe systems shall be in accordance with Section 912.

- ❖ This section requires the installation of standpipe systems to comply with the applicable provisions of NFPA 14 in addition to Section 905. NFPA 14 contains the minimum requirements for the installation of standpipe and hose systems for buildings and structures. The standard addresses additional requirements not addressed in the code, such as pressure limitations, minimum flow rates, piping specifications, hose connection details, valves, fittings, hangers and the testing and inspection of standpipes. The periodic inspection, testing and maintenance of standpipe systems must comply with NFPA 25.

Section 905 and NFPA 14 recognize three classes of standpipe systems: Class I, II or III. The type of system required depends on building height, building area, type of occupancy and the extent of automatic sprinkler protection. Section 905 also recognizes five types of standpipe systems: automatic dry, automatic wet, manual dry, manual wet and semiautomatic dry. The use of each type of system is limited to the building conditions and locations identified in Section 905.3. The classes and types of standpipe systems are defined in Section 202.

Section 912, to which this section points, provides a comprehensive set of requirements for FDCs reducing the opportunity for any of its requirements to be overlooked. See the commentary for Section 912.

**905.3 Required Installations.** Standpipe systems shall be installed where required by Sections 905.3.1 through 905.3.8. Standpipe systems are allowed to be combined with *automatic sprinkler systems*.

**Exception:** Standpipe systems are not required in Group R-3 occupancies.

- ❖ Standpipe systems are installed in buildings based on the occupancy, fire department accessibility and special conditions that may require manual fire suppression exceeding the capacity of a fire extinguisher. Standpipe systems are most commonly required for buildings that exceed the height threshold requirement in Section 905.3.1 or due to features of a specific occupancy or the building, such as covered and open mall buildings, stages and underground buildings.

This section also states that a standpipe system does not have to be separate from an installed sprinkler system. It is common practice in multistory buildings for the standpipe system risers to also serve as risers for the automatic sprinkler systems.

In these instances, precautions need to be taken so that the operation of one system will not interfere with the operation of the other system. Therefore, control valves for the sprinkler system must be installed where the sprinklers are connected to the standpipe riser at each floor level. This allows the

standpipe system to remain operational, even if the sprinkler system is shut off at the floor control valve.

The exception recognizes that standpipe systems in Group R-3 occupancies would be of minimal value to the fire department and would send the wrong message to the occupants of a dwelling unit. In the case of multiple single-family dwellings, each dwelling unit has a separate entrance and is separated from the other units by 1-hour fire partitions. These conditions permit ready access to fires and also provide for a degree of fire containment through compartmentation, which is not always present in other occupancies.

**905.3.1 Height.** Class III standpipe systems shall be installed throughout buildings where the floor level of the highest story is located more than 30 feet (9144 mm) above the lowest level of the fire department vehicle access, or where the floor level of the lowest story is located more than 30 feet (9144 mm) below the highest level of fire department vehicle access.

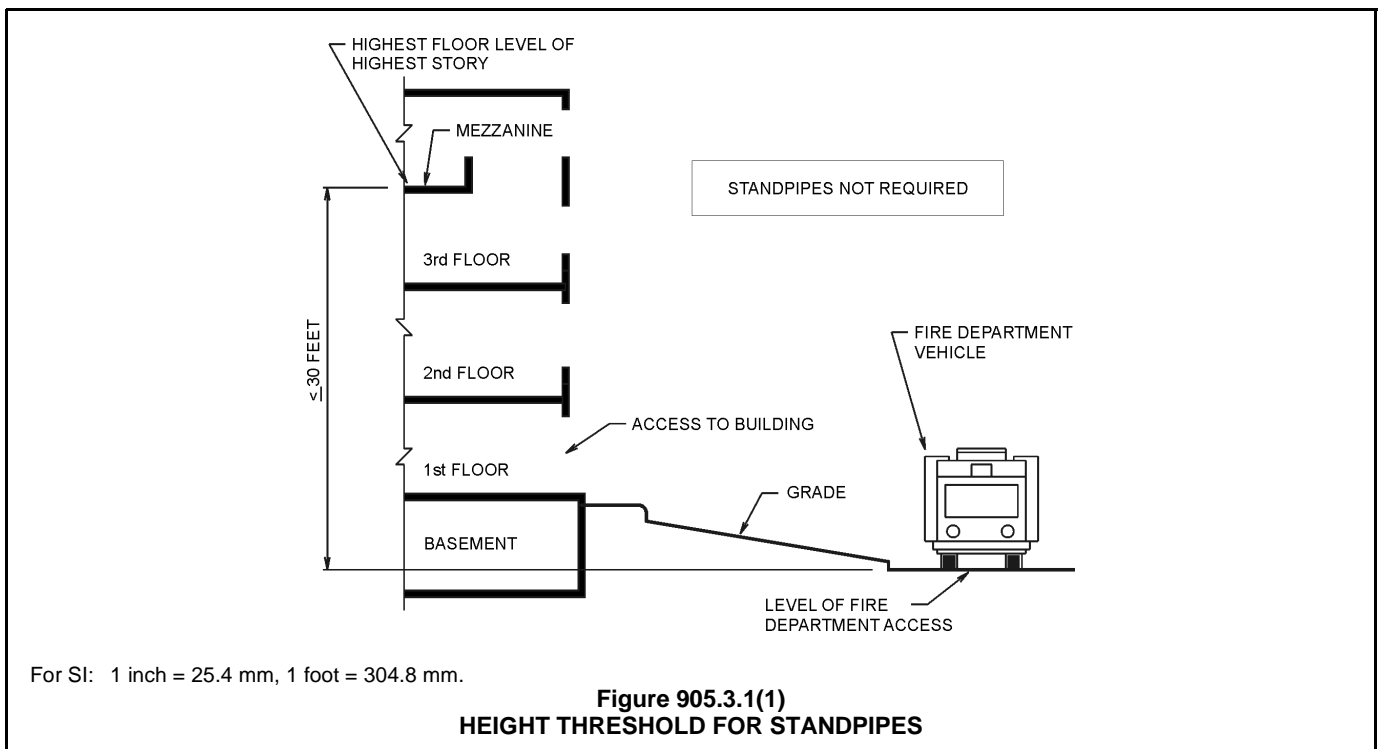
**Exceptions:**

1. Class I standpipes are allowed in buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2.
2. Class I manual standpipes are allowed in open parking garages where the highest floor is located not more than 150 feet (45 720 mm) above the lowest level of fire department vehicle access.
3. Class I manual dry standpipes are allowed in open parking garages that are subject to freezing temperatures, provided that the hose connections are located as required for Class II standpipes in accordance with Section 905.5.

4. Class I standpipes are allowed in *basements* equipped throughout with an *automatic sprinkler system*.
5. In determining the lowest level of fire department vehicle access, it shall not be required to consider either of the following:
  - 5.1. Recessed loading docks for four vehicles or less.
  - 5.2. Conditions where topography makes access from the fire department vehicle to the building impractical or impossible.

❖ Given the available manpower on the fire department vehicle, standard fire-fighting operations and standard hose sizes, a 30-foot (9144 mm) vertical distance is generally considered the maximum height to which a typical fire department engine company can practically and readily extend its hose lines. Thus, the maximum vertical travel (height) threshold is based on the time it would take a typical fire department engine (pumper) company to manually suppress a fire. The standpipe connection reduces the time needed for the fire department to extend hose lines up or down stairways to advance and apply water to the fire. For this use, a minimum Class III standpipe system is required.

With respect to the height of the building, the threshold is measured from the level at which the fire department can gain access to the building directly from its vehicle and begin vertical movement. Floor levels above grade are measured from the lowest level of fire department vehicle access to the highest floor level above [see Commentary Figure 905.3.1(1)]. If a building contains floor levels below



the level of fire department vehicle access, the measurement is made from the highest level of fire department vehicle access to the lowest floor level. In cases where a building has more than one level of fire department vehicle access, the most restrictive measurement is used because it is not known at which level the fire department will access the building. In other words, the vertical distance is to be measured from the more restrictive level of fire department vehicle access to the level of the highest (or lowest, if below) floor [see Commentary Figure 905.3.1(2)].

The threshold based on the height of the building is independent of the occupancy of the building, the area of the building or the presence of an automatic sprinkler system. This is based on the universal need to be able to provide a water supply for fire suppression in any building and on the limitations of the physical effort necessary to extend hose lines vertically.

Before discussing the exceptions it is important to understand the differences between the different classes and operational characteristics of standpipes. More detailed information is included in Section 202 for the definitions of the different classes and types of standpipes.

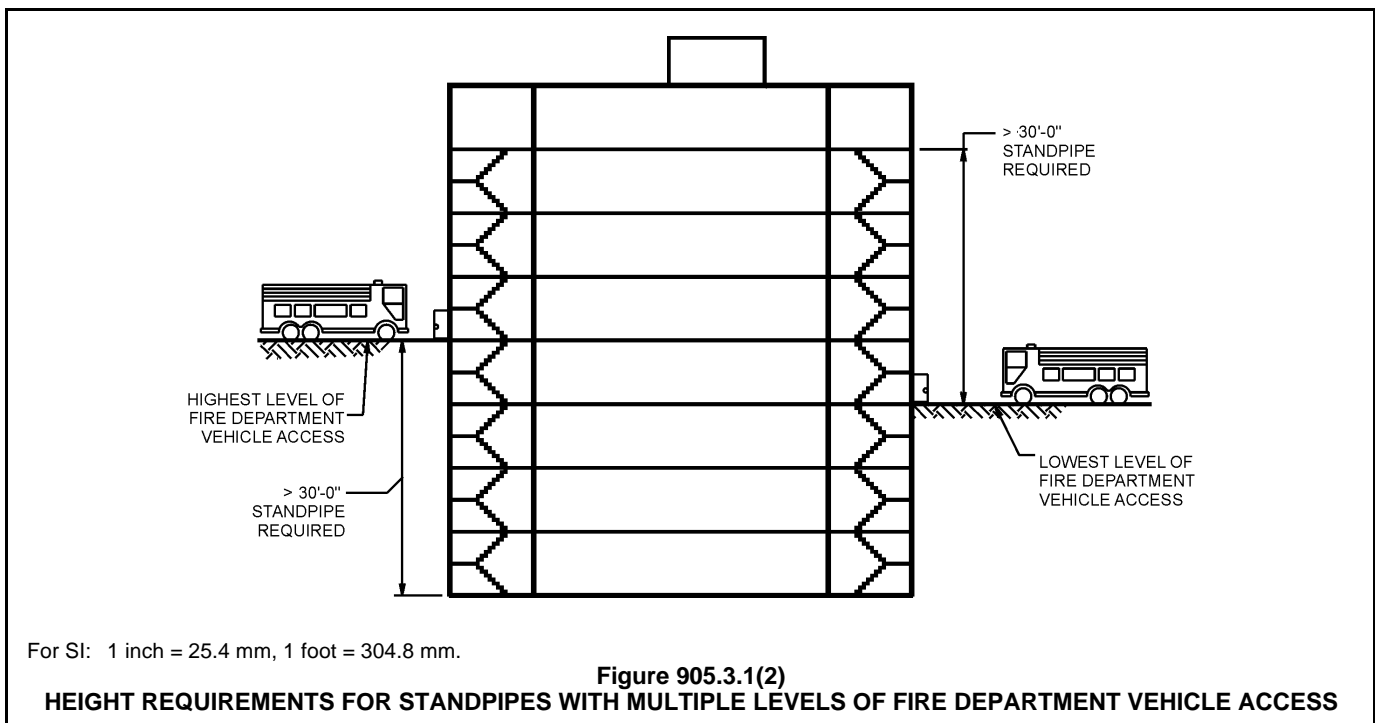
Standpipes can be dry or wet, manual, automatic or semiautomatic. Automatic systems can be either wet or dry. Manual systems can be either wet or dry. A semiautomatic system is always in association with a dry system.

The code is written such that it could be assumed the default is an automatic wet system. This is, however, not the case. The requirement is left to the design standard, NFPA 14. Section 5.4.1.1 of NFPA 14 indicates that Class I standpipes can be manual if

the building is not high-rise. Section 5.4.1.4 of the standard indicates that a Class I standpipe must be wet except where the pipe is subject to freezing. Thus, where a Class I standpipe is installed, possibly as a part of Exception 1, the system can be manual wet if the building is not a high rise. This is consistent with IFC Committee Interpretation No. 33-03. As long as the building is not high rise, it can be provided with a Class I standpipe system that is manual wet.

Class II and III standpipes are required to be automatic-wet or semiautomatic wet except where the piping is subject to freezing according to Section 5.4.2 of NFPA 14. They cannot be manual. Only Class I standpipes can be manual and only be used under the conditions noted in this code. Note that other sections of the code may specify whether the system must be automatic or not. If the requirement is not noted elsewhere in the code, then the decision to use an automatic or manual system is left to the designer.

Exception 1 recognizes the fact that with a fully operational automatic sprinkler system, the time that the fire department has to extend hoses within the building is substantially increased and that the amount of effort required is greatly reduced. Consequently, a single Class I connection can be provided. The second, 1½-inch (38 mm) connection is allowed to be omitted. NFPA 14 also has a similar provision but is more restrictive as it only eliminates the hose station and additionally requires a 2½ inch by 1½ inch (65 mm by 40 mm) reducer and a cap attached with a chain (Section 7.3.4.1 of NFPA 14). In accordance with Section 102.7, the code would take precedence and the reducer and cap would not be required.



Exception 2 identifies one of the issues relative to open parking garages. This exception allows for the garage, when not more than 150 feet (45 720 mm) in height above the lowest level of fire department access, to have a wet standpipe but without additional operating pressure until the fire department connects and begins pumping into the system. This makes sense since normal operations typically do not begin until after the fire department is on the scene and has made its initial assessments. This is generally considered to be the maximum safe height for pumpers to overcome the hydrostatic head presented by 150 feet (45 720 mm) of water. Careful considerations should be made since not all fire departments have equipment capable of this type of pumping capacity.

Exception 3 is similar to the prior exception but with the added provision that the standpipe can be dry if subject to freezing, regardless of height. Because the standpipe will be without water and dependent upon the fire department to provide both water and pressure, standpipe outlets must be spaced more frequently, as noted in Section 905.5 for Class II standpipes so that fire fighters can connect and begin operations quicker. The exception does not require Class II outlets; only that the spacing be consistent with the requirement for Class II.

Exception 4 is similar to Exception 1 but only addresses sprinklers in the basement. Thus it is possible to use this exception if only the basement is protected by automatic sprinklers. However, Class I connections can only be provided in the basements—not on the upper floors. The exception cannot be used for stories above grade unless the entire building is sprinklered and, therefore, compliant with Exception 1.

Exception 5 provides additional information about what must be considered when determining building height with respect to the level of fire department vehicle access. The first item is a practical one that excludes loading docks of a limited size. The second item notes that although it may be possible to have a fire department vehicle arrive adjacent to the building at a low level, it may not be possible for the fire department to access the building from that level. An example of this condition would be where a road surface is located below a building constructed on a bluff. Although the fire department vehicles can approach from the lower road, fire department personnel cannot access the building from that lower level. Thus, the standpipe requirement would not be based on the road below the bluff.

**905.3.2 Group A.** Class I automatic wet standpipes shall be provided in nonsprinklered Group A buildings having an *occupant load* exceeding 1,000 persons.

**Exceptions:**

1. Open-air-seating spaces without enclosed spaces.

2. Class I automatic dry and semiautomatic dry standpipes or manual wet standpipes are allowed in buildings that are not high-rise buildings.

❖ The main concern in assembly occupancies with a high occupant load is evacuation. Many occupants may not be familiar with either their surroundings or the egress arrangement in the building. This section also assumes the building is not sprinklered; therefore, control and suppression of the fire is left to the fire department.

Exception 1 exempts open-air seating without enclosed spaces, such as grandstands and bleachers. In such occupancies, a buildup of smoke and hot gases is not possible because these structures are open to the atmosphere.

Exception 2 states that in lieu of a Class I automatic wet standpipe, automatic-dry and semiautomatic dry Class I standpipes are permitted in buildings that are not considered to be a high rise.

**905.3.3 Covered and open mall buildings.** Covered mall and open mall buildings shall be equipped throughout with a standpipe system where required by Section 905.3.1. Mall buildings not required to be equipped with a standpipe system by Section 905.3.1 shall be equipped with Class I hose connections connected to the *automatic sprinkler system* sized to deliver water at 250 gallons per minute (946.4 L/min) at the most hydraulically remote hose connection while concurrently supplying the automatic sprinkler system demand. The standpipe system shall be designed not to exceed a 50 pounds per square inch (psi) (345 kPa) residual pressure loss with a flow of 250 gallons per minute (946.4 L/min) from the fire department connection to the hydraulically most remote hose connection. Hose connections shall be provided at each of the following locations:

1. Within the mall at the entrance to each exit passageway or corridor.
2. At each floor-level landing within *interior exit stairways* opening directly on the mall.
3. At exterior public entrances to the mall of a covered mall building
4. At public entrances at the perimeter line of an open mall building.
5. At other locations as necessary so that the distance to reach all portions of a tenant space does not exceed 200 feet (60 960 mm) from a hose connection.

❖ Covered and open mall buildings are only required to have a standpipe system if Section 905.3.1 requires such features. If standpipes are not required due to building height, Class I hose connections that are connected to the automatic sprinkler system are still required. Also, to ensure that both the sprinkler system and hose connections will function at an acceptable level, the system must be sized for both the sprinkler demand and the hose connection demand. This section specifies a minimum flow rate and a

maximum pressure loss to the most remote hose connection so that the fire department can gain full use of the hose connection during a fire. Hose connections are required when a standpipe system is not at key locations, such as entrances to exit passageways and at entrances to the covered or open mall. Note that these locations are essentially the same locations required for Class I hose connections in Section 905.4, except that this section also requires that the distance of all portions of tenant spaces does not exceed 200 feet (60 960 mm) from a hose connection.

**905.3.4 Stages.** Stages greater than 1,000 square feet (93 m<sup>2</sup>) in area shall be equipped with a Class III wet standpipe system with 1½-inch and 2½-inch (38 mm and 64 mm) hose connections on each side of the stage.

**Exception:** Where the building or area is equipped throughout with an *automatic sprinkler system*, a 1½-inch (38 mm) hose connection shall be installed in accordance with NFPA 13 or in accordance with NFPA 14 for Class II or III standpipes.

- ❖ Because of the potentially large fuel load and three-dimensional aspect of the fire hazard associated with stages greater than 1,000 square feet (93 m<sup>2</sup>) in area, Class III standpipes are required on each side of these large stages. The standpipes must be equipped with a 1½-inch (38 mm) hose connection and a 2½-inch (64 mm) hose connection. The 1½-inch (38 mm) connection is for the hose requirement in Section 905.3.4.1. The 2½-inch (64 mm) connection is to provide greater flexibility for the fire department in its fire-fighting operations.

Stages, as used in this section, are those stages defined in Section 410.2 of the IBC, which include overhead hanging curtains, drops, scenery or stage effects other than lighting and sound. These were traditionally referred to as “legitimate stages.” It is not an appropriate application of this section to require standpipes for elevated areas in banquet rooms, or theatrical platforms where the higher fuel loads associated with a legitimate stage do not exist.

The exception recognizes the benefit of the building or area being sprinklered. If so, then only a single 1½-inch (38 mm) connection is required. This hose connection is intended to be used by the fire department and apply less water from the hose due to the suppression activity of the sprinkler system. Hose threads must be compatible with those of the fire department as required in Section 903.3.6.

In a fully sprinklered building it is acceptable to supply the hose connections through the same standpipe as the sprinklers. This is reflected in the reference to both NFPA 13, which acknowledges this concept, and NFPA 14, which contains similar provisions. If the provisions of NFPA 14 are used, although the standpipe must be wet and Class II in its installation, the design of the water supply and interconnection of systems can be in accordance with the

requirements for Class II as well as for Class III standpipes.

**905.3.4.1 Hose and cabinet.** The 1½-inch (38 mm) hose connections shall be equipped with sufficient lengths of 1½-inch (38 mm) hose to provide fire protection for the stage area. Hose connections shall be equipped with an *approved* adjustable fog nozzle and be mounted in a cabinet or on a rack.

- ❖ The 1½-inch (38 mm) standpipe hose installed for stages greater than 1,000 square feet (93 m<sup>2</sup>) in area is intended for use by stage personnel who have been trained to use it. The length of hose provided is a function of the size and configuration of the stage. This includes by definition the entire performance area and adjacent backstage and support areas not fire separated from the performance area. The effective reach of the fire stream from the fog nozzle is a function of the available water supply, and in particular, the pressure. Fog nozzles typically require 100 pounds per square inch (psi) (690 kPa) for optimum performance.

**905.3.5 Underground buildings.** Underground buildings shall be equipped throughout with a Class I automatic wet or manual wet standpipe system.

- ❖ Underground buildings present unique hazards to life safety because of their isolation and inaccessibility. Additional fire protection and fire fighting measures for the fire department are required to compensate for the lack of exterior access for fire suppression and rescue operations (see Section 405 of the IBC).

**905.3.6 Helistops and heliports.** Buildings with a rooftop *helistop* or *heliport* shall be equipped with a Class I or III standpipe system extended to the roof level on which the *helistop* or *heliport* is located in accordance with Section 2007.5.

- ❖ Buildings containing rooftop helistops or heliports are required to be equipped with a Class I or III standpipe. A heliport is a distinct hazard that will involve flammable fuels. In the event of an emergency, rapid deployment of hand hose lines will be necessary to attack a resulting fire, effectuate rescue and to protect exposures and the remainder of the building.

The requirement results in a standpipe system throughout the building, not just a connection at the roof level. This is critical in fire-fighting operations because many times the connection below the rooftop level may be needed just to gain access onto the roof. If the only connection is on the roof, it is of no use if the fire fighters cannot get to it.

Additionally, a heliport includes fueling operations. It is entirely possible for a spill to not only affect the rooftop, but also floors below as the liquid fuel spreads. The standpipe system will again be utilized in these situations.

Section 2007.5 requires a 2½-inch (64 mm) standpipe outlet to be within 150 feet (45 675 mm) of all portions of the heliport or helistop area and be either Class I or III.

**905.3.7 Marinas and boatyards.** Standpipes in marinas and boatyards shall comply with Chapter 36.

❖ Section 3604.2 contains the specifics as to when standpipes are required at marinas. Marinas and boatyards have unique challenges for fire fighting. Although there is water readily available, it is not easily or effectively capable of being applied to a fire at such a facility. A fire in such facilities can spread from structure to structure and from vessel to vessel with no effective way to attack and control it. Section 3604.2 references NFPA 303 for the standpipe requirements and additionally requires that no point on the marina pier or float system exceed 150 feet (45 675 mm) from a standpipe hose connection (see commentary, Section 3604.2).

**905.3.8 Rooftop gardens and landscaped roofs.** Buildings or structures that have rooftop gardens or landscaped roofs and that are equipped with a standpipe system shall have the standpipe system extended to the roof level on which the rooftop garden or landscaped roof is located.

❖ This section requires that if the building is equipped with a standpipe system, whether or not such systems are required, it must be extended to a roof containing a garden or that is landscaped. These requirements relate to the requirements in Section 317 that address the increased fuel load being added to roofs.

**905.4 Location of Class I standpipe hose connections.** Class I standpipe hose connections shall be provided in all of the following locations:

1. In every required *interior exit stairway*, a hose connection shall be provided for each story above and below grade plane. Hose connections shall be located at an intermediate landing between stories, unless otherwise *approved by the fire code official*.
2. On each side of the wall adjacent to the *exit* opening of a horizontal *exit*.

**Exception:** Where floor areas adjacent to a horizontal *exit* are reachable from an *interior exit stairway* hose connection by a 30-foot (9144 mm) hose stream from a nozzle attached to 100 feet (30 480 mm) of hose, a hose connection shall not be required at the horizontal *exit*.

3. In every *exit* passageway, at the entrance from the exit passageway to other areas of a building.

**Exception:** Where floor areas adjacent to an exit passageway are reachable from an *interior exit stairway* hose connection by a 30-foot (9144 mm) hose stream from a nozzle attached to 100 feet (30 480 mm) of hose, a hose connection shall not be required at the entrance from the exit passageway to other areas of the building.

4. In covered mall buildings, adjacent to each exterior public entrance to the mall and adjacent to each entrance from an *exit* passageway or *exit corridor* to the mall. In open mall buildings, adjacent to each public entrance to the mall at the perimeter line and adjacent

to each entrance from an exit passageway or exit corridor to the mall.

5. Where the roof has a slope less than four units vertical in 12 units horizontal (33.3-percent slope), a hose connection shall be located to serve the roof or at the highest landing of an *interior exit stairway* with access to the roof provided in accordance with Section 1011.12.
6. Where the most remote portion of a nonsprinklered floor or story is more than 150 feet (45 720 mm) from a hose connection or the most remote portion of a sprinklered floor or story is more than 200 feet (60 960 mm) from a hose connection, the *fire code official* is authorized to require that additional hose connections be provided in *approved* locations.

❖ Hose connections are required for the fire department to make use of the standpipe system. Since the fire department will typically access the building using the stairways, and most fire departments do not permit entry to the fire floor without an operating hose line, a hose connection must be installed for each floor level of each required enclosed stairway.

Item 1 also specifies that the hose connections are to be located at intermediate landings between stories. This reduces congestion at the stairway door and may reduce the hose lay distance. The hose connections, however, are still permitted at each story instead of at the intermediate landing if this arrangement is approved by the fire code official.

Because horizontal exits are also primary entrances to the fire floor, Item 2 states that hose connections must also be provided at each horizontal exit. The construction of the fire separation assembly used as the horizontal exit will protect the fire fighters while they are connecting to the standpipe system. The hose connections are to be located on each side of the horizontal exit to enable fire fighters to be in a protected area, regardless of the location of the fire. The exception acknowledges that there may already be a hose connection in close proximity to the horizontal exit if there is a stairway adjacent to the horizontal exit. The intent is to allow fewer standpipe outlets if the area can be adequately covered by the standpipes in stairways since those are the standpipes typically used by the fire department.

Item 3 states that an exit passageway in a building required to have a standpipe system is typically used as an extension of a required exit stairway. This allows use of the exit passageway for fire-fighting staging operations in the same way as an exit stair. The exception acknowledges that there may already be a hose connection in close proximity to the exit passageway. If there is a stairway containing a hose connection in close proximity to the exit passageway that can meet the 30-foot hose stream from a nozzle attached to 100 feet of hose then an additional standpipe is not required. The intent is to allow fewer standpipe outlets if the area can be adequately covered by the standpipes in stairways since those are the standpipes typically used by the fire department.

In covered and open mall buildings, Item 4 requires hose connections at each entrance to an exit passageway or exit corridor. In addition, covered mall buildings would be required to have connections at each exterior public entrance. Open malls would require connections at the public entrance perimeter line. These locations allow fire personnel to have a support line as soon as they enter the building.

Item 5 is consistent with NFPA 14 regarding the installation of Class I standpipe hose connections on the roofs of buildings. This requirement requires only one standpipe to extend to the roof level or highest landing of the stair serving the roof. This coordinates with Section 1011.12 which only requires one stairway to extend to the roof.

Hose connections in each exit stairway result in hose connections being located based on the travel distances permitted in Table 1017.2, which recognizes that most fire departments carry standpipe hose packs with 150 feet (45 720 mm) of hose or possibly with 100 feet (30 480 mm) of hose and an additional 50-foot (15 240 mm) section that could be easily connected.

With the typical travel distance permitted in non-sprinklered buildings of 200 feet (60 960 mm), reasonable coverage is provided when the effective reach of a fire stream is considered. Depending on the arrangement of the floor, however, all areas may not be effectively protected. Although this situation could easily be corrected by locating additional hose connections on the floor, such connections may rarely be used because of the difficulty in identifying their location during a fire and the fact that most fire departments require an operational hose line before they enter the fire floor. Because longer travel distances are allowed in sprinklered buildings, the problem is increased, but the need for prompt manual suppression is reduced by the presence of the sprinkler system. Item 6 gives the fire code official the authority to require additional hose connections if needed.

**905.4.1 Protection.** Risers and laterals of Class I standpipe systems not located within an *interior exit stairway* shall be protected by a degree of *fire resistance* equal to that required for vertical enclosures in the building in which they are located.

**Exception:** In buildings equipped throughout with an *approved automatic sprinkler system*, laterals that are not located within an *interior exit stairway* are not required to be enclosed within fire-resistance-rated construction.

- ❖ To minimize the potential for damage to the standpipe systems from a fire, the risers and laterals (i.e., the horizontal segments of standpipe system piping) must be located in an enclosure having the same fire-resistance rating as required for a vertical or shaft enclosure within the building. The required fire-resistance rating for the enclosure can be determined as detailed in Section 713.4 of the IBC.

The exception states that the enclosure for laterals is not required if the building is equipped throughout with an approved automatic sprinkler system. The

potential for damage to the standpipe system is minimized by the protection provided by the sprinkler system. The automatic sprinkler system may be either an NFPA 13 or 13R system, depending on what was permitted for the building occupancy.

If the interior exit stairway is not required to have a rated enclosure, such as in an open parking garage, the laterals are similarly not required to be in an enclosure. The protection afforded the vertical riser in the stairway must be the same as that afforded the laterals. If the stairway is not required by other sections of the code to be located in a rated enclosure then the laterals are not required to be in rated protection either.

**905.4.2 Interconnection.** In buildings where more than one standpipe is provided, the standpipes shall be interconnected in accordance with NFPA 14.

- ❖ In cases where there are multiple Class I standpipe risers, the risers must be supplied from and interconnected to a common supply line. The required fire department connection must serve all of the sprinklers or standpipes in the building.

**905.5 Location of Class II standpipe hose connections.** Class II standpipe hose connections shall be accessible and shall be located so that all portions of the building are within 30 feet (9144 mm) of a nozzle attached to 100 feet (30 480 mm) of hose.

- ❖ Sections 905.5.1 through 905.5.3 specify the requirements for Class II standpipe hose connections. Class II standpipe systems are primarily intended for use by the building occupants.

This section for Class II standpipes does not specifically require hose stations and uses the term hose connection with a location based upon 100 feet (30 480 mm) of hose. However, the definition of Class II and III standpipes and Section 7.3.3.1 of NFPA 14 specifically require hose stations. Section 905.2 specifically references NFPA 14.

Although NFPA 14 requires a hose station, the decision as to whether a hose station is required may be one that is affected by the policies and procedures of the local fire department. It should be remembered that Class II hose connections and hose stations are intended for occupant use and not necessarily for fire department use. The fire department typically uses the Class I connection that is compatible with 2<sup>1</sup>/<sub>2</sub>-inch (64 mm) hose.

**905.5.1 Groups A-1 and A-2.** In Group A-1 and A-2 occupancies with *occupant loads* of more than 1,000, hose connections shall be located on each side of any stage, on each side of the rear of the auditorium, on each side of the balcony and on each tier of dressing rooms.

- ❖ Because of the high occupant load density in Group A-1 and A-2 occupancies, providing additional means for controlling fires in their initial stage is important to enable prompt evacuation of the building. This section is independent of the Class I standpipe requirement for stages based on square footage as indicated in Section 905.3.4.

**905.5.2 Protection.** Fire-resistance-rated protection of risers and laterals of Class II standpipe systems is not required.

- ❖ Class II standpipe systems are normally not located in exit stairways; standpipe hose connections are located near the protected area to allow quick access. Therefore, it is likely that neither the risers nor the laterals would be located in any enclosure.

**905.5.3 Class II system 1-inch hose.** A minimum 1-inch (25 mm) hose shall be allowed to be used for hose stations in light-hazard occupancies where investigated and *listed* for this service and where *approved* by the *fire code official*.

- ❖ This section permits the use of 1-inch (25 mm) listed noncollapsible hose as an alternative to 1½-inch (38 mm) hose, subject to the approval of the fire code official. This alternative is limited to light-hazard occupancies, such as office buildings and certain assembly occupancies that tend to have lower fuel loads, since a smaller hose can discharge less water.

**905.6 Location of Class III standpipe hose connections.** Class III standpipe systems shall have hose connections located as required for Class I standpipes in Section 905.4 and shall have Class II hose connections as required in Section 905.5.

- ❖ Class III standpipe systems that have both a 2½-inch (64 mm) hose connection and a 1½-inch (38 mm) hose connection must comply with the applicable requirements of Sections 905.4, 905.5 and 905.6. Thus, it is necessary to review and comply with all applicable provisions.

**905.6.1 Protection.** Risers and laterals of Class III standpipe systems shall be protected as required for Class I systems in accordance with Section 905.4.1.

- ❖ Because Class III standpipe systems are intended for use by fire-suppression personnel, they must be located in construction that has a fire-resistance rating equivalent to that of the vertical or shaft enclosure requirements of the building (see commentary, Section 905.4.1).

**905.6.2 Interconnection.** In buildings where more than one Class III standpipe is provided, the standpipes shall be interconnected in accordance with NFPA 14.

- ❖ As indicated in Section 905.4.2 for Class I standpipe systems, multiple standpipe risers must be interconnected with a common supply line. An indicating valve is typically installed at the base of each riser so that individual risers can be taken out of service without affecting the water supply or the operation of other standpipe risers.

**905.7 Cabinets.** Cabinets containing fire-fighting equipment, such as standpipes, fire hose, fire extinguishers or fire department valves, shall not be blocked from use or obscured from view.

- ❖ This section does not require that cabinets be provided to contain fire protection equipment. However, if they

are provided, cabinets must be readily visible and accessible at all times. Sections 905.7.1 and 905.7.2 contain additional criteria for the construction and identification of the cabinets. Where cabinets are located in fire-resistance-rated assemblies, the integrity of the assembly must be maintained. Cabinet design for hose connections, control valves or other devices that require manual operation should be such that there is sufficient clearance between the cabinet body and the device to allow grasping of the device (quite likely with a gloved hand) and prompt operation of it.

**905.7.1 Cabinet equipment identification.** Cabinets shall be identified in an *approved* manner by a permanently attached sign with letters not less than 2 inches (51 mm) high in a color that contrasts with the background color, indicating the equipment contained therein.

**Exceptions:**

1. Doors not large enough to accommodate a written sign shall be marked with a permanently attached pictogram of the equipment contained therein.
2. Doors that have either an *approved* visual identification clear glass panel or a complete glass door panel are not required to be marked.

- ❖ This section specifies the minimum criteria to make the signs readily visible. Different color combinations may be approved by the fire code official if the color contrast between the letters and the background is vivid enough to make the sign visible at an approved distance. The exceptions address alternatives to letter signage if the cabinet is still conspicuously identified or the contents are readily visible.

**905.7.2 Locking cabinet doors.** Cabinets shall be unlocked.

**Exceptions:**

1. Visual identification panels of glass or other *approved* transparent frangible material that is easily broken and allows access.
2. *Approved* locking arrangements.
3. Group I-3 occupancies.

- ❖ Ready access to all fire-fighting equipment in the cabinet is essential. The exceptions, however, recognize the need to lock cabinets for security reasons and to prevent theft or vandalism (see also the commentary, Section 906.8).

**905.8 Dry standpipes.** Dry standpipes shall not be installed.

**Exception:** Where subject to freezing and in accordance with NFPA 14.

- ❖ Wet standpipe systems are preferred because they tend to be the most reliable type of standpipe system; therefore, dry standpipes are prohibited unless subject to freezing. For example, Class I manual standpipe systems, which do not have a permanent water supply, are permitted in open parking structures. This recognizes that open parking structures are not

heated and that most fires are limited to the vehicle of origin. The use of any dry standpipe system instead of a wet standpipe should take into consideration the added response time and its effect on the occupancy characteristics of the building.

**905.9 Valve supervision.** Valves controlling water supplies shall be supervised in the open position so that a change in the normal position of the valve will generate a supervisory signal at the supervising station required by Section 903.4. Where a fire alarm system is provided, a signal shall be transmitted to the control unit.

**Exceptions:**

1. Valves to underground key or hub valves in roadway boxes provided by the municipality or public utility do not require supervision.
  2. Valves locked in the normal position and inspected as provided in this code in buildings not equipped with a fire alarm system.
- ❖ As with sprinkler systems, water control valves for standpipe systems must be electrically supervised as a means of determining that the system is operational (see commentary, Section 903.4).

Exception 1 recognizes that underground key or hub valves in roadway boxes are not normally supervised or need to be supervised whether the building contains a standpipe system or an automatic sprinkler system.

Exception 2 does not require the control valves for the standpipes to be electrically monitored if they are locked in the normal position and a fire alarm system is not installed in the building. When a fire alarm system is installed, the control valves for the standpipes must be electrically monitored and tied into the supervision required for the fire alarm system.

**905.10 During construction.** Standpipe systems required during construction and demolition operations shall be provided in accordance with Section 3313.

- ❖ As stated in Section 3313, at least one standpipe is required during construction of buildings four stories or more in height or during demolition of standpipe-equipped buildings. Standpipe systems must be accessible and operable during construction and demolition operations to assist in any potential fire (see commentary, Sections 3313.1 and 3313.2 of the code and Sections 3311.1 and 3311.2 of the IBC).

**905.11 Existing buildings.** Where required in Chapter 11, existing structures shall be equipped with standpipes installed in accordance with Section 905.

- ❖ This section simply refers to Chapter 11 which addresses all requirements that apply to existing buildings (see commentary, Section 1103.6).

**SECTION 906  
PORTABLE FIRE EXTINGUISHERS**

**906.1 Where required.** Portable fire extinguishers shall be installed in all of the following locations:

1. In new and existing Group A, B, E, F, H, I, M, R-1, R-2, R-4 and S occupancies.

**Exception:** In Group R-2 occupancies, portable fire extinguishers shall be required only in locations specified in Items 2 through 6 where each *dwelling unit* is provided with a portable fire extinguisher having a minimum rating of 1-A:10-B:C.

2. Within 30 feet (9144 mm) of commercial cooking equipment.
3. In areas where flammable or *combustible liquids* are stored, used or dispensed.
4. On each floor of structures under construction, except Group R-3 occupancies, in accordance with Section 3315.1.
5. Where required by the sections indicated in Table 906.1.
6. Special-hazard areas, including but not limited to laboratories, computer rooms and generator rooms, where required by the *fire code official*.

- ❖ Portable fire extinguishers (PFEs) are required in certain instances to give the occupants the means to suppress a fire in its incipient stage. The capability for manual fire suppression can contribute to the protection of the occupants, especially if there are evacuation difficulties associated with the occupancy or the specific hazard in the area. To be effective, personnel must be properly trained in the use of portable fire extinguishers.

Because of the high-hazard nature of building contents, portable fire extinguishers are required in occupancies in Group H.

Portable fire extinguishers are required in occupancies in Groups A, B, E, F, I, M, R-1, R-2, R-4 and S because of the need to control the fire in its early stages and because evacuation can be slowed by the density of the occupant load, the capability of the occupants to evacuate or the overall fuel load in the building. Because the IBC references the code for fire extinguisher requirements in new buildings, the code is applicable to new buildings.

Portable fire extinguishers are required in areas containing special hazards such as commercial cooking equipment and specific hazardous operations as indicated in Table 906.1. Because of the potentially extreme fire hazard associated with such areas or occupancy conditions, prompt extinguishment of the fire is critical.

Portable fire extinguishers are required in all buildings under construction, except in occupancies in Group R-3. The extinguishers are intended for use by construction personnel to suppress a fire in its incipient stages.

Portable fire extinguishers are also required in laboratories, computer rooms and other work spaces in which fire hazards may exist based on the use of the space. Many of these will be addressed by the required occupancy group criteria or by the specific hazard provisions of Table 906.1. Laboratories, for example, may not be considered Group H, but still use limited amounts of hazardous materials that would make manual means of fire extinguishment desirable.

The exception to Item 1 permits smaller PFEs in dwelling units of Group R-2 occupancies instead of larger PFEs in the common areas. Under the revised exception, the installation of 1-A:10-B:C PFEs within individual dwelling units that allows apartment owners to eliminate their installation in common areas such as corridors, laundry rooms and swimming pool areas. PFEs in these areas are susceptible to vandalism or theft. Another issue is that larger PFEs are more difficult for the infirm and elderly to safely deploy and operate. Note that the exception does not waive the ongoing maintenance requirement for PFEs within the dwelling units.

For the period of 2003 through 2007, NFPA reported that approximately 38,000 fires occurred annually in apartment buildings. Sixty percent of these fires occurred inside of dwelling units versus 14 percent that occur in common areas covered by Items 3 and 6 of Section 906.1. It is more logical to place PFEs inside of dwelling units versus common areas because it locates the extinguisher in an area where statistically most fires occur. If the occupant cannot control the fire using the PFE, he or she can escape and allow the automatic sprinkler system to operate and control the fire. This exception improves the safety of Group R-2 residents because it does not require them to leave a dwelling involved in a fire, find a PFE and then return to the fire-involved dwelling unit to attempt incipient fire attack.

Including this requirement in the code alerts designers and building officials that the extinguishers are required. This will allow designers to plan for thicker walls where recessed cabinets may be used or to design locations where the extinguishers will not project into or obstruct the egress or circulation path.

**TABLE 906.1.** See next column.

- ❖ Table 906.1 lists those sections of the code that represent specific occupancy conditions requiring portable fire extinguishers for incipient fire control. Wherever the code requires a fire extinguisher because of one of the listed occupancy conditions, it may identify the required rating of the extinguisher that is compatible with the hazard involved in addition to referencing Section 906.

**TABLE 906.1**  
**ADDITIONAL REQUIRED PORTABLE FIRE EXTINGUISHERS**

SECTION	SUBJECT
303.5	Asphalt kettles
307.5	Open burning
308.1.3	Open flames—torches
309.4	Powered industrial trucks
2005.2	Aircraft towing vehicles
2005.3	Aircraft welding apparatus
2005.4	Aircraft fuel-servicing tank vehicles
2005.5	Aircraft hydrant fuel-servicing vehicles
2005.6	Aircraft fuel-dispensing stations
2007.7	Heliports and helistops
2108.4	Dry cleaning plants
2305.5	Motor fuel-dispensing facilities
2310.6.4	Marine motor fuel-dispensing facilities
2311.6	Repair garages
2404.4.1	Spray-finishing operations
2405.4.2	Dip-tank operations
2406.4.2	Powder-coating areas
2804.3	Lumberyards/woodworking facilities
2808.8	Recycling facilities
2809.5	Exterior lumber storage
2903.5	Organic-coating areas
3006.3	Industrial ovens
3104.12	Tents and membrane structures
3206.10	High-piled storage
3315.1	Buildings under construction or demolition
3317.3	Roofing operations
3408.2	Tire rebuilding/storage
3504.2.6	Welding and other hot work
3604.4	Marinas
3703.6	Combustible fibers
5703.2.1	Flammable and combustible liquids, general
5704.3.3.1	Indoor storage of flammable and combustible liquids
5704.3.7.5.2	Liquid storage rooms for flammable and combustible liquids
5705.4.9	Solvent distillation units
5706.2.7	Farms and construction sites—flammable and combustible liquids storage
5706.4.10.1	Bulk plants and terminals for flammable and combustible liquids
5706.5.4.5	Commercial, industrial, governmental or manufacturing establishments—fuel dispensing
5706.6.4	Tank vehicles for flammable and combustible liquids
5906.5.7	Flammable solids
6108.2	LP-gas

**906.2 General requirements.** Portable fire extinguishers shall be selected, installed and maintained in accordance with this section and NFPA 10.

**Exceptions:**

1. The distance of travel to reach an extinguisher shall not apply to the spectator seating portions of Group A-5 occupancies.
  2. Thirty-day inspections shall not be required and maintenance shall be allowed to be once every 3 years for dry-chemical or halogenated agent portable fire extinguishers that are supervised by a *listed* and *approved* electronic monitoring device, provided that all of the following conditions are met:
    - 2.1. Electronic monitoring shall confirm that extinguishers are properly positioned, properly charged and unobstructed.
    - 2.2. Loss of power or circuit continuity to the electronic monitoring device shall initiate a trouble signal.
    - 2.3. The extinguishers shall be installed inside of a building or cabinet in a noncorrosive environment.
    - 2.4. Electronic monitoring devices and supervisory circuits shall be tested every 3 years when extinguisher maintenance is performed.
    - 2.5. A written log of required hydrostatic test dates for extinguishers shall be maintained by the *owner* to verify that hydrostatic tests are conducted at the frequency required by NFPA 10.
  3. In Group I-3, portable fire extinguishers shall be permitted to be located at staff locations.
- ❖ NFPA 10 contains minimum requirements for the selection, installation and maintenance of portable fire extinguishers. Portable fire extinguishers are investigated and rated in conformance to NFPA 10 and listed under a variety of standards. Portable fire extinguishers must be labeled and rated for use on fires of the type, severity and hazard class protected. NFPA 10 notes that more frequent inspections may be necessary where conditions warrant. For existing installations, a history of recent fires, vandalism, physical abuse and theft should be considered in determining if more frequent inspections are needed. For both existing and new facilities, determining the frequency of inspections should consider the environmental conditions in which the extinguisher will be located, including corrosiveness and temperature variations; and, the possibility of obstructions that may place the extinguisher out of reach in case of an emergency.
- Exception 1 recognizes the openness to the atmosphere associated with Group A-5 occupancies. A fire in open areas is more obvious to all spectators. Group A-5 occupancies also do not accumulate

smoke and hot gases because they are not enclosed spaces. These reasons, in addition to the large and expansive layout within seating areas, make it reasonable and practical not to apply the distance of travel to a PFE criteria in Group A-5. Revised distance of travel allowances would need to be approved by the fire code official. Group A-5 occupancies also tend to be more subject to the corrosive conditions of an outdoor environment, and may include freeze/thaw cycles that can be detrimental to fire extinguishers.

Exception 2 acknowledges a 30-day inspection interval similar to NFPA 10. An electronic monitoring device can determine whether or not the fire extinguisher is still present and whether or not its contents are still at the proper charge. The use of such devices, being relatively new, is allowed if it is limited to dry-chemical and halogenated agents with the additional safeguards noted in the list. Where inspection intervals may be at more frequent intervals, as discussed above, the use of electronic monitoring may have even greater benefit and is acknowledged as such in NFPA 10. The log, noted in the exception, can be a written log or a printout of the electronic log maintained by the electronic monitoring device. This exception provides the building owner with an alternative to the contract inspections popularly used.

Exception 3 recognizes that portable fire extinguishers located throughout the facility are at times tampered with, removed or used for weapons by inmates in a detention or correctional setting. This exception would protect the extinguishers from damage or removal by inmates while still making them available to staff and employees for use in an emergency situation.

**906.2.1 Certification of service personnel for portable fire extinguishers.** Service personnel providing or conducting maintenance on portable fire extinguishers shall possess a valid certificate issued by an *approved* governmental agency, or other *approved* organization for the type of work performed.

❖ Maintenance of fire protection systems and devices are minimum Chapter 9 requirements. Fire protection systems, like other technologies, have advanced new designs which require a clear understanding of their construction and maintenance. To ensure that systems and devices are properly maintained, the code now requires individuals performing these activities be certified. Certification must be issued by an approved organization or governmental agency.

These provisions align the code with NFPA standards governing the inspection and maintenance of portable fire extinguishers.

Qualifications for individuals who service portable fire extinguishers are established in the 2010 edition of NFPA 10. Section 7.1.2.1 of NFPA 10 requires individuals inspecting and servicing portable fire extinguishers be trained and certified to reliably perform these activities.

**906.3 Size and distribution.** The size and distribution of portable fire extinguishers shall be in accordance with Sections 906.3.1 through 906.3.4.

❖ Proper selection and distribution of portable fire extinguishers is essential to having adequate protection for the building structure and the occupancy conditions within. This section introduces the sections that provide those requirements. Determination of the desired type of portable fire extinguisher depends on the character of the fire anticipated, building occupancy, specific hazards and ambient temperature conditions [see commentary, Tables 906.3(1) and 906.3(2)].

**906.3.1 Class A fire hazards.** Portable fire extinguishers for occupancies that involve primarily Class A fire hazards, the minimum sizes and distribution shall comply with Table 906.3(1).

❖ Class A fires generally involve materials considered to be “ordinary combustibles,” such as wood, cloth, paper, rubber and most plastics [see commentary, Table 906.3(1)].

**TABLE 906.3(1)  
FIRE EXTINGUISHERS FOR CLASS A FIRE HAZARDS**

	LIGHT (Low) HAZARD OCCUPANCY	ORDINARY (Moderate) HAZARD OCCUPANCY	EXTRA (High) HAZARD OCCUPANCY
Minimum rated single extinguisher	2-A <sup>c</sup>	2-A	4-A <sup>a</sup>
Maximum floor area per unit of A	3,000 square feet	1,500 square feet	1,000 square feet
Maximum floor area for extinguisher <sup>b</sup>	11,250 square feet	11,250 square feet	11,250 square feet
Maximum distance of travel to extinguisher	75 feet	75 feet	75 feet

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 gallon = 3.785 L.  
 a. Two 2½-gallon water-type extinguishers shall be deemed the equivalent of one 4-A rated extinguisher.  
 b. Annex E.3.3 of NFPA 10 provides more details concerning application of the maximum floor area criteria.  
 c. Two water-type extinguishers each with a 1-A rating shall be deemed the equivalent of one 2-A rated extinguisher for Light (Low) Hazard Occupancies.

❖ Table 906.3(1), which parallels Table 6.2.1.1 of NFPA 10, establishes the minimum number and rating of fire extinguishers for Class A fires in any particular occupancy. The occupancy classifications are further defined in NFPA 10. The maximum area that a single fire extinguisher can protect is determined based on the rating of the fire extinguisher. The distance of travel limitation of 75 feet (22 860 mm) is intended to be the actual walking distance along a normal path of travel to the extinguisher. For this reason, it is necessary to select fire extinguishers that comply with both the distribution criteria and travel distance limitation for a specific occupancy classification.

**906.3.2 Class B fire hazards.** Portable fire extinguishers for occupancies involving flammable or *combustible liquids* with depths of less than or equal to 0.25-inch (6.4 mm) shall be selected and placed in accordance with Table 906.3(2).

Portable fire extinguishers for occupancies involving flammable or *combustible liquids* with a depth of greater than 0.25-inch (6.4 mm) shall be selected and placed in accordance with NFPA 10.

❖ Class B fires involve flammable and combustible liquids, oil-based paints, alcohols, solvents, flammable gases and similar materials. Selection of these extinguishers is made based on the depth of the liquid that could become involved in a fire. If the depth is ¼-inch (6.35 mm) or less, selection is made using Table 906.3(2). Class B extinguishers for greater liquid depth, characterized in NFPA 10 as “appreciable depth,” must be selected and installed in accordance with Section 6.3.2 of NFPA 10 [see commentary, Table 906.3(2)].

**TABLE 906.3(2)  
FLAMMABLE OR COMBUSTIBLE LIQUIDS WITH  
DEPTHS OF LESS THAN OR EQUAL TO 0.25-INCH<sup>a</sup>**

TYPE OF HAZARD	BASIC MINIMUM EXTINGUISHER RATING	MAXIMUM DISTANCE OF TRAVEL TO EXTINGUISHERS (feet)
Light (Low)	5-B	30
	10-B	50
Ordinary (Moderate)	10-B	30
	20-B	50
Extra (High)	40-B	30
	80-B	50

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.  
 a. For requirements on water-soluble flammable liquids and alternative sizing criteria, see Section 5.5 of NFPA 10.

❖ Fires involving flammable or combustible liquids present a severe hazard challenge regardless of occupancy. Table 906.3(2), which parallels Table 6.3.1.1 of NFPA 10, prescribes the minimum portable fire extinguisher requirements where flammable or combustible liquids are limited in depth [0.25 inch (6 mm) or less]. As can be seen in the table, the size of the extinguisher is directly related to the distance of travel to the extinguisher for each given occupancy classification. These fire extinguisher provisions are independent of whether other fixed automatic fire-extinguishing systems are installed. For occupancy conditions involving flammable or combustible liquids in potential depths greater than 0.25 inch (6 mm), the selection and spacing criteria of NFPA 10 must be used in addition to any applicable requirements in Chapter 57 and NFPA 30.

**906.3.3 Class C fire hazards.** Portable fire extinguishers for Class C fire hazards shall be selected and placed on the basis of the anticipated Class A or B hazard.

❖ Class C fires involve energized electrical equipment where the electrical nonconductivity of the extinguish-

ing agent is critical. The need for this class of extinguisher is simply based on the presence of the hazard in an occupancy and no numerical rating is required.

**906.3.4 Class D fire hazards.** Portable fire extinguishers for occupancies involving combustible metals shall be selected and placed in accordance with NFPA 10.

❖ Class D fires are fires involving flammable solids, the bulk of which are combustible metals, including, but not limited to magnesium, potassium, sodium and titanium. Most Class D extinguishers will have a special low velocity nozzle or discharge wand to gently apply the agent in large volumes to avoid disrupting any finely divided burning materials. Extinguishing agents are also available in bulk and can be applied with a scoop or shovel. While Class D extinguishers are often referred to as “dry chemical” fire extinguishers, they are more properly called “dry powder” fire extinguishers because their mechanism of extinguishment is by a smothering action rather than by chemical reaction with the combustion process.

There are several Class D fire-extinguisher agents available, some will handle multiple types of metal fires, others will not. Sodium carbonate-based extinguishers are used to control sodium, potassium, and sodium-potassium alloy fires but have limited use on other metals. This material smothers and forms a crust. Sodium chloride-based extinguishers contain sodium chloride salt and a thermoplastic additive. The plastic melts to form an oxygen-excluding crust over the metal, and the salt dissipates heat. This powder is useful on most alkali metals including magnesium, titanium, aluminum, sodium, potassium, and zirconium. Graphite based-extinguishers contain dry graphite powder that smothers burning metals. Unlike sodium chloride powder extinguishers, the graphite powder fire extinguishers can be used on very hot burning metal fires, such as lithium, but the powder will not stick to and extinguish flowing or vertical lithium fires. The graphite powder acts as a heat sink as well as smothering the metal fire. See the commentary to Section 5906.5.7 for a discussion of extinguishing flammable solid fires.

**906.4 Cooking grease fires.** Fire extinguishers provided for the protection of cooking grease fires shall be of an *approved* type compatible with the automatic fire-extinguishing system agent and in accordance with Section 904.12.5.

❖ The combination of high-efficiency cooking appliances and hotter burning cooking media creates a potentially severe fire hazard. Although commercial cooking systems must have an approved exhaust hood and be protected by an approved automatic fire-extinguishing system, a manual means of extinguishment is desirable to attack a fire in its incipient stage.

As indicated in Section 904.12.5, a Class K-rated portable fire extinguisher must be located within 30

feet (9144 mm) of travel distance of commercial-type cooking equipment. Class K-rated extinguishers have been specifically tested on commercial cooking appliances using vegetable or animal oils or fats. These portable fire extinguishers are usually of sodium bicarbonate or potassium bicarbonate dry-chemical type.

**906.5 Conspicuous location.** Portable fire extinguishers shall be located in conspicuous locations where they will be readily accessible and immediately available for use. These locations shall be along normal paths of travel, unless the *fire code official* determines that the hazard posed indicates the need for placement away from normal paths of travel.

❖ Fire extinguishers must be located in readily accessible locations along normal egress paths. This increases the occupants familiarity with the location of the fire extinguishers. When considering location, the most frequent occupants should be considered. These are the occupants who would become most familiar with the fire-extinguisher placement. For most buildings, it is the employees who are most familiar with their surroundings; therefore, a good understanding of employee operations is important for proper extinguisher placement.

**906.6 Unobstructed and unobscured.** Portable fire extinguishers shall not be obstructed or obscured from view. In rooms or areas in which visual obstruction cannot be completely avoided, means shall be provided to indicate the locations of extinguishers.

❖ Portable fire extinguishers must be located where they are readily visible at all times. If visual obstruction cannot be avoided, the location of the extinguishers must be marked by an approved means of identification. This could include additional signage, lights, arrows or other means approved by the fire code official. Unobstructed does not necessarily mean visible from all angles within the space. Often, columns or furnishings may obscure the extinguisher from one direction or another. These are not by themselves obstructions. The intent is that the extinguisher is not hidden but rather can be readily found. If the extinguisher is placed in the wall behind a door, it is clearly obstructed since it cannot be easily viewed. An extinguisher on a wall that is visible from most of the space would be considered unobstructed.

**906.7 Hangers and brackets.** Hand-held portable fire extinguishers, not housed in cabinets, shall be installed on the hangers or brackets supplied. Hangers or brackets shall be securely anchored to the mounting surface in accordance with the manufacturer’s installation instructions.

❖ Portable fire extinguishers not housed in cabinets are usually mounted on walls or columns using securely fastened hangers. Brackets must be used where the fire extinguishers need to be protected from impact or other potential physical damage.

**906.8 Cabinets.** Cabinets used to house portable fire extinguishers shall not be locked.

**Exceptions:**

1. Where portable fire extinguishers subject to malicious use or damage are provided with a means of ready access.
  2. In Group I-3 occupancies and in mental health areas in Group I-2 occupancies, access to portable fire extinguishers shall be permitted to be locked or to be located in staff locations provided the staff has keys.
- ❖ Cabinets housing fire extinguishers must not be locked in order to provide quick access in an emergency. Exception 1, however, allows the cabinets to be locked in occupancies where vandalism, theft or other malicious behavior is possible. Exception 2 also permits cabinets housing fire extinguishers to be locked or to be located in staff locations in Group I-3 occupancies and mental health areas in Group I-2 occupancies. Occupants in Group I-3 areas of jails, prisons or similar restrained occupancies should not have access to fire extinguishers because they could possibly be used as a weapon or be subject to vandalism. Staff adequately trained in the use of fire extinguishers are assumed to have ready access to the keys for the cabinets at all times

**906.9 Extinguisher installation.** The installation of portable fire extinguishers shall be in accordance with Sections 906.9.1 through 906.9.3.

- ❖ This section introduces the installation criteria for portable fire extinguishers based on the weight of the unit.

**906.9.1 Extinguishers weighing 40 pounds or less.** Portable fire extinguishers having a gross weight not exceeding 40 pounds (18 kg) shall be installed so that their tops are not more than 5 feet (1524 mm) above the floor.

- ❖ Due to the varying height and physical strength levels of persons who might be called upon to operate a portable fire extinguisher, the mounting height of the extinguisher must be commensurate with its weight so that it may be easily retrieved by anyone from its mounting location and placed into use.

**906.9.2 Extinguishers weighing more than 40 pounds.** Hand-held portable fire extinguishers having a gross weight exceeding 40 pounds (18 kg) shall be installed so that their tops are not more than 3.5 feet (1067 mm) above the floor.

- ❖ See the commentary to Section 906.9.1.

**906.9.3 Floor clearance.** The clearance between the floor and the bottom of installed hand-held portable fire extinguishers shall be not less than 4 inches (102 mm).

- ❖ The clearance between the floor and the bottom of installed hand-held extinguishers must not be less than 4 inches (102 mm) to facilitate cleaning beneath the unit and reduce the likelihood of the extinguisher becoming dislodged during cleaning operations (floor mopping, sweeping, etc.).

**906.10 Wheeled units.** Wheeled fire extinguishers shall be conspicuously located in a designated location.

- ❖ Wheeled fire extinguishers consist of a large-capacity (up to several hundred pounds of agent) fire extinguisher assembly (either stored-pressure or pressure transfer type) equipped with a carriage and wheels and discharge hose. They are constructed so that one able-bodied person could move the unit to the fire area and begin extinguishment unassisted. Wheeled fire extinguishers are capable of delivering greater flow rates and stream range for various extinguishing agents than hand-held portable fire extinguishers. Wheeled fire extinguishers are generally more effective in high-hazard areas and, as with any extinguisher, must be readily available and stored in an approved location. The wheeled fire extinguisher should be located a safe distance from the hazard area so that it will not become involved in the fire or access to it compromised by a fire. These units are typically found at airport fueling ramps, refineries, bulk plants and similar locations where high-challenge fires may be encountered. The extinguishing agents available in wheeled units include carbon dioxide, dry chemical, dry powder and foam.

## SECTION 907 FIRE ALARM AND DETECTION SYSTEMS

**907.1 General.** This section covers the application, installation, performance and maintenance of fire alarm systems and their components in new and existing buildings and structures. The requirements of Section 907.2 are applicable to new buildings and structures. The requirements of Section 907.9 are applicable to existing buildings and structures.

- ❖ Fire alarm systems, which typically include manual fire alarm systems and automatic fire detection systems, must be installed in accordance with Section 907 and NFPA 72. As indicated in this section, only Section 907.9 is intended to be applicable to existing buildings and structures.

Manual fire alarm systems are installed in buildings to limit fire casualties and property losses. Fire alarm systems do this by promptly notifying the occupants of the building of an emergency, which increases the time available for evacuation. Similarly, when fire alarm systems are supervised, the fire department will be promptly notified and its response time relative to the onset of the fire will be reduced.

Automatic fire detection systems are required under certain conditions to increase the likelihood that a fire is detected and occupants are given an early warning. The detection system is a system of devices and associated hardware that activates the alarm system. The automatic detecting devices are to be smoke detectors, unless a condition exists that calls for the use of a different type of detector.

**907.1.1 Construction documents.** *Construction documents* for fire alarm systems shall be of sufficient clarity to indicate

the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code, the *International Building Code* and relevant laws, ordinances, rules and regulations, as determined by the *fire code official*.

❖ Construction documents for fire alarm systems must be submitted for review to determine compliance with the code, the IBC and NFPA 72. All of the information required by this section may not be available during the design stage and initial permit process. Later submission of more detailed shop drawings may be required in accordance with Section 907.1.2. These provisions are intended to reflect the minimum scope of information needed to determine code compliance. When the work can be briefly described on the application form, the fire code official may utilize judgment in determining the need for more detailed documents.

**907.1.2 Fire alarm shop drawings.** Shop drawings for fire alarm systems shall be submitted for review and approval prior to system installation, and shall include, but not be limited to, all of the following where applicable to the system being installed:

1. A floor plan that indicates the use of all rooms.
  2. Locations of alarm-initiating devices.
  3. Locations of alarm notification appliances, including candela ratings for visible alarm notification appliances.
  4. Design minimum audibility level for occupant notification.
  5. Location of fire alarm control unit, transponders and notification power supplies.
  6. Annunciators.
  7. Power connection.
  8. Battery calculations.
  9. Conductor type and sizes.
  10. Voltage drop calculations.
  11. Manufacturers' data sheets indicating model numbers and listing information for equipment, devices and materials.
  12. Details of ceiling height and construction.
  13. The interface of fire safety control functions.
  14. Classification of the supervising station.
- ❖ Since the fire protection contractor(s) may not have been selected at the time a permit is issued for construction of a building, detailed shop drawings for fire alarm systems may not be available. Because they provide the information necessary to determine code compliance, as specified in this section, they must be submitted and approved by the fire code official before the contractor can begin installing the system.

**907.1.3 Equipment.** Systems and components shall be *listed* and *approved* for the purpose for which they are installed.

❖ The components of the fire alarm system must be approved for use in the planned system. NFPA 72 requires all devices, combinations of devices, appliances and equipment to be labeled for their proposed use. The testing agency will test the components for use in various types of systems and stipulate the use of the component on the label. Evidence of listing and labeling of the system components must be submitted with the shop drawings. In some instances, the entire system may be labeled.

At least one major testing agency, Underwriters Laboratories, Inc. (UL), has a program in which alarm installation and service companies are issued a certificate and become listed by the agency as being qualified to design, install and maintain local, auxiliary, remote station or proprietary fire alarm systems. The listed companies may then issue a certificate showing that the system is in compliance with Section 907. Terms of the company certification by UL include the company being responsible for keeping accurate system documentation, including as-built record drawings, acceptance test records and complete maintenance records on a given system. The company is also responsible for the required periodic inspection and testing of the system under contract with the owner. A similar program has been available for many years for central station alarm service, whereas the UL program is relatively new to the industry. Even though this company and system listing program is not required by the code or NFPA 72, it can be a valuable tool for the fire code official in determining compliance with the referenced standard.

Another issue that must be considered is the compatibility of the system components as required by NFPA 72. The labeling of system components discussed above should include any compatibility restrictions for components. Compatibility is primarily an issue of the ability of smoke detectors and fire alarm control panels (FACPs) to function properly when interconnected and affects the two-wire type of smoke detectors, which obtain their operating power over the same pair of wires used to transmit signals to the FACP (the control unit initiating device circuits). Laboratories will test for component compatibility either by actual testing or by reviewing the circuit parameters of both the detector and the FACP. Generally, if both the two-wire detector and the FACP are of the same brand, there should not be a compatibility problem. Nevertheless, the fire code official must be satisfied that the components are listed as being compatible. Failure to comply with the compatibility requirements of NFPA 72 can lead to system malfunction or failure when it may be needed the most.

**907.2 Where required—new buildings and structures.** An *approved* fire alarm system installed in accordance with the provisions of this code and NFPA 72 shall be provided in new buildings and structures in accordance with Sections 907.2.1 through 907.2.23 and provide occupant notification in accordance with Section 907.5, unless other requirements are provided by another section of this code.

Not fewer than one manual fire alarm box shall be provided in an *approved* location to initiate a fire alarm signal for fire alarm systems employing automatic fire detectors or waterflow detection devices. Where other sections of this code allow elimination of fire alarm boxes due to sprinklers, a single fire alarm box shall be installed.

**Exceptions:**

1. The manual fire alarm box is not required for fire alarm systems dedicated to elevator recall control and supervisory service.
2. The manual fire alarm box is not required for Group R-2 occupancies unless required by the *fire code official* to provide a means for fire watch personnel to initiate an alarm during a sprinkler system impairment event. Where provided, the manual fire alarm box shall not be located in an area that is accessible to the public.

❖ This section specifies the occupancies or conditions in new buildings or structures that require some form of fire alarm system. The fire alarm system is either a manual fire alarm system (manual fire alarm boxes) or an automatic smoke detection system. These systems must, upon activation, provide occupant notification throughout the area protected by the system unless other alternative provisions are allowed by this section.

Manual fire alarm systems must be installed in certain occupancies depending on the number of occupants, capabilities of the occupants and height of the building. An automatic smoke detection system must be installed in those occupancies and conditions where the need to detect the fire is essential to evacuation or protection of the occupants. The requirements for automatic smoke detection are generally based on the evacuation needs of the occupants and whether the occupancy includes sleeping accommodations.

Fire alarm systems must be installed in accordance with the code and NFPA 72. NFPA 72 identifies the minimum performance, location, mounting, testing and maintenance requirements for fire alarm systems. Smoke detectors must be used, except when ambient conditions would prohibit their use. In that case other detection methods may be used. The manufacturer's literature will identify the limitations on the use of smoke detectors, including environmental conditions such as humidity, temperature and airflow.

Only certain occupancies are required to have either a manual fire alarm or automatic fire detection system installed (see Commentary Figure 907.2). The need for either system is generally determined

by the number of occupants, the height of the building or the ability of the occupants for self-preservation.

Note that generally the fire alarm requirements are based upon occupancy and not on fire area. Commentary Figure 907.2 contains the conditions that require when either system must be installed in a building. The extent that an alarm system must be installed in a building once it has been determined that such a system is required is based on several factors. One, if it is the only occupancy in the building, then it would be required throughout the building. Two, if the building is a mixed occupancy, it can either be separated or nonseparated. If the occupancy is separated in accordance with Section 508.4 of the IBC, then the alarm system is only required within that separated portion of the building. If the building is considered a nonseparated, mixed occupancy building, then Section 508.3.1 of the IBC states that the code apply to each portion of the building based upon the occupancy classification of that space and the most restrictive provisions of Chapter 9 shall apply to the building or portion thereof in which the nonseparated occupancies are located. Therefore, if you had a Group A occupancy in a nonseparated mixed occupancy (containing other occupancies such as Group B and M) where the Group A occupancy exceeds an occupant load of 300, then the entire nonseparated mixed occupancy would require the alarm system. Note that Section 508.3.1 focuses on each space to determine occupancy and requirements. Once the occupant load is determined, then any requirements, such as fire alarms, would be required throughout.

The code does not address whether or not a non-separated mixed occupancy has a completely independent means of egress such as in a strip mall. Additionally, in a building containing primarily Group A occupancies, the code does not clearly address whether such occupancies within a building should be looked at as an aggregate or individual space. This issue has been clarified in the 2012 edition of the code through the use of the fire area concept for Group A occupancies, but only for the basic manual fire alarm requirements in Section 907.2.1. The emergency voice/alarm communication requirements in Section 907.2.1.1 still simply provide a criteria of 1000 or more occupants in a Group A occupancy. A building with multiple Group A occupancies without using the concept of separation of egress paths would need to be reviewed in aggregate. Fire area separation could not be used to provide separation of occupancies in this case.

Commentary Figure 907.2 contains the threshold requirements for when a manual fire alarm system or an automatic fire detection system is required based on the occupancy group. It is important to remember that although the requirement for manual pull stations may not apply (e.g., sprinklered buildings), alarm and occupant notification may still be required. Sections 907.2.11 through 907.2.23 contain additional require-

ments for fire alarm systems depending on special occupancy conditions such as atriums, high-rise buildings or covered mall buildings.

The single manual fire alarm box required by this section is needed to provide a means of manually activating a fire alarm system that only contains automatic devices such as sprinkler waterflow switches or smoke detectors. Its primary use is for alarm system maintenance technicians to be able to manually activate the fire alarm system in the event of a fire during the time the system or portions of the system is down for maintenance. Note that this requirement is not subject to any of the exceptions in Sections 907.2.1

through 907.2.23 that might waive the need for manual fire alarm boxes in certain buildings.

Exception 1 recognizes the specialized nature of fire alarm systems installed only for emergency elevator control and supervision.

Exception 2 waives the single manual fire alarm box but gives the fire code official authority to require it in sprinklered buildings for use by fire watch personnel or sprinkler maintenance personnel to be able to manually activate the fire alarm system in the event of a fire during the time the sprinkler system is down for maintenance.

MANUAL FIRE ALARM SYSTEM	
Occupancy Group(s)	Threshold
Assembly (A-1, A-2, A-3, A-4, A-5)	All with an occupant load of > 300 (907.2.1)
Business (B)	Total Group B occupant load of > 500; or, > 100 above/below level of exit discharge; or, in Group B fire areas containing an ambulatory care facility (907.2.2)
Educational (E)	> 50 occupants (several exceptions for manual fire alarm box placement) (907.2.3)
Factory (F-1, F-2)	> 2 stories with occupant load of > 500 above/below lowest level of exit discharge (exception for sprinklers) (907.2.4)
High hazard (H)	Group H-5 and in occupancies for manufacture of organic coatings. (907.2.5)
Institutional (I-1, I-2, I-3, I-4)	All (exceptions for I-1 and I-2 manual fire alarm box placement and private mode signaling) (907.2.6)
Mercantile (M)	Total Group M occupant load of > 500; or, occupant load of >100 above/below level of exit discharge (907.2.7)
Hotels (R-1)	All (exceptions for < 2 stories with sleeping units having exit directly to exterior; sprinklers) (907.2.8.1)
Multi-family (R-2)	If units > 3 stories above lowest level of exit discharge; or, > 1 story below highest level of exit discharge; or, > 16 units (exceptions for < 2 stories with sleeping units having exit directly to exterior; sprinklers) open ended corridors/no corridor (907.2.9.1)
Residential care/assisted living (R-4)	All (exceptions for sprinklers, manual fire alarm boxes at staff locations, direct exit to exterior, less than 2 stories) (907.2.10.1)
AUTOMATIC SMOKE DETECTION SYSTEM	
Business (B) Ambulatory care facilities	Facility plus public use areas outside of it including public corridors and elevator lobbies (exception for sprinklers) (907.2.2.1)
High hazard (H)	Highly toxic gases, organic peroxides, oxidizers (907.2.5)
Institutional (I-1, I-2, I-3)	All, in specific areas by occupancy (907.2.6.1, 907.2.6.2, 907.2.6.3.3)
Hotels (R-1)	All, in interior corridors (exception for buildings without interior corridors and with sleeping units having exit directly to exterior) (907.2.8.2)
Residential care/assisted living (R-4)	All, in corridors, waiting areas open to corridors, nonsleeping area habitable spaces and kitchens (exceptions for sprinklers and sleeping units having exit directly to exterior) (907.2.10.2)
College and university buildings (R-2 dormitories)	Common spaces; laundry, mechanical and storage rooms; interior corridors. No interior corridors and each unit has direct exit access or exit.

**Figure 907.2**  
**SUMMARY OF MANUAL FIRE ALARM AND AUTOMATIC SMOKE DETECTION SYSTEM THRESHOLDS**

**907.2.1 Group A.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group A occupancies where the occupant load due to the assembly occupancy is 300 or more. Group A occupancies not separated from one another in accordance with Section 707.3.10 of the *International Building Code* shall be considered as a single occupancy for the purposes of applying this section. Portions of Group E occupancies occupied for assembly purposes shall be provided with a fire alarm system as required for the Group E occupancy.

**Exception:** Manual fire alarm boxes are not required where the building is equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 and the occupant notification appliances will activate throughout the notification zones upon sprinkler water flow.

- ❖ Group A occupancies are typically occupied by a significant number of people who are not completely familiar with their surroundings. The provisions of this section address three separate situations regarding the application of the alarm requirements for Group A occupancies. The three situations addressed by the provisions are: (1) where an assembly occupancy and another occupancy are involved, (2) where multiple assembly areas exist in a building, and (3) where the assembly use occurs in and is a part of a Group E occupancy.

In situations where an assembly area and another occupancy are involved, the code specifies that it is the occupant load “due to the assembly occupancy” that would need to be 300 or more before the manual alarm system is required. For example, if the building is constructed with an assembly occupancy, such as a restaurant, with an occupant load of 250 and an adjacent office area with an occupant load of 100, the assembly space would not require an alarm system because the occupant load “due to the assembly occupancy” is less than 300. This is really simply a clarification of the way the provisions were intended to be applied. This would be the intended way to apply the provision whether the building was constructed using the accessory-, separated-, or nonseparated-occupancy requirements of Chapter 5 of the IBC.

In buildings that contain multiple assembly areas, the second portion of the code text requires that the aggregate occupant load of the assembly areas is used unless the spaces are separated as required for fire areas in Section 707.3.10 of the IBC. Consider two examples to address this portion of the requirements. In a multitheater complex, the auditoriums are generally not separated from each other by the 2-hour fire-resistance rating that Table 707.3.10 of the IBC would require; therefore, the aggregate occupant load of all of the assembly spaces would be combined to determine if the occupant load was 300 or more. If it was, then the manual alarm would be required in all of the assembly spaces. As another

example, consider a strip mall shopping center with a restaurant at one end of the building with an occupant load of 200 and a different restaurant with an occupant load of 150 at the other end of the building. Even though these are two completely separate establishments and have an amount of retail occupancy between them, the occupant load of the assembly areas does exceed 300. Therefore, unless a 2-hour fire-resistance-rated separation complying with Section 707.3.10 of the IBC is provided somewhere between the two restaurants to separate them into different fire areas, a manual fire alarm would be required in the Group A occupancies. If a complying separation is provided at some point in the building, then each assembly space can be reviewed independently and would not require the installation of the alarm system. Be aware that the separation of assembly spaces or the need to aggregate the occupant loads from them could occur not only on the same floor within a building but also to assembly uses located on different stories.

The exception allows the omission of manual fire alarm boxes in buildings equipped throughout with an automatic sprinkler system if activation of the sprinkler system will activate the building evacuation alarms associated with the manual fire alarm system.

This section also permits assembly-type areas in Group E occupancies to comply with Section 907.2.3 instead of the requirements of this section. A typical high school, for example, contains many areas used for assembly purposes such as a gymnasium, cafeteria, auditorium or library; however, they all exist to serve as an educational facility as their main function. The exception does not eliminate the fire alarm system and occupant notification system, but rather permits them to be initiated automatically by the sprinkler waterflow switch(es) instead of by the manual fire alarm boxes. It also reduces the possibility of mischievous or malicious false alarms being turned on by manual fire alarm boxes in venues where large numbers of people congregate.

**907.2.1.1 System initiation in Group A occupancies with an occupant load of 1,000 or more.** Activation of the fire alarm in Group A occupancies with an *occupant load* of 1,000 or more shall initiate a signal using an emergency voice/alarm communications system in accordance with Section 907.5.2.2.

**Exception:** Where *approved*, the prerecorded announcement is allowed to be manually deactivated for a period of time, not to exceed 3 minutes, for the sole purpose of allowing a live voice announcement from an *approved*, constantly attended location.

- ❖ In order to afford authorized personnel the ability to selectively evacuate or manage occupant relocation in large assembly venues, this section requires the fire alarm system to operate through an emergency voice/alarm communications system. The exception allows the automatic alarm signals to be overridden for live voice instructions if the live voice instructions

do not exceed 3 minutes. The location from which the live voice announcement originates must be constantly attended and approved by the fire code official (see also commentary, Section 907.5.2.2). In terms of the applicability of this section, it is not as specific as Section 907.2.1. More specifically, the concept of fire areas does not apply. Credit is not given to reduce the occupant load through the use of the fire area concept (see commentary, Section 907.2).

**907.2.1.2 Emergency voice/alarm communication system captions.** Stadiums, arenas and grandstands required to caption audible public announcements shall be in accordance with Section 907.5.2.2.4.

❖ A 2008 U.S. Federal Court case prompted a change to the code and the IBC. The court ruled that persons with hearing impairments who attend events at stadiums, grandstands and arenas require a means of equivalent communications in lieu of the public address system. Providing occupant notification in these structures is challenging because of the building area and the number and diversity of occupants. Provisions were added in the code to require captioned messages in these buildings and grandstands when public address (PA) systems are prescribed by the accessibility requirements.

IBC Section 1108.2.7.3 sets forth requirements for audible PA systems in stadiums, arenas and grandstands. It requires that equivalent text information be provided to the audience and that the delivery time for these messages be the same as those broadcast from the PA system. These requirements apply to pre-recorded and real-time messages. Section 1108.2.7.3 of the IBC also requires captioning of messages in stadiums, arenas and grandstands that have more than 15,000 fixed seats.

Because messages being broadcast can include instructions to building or site occupants explaining the actions they need to take in the event of an emergency, the requirements of NFPA 72 are applicable for captioning systems. Such a system falls within the scope of Chapter 24 of NFPA 72, entitled “Emergency Communication Systems.” NFPA 72 defines an emergency communications system (ECS) as a system designed for life safety that indicates the existence of an emergency and communicates the appropriate response and action. The ECS is required to be classified as either a one- or two-way path system. It can be within a building or over a wide area or can be targeted to a particular group of recipients. The messages that will be broadcast are based on an emergency response plan developed during a risk analysis by the project stakeholders and is approved by the fire code official.

The NFPA 72 ECS requirements are based on in-building or wide-area occupant notification. Wide-area systems could include the entire area of a jurisdiction. For a stadium, arena or grandstand captioning, NFPA 72 defines these as mass notification systems (MNS). In the context of the NFPA 72 requirements, this particular code change requires a

one-way MNS where instructions are broadcast by personnel authorized to distribute messages. This could include firefighters during a fire event; the system could be used by law enforcement officers during a domestic terrorism incident or a weather event like a tornado warning.

The design of the compliant MNS in Chapter 24 of NFPA 72 is not prescriptive—a MNS is a performance-based design. Accordingly, fire code officials should require their design to be sealed by a registered professional engineer. Chapter 24 of the standard requires the preparation of a risk analysis based on the nature and anticipated risks of the facility. The risk analysis is part of the design brief, which will serve as the basis of the system design and is a required design document. NFPA 72 requires the following elements included in the risk analysis:

- The number of persons within the building, area, space, campus or region;
- The character of the occupancy, such as unique hazards and the rate at which the hazard can develop;
- The anticipated threats, including natural, technological and intentional events;
- The reliability and performance of the MNS;
- Security of the MNS and its components;
- How the building or staff implement the risk analysis, including the use of the MNS; and
- How emergency services, such as the fire service and law enforcement agencies, can employ the MNS.

In a stadium or arena, the captioning system is required to be a component of the emergency voice/communication alarm system (EV/ACS). Such a system is required by Section 907.2.1.1 in Group A occupancies with an occupant load of 1,000 or more.

The requirement in Section 907.5.2.2.4 specifies the captioning system would be connected to the EV/ACS. The fire alarm control unit will require a listed interface unit capable of displaying text messages. Textual visible appliances are allowed by NFPA 72 when used in conjunction with audible, visual or both types of notification appliances. In the public mode, textual visible appliances are located to ensure readability by the building occupants. Such a system can display messages using televisions or light-emitting diode (LED) marquee signs.

The design concept of MNS is relatively new in the design community. Captioning systems might utilize components that are not listed for fire alarm service so the design will be required to comply with Chapter 241 of NFPA 72 for textual visible notification appliances. Emergency textual messages take precedence over any nonemergency text messages. Under NFPA 72, these devices require a primary and secondary power supply. If the devices are not monitored for integrity or loss of communications by an autonomous control or a fire alarm control unit, the appliance

must clearly display its status. The size of characters displayed must comply with the requirements in NFPA 72. The NFPA 72 size, character and font requirements are based on the location of the display in relation to the height and distance from the persons viewing it.

**907.2.2 Group B.** A manual fire alarm system shall be installed in Group B occupancies where one of the following conditions exists:

1. The combined Group B *occupant load* of all floors is 500 or more.
2. The Group B *occupant load* is more than 100 persons above or below the lowest *level of exit discharge*.
3. The *fire area* contains an ambulatory care facility.

**Exception:** Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 and the occupant notification appliances will activate throughout the notification zones upon sprinkler water flow.

❖ Group B occupancies generally involve individuals or groups of people in separate office areas. As a result, the occupants are not necessarily aware of what is going on in other parts of the building. Group B buildings with large occupant loads, even in single-story buildings, or where a substantial number of occupants are above or below the level of exit discharge, increase the difficulty of alerting the occupants of a fire. This is especially true in nonsprinklered buildings with given occupant load thresholds. Group B occupancies include a specific use called ambulatory care facilities which present a higher level of life hazard than the typical Group B occupancy. The fact that the care recipients of such facilities may be rendered incapable of self-preservation for limited periods of time makes the need for a fire alarm system critical. Section 907.2.2 requires a manual alarm system any time a fire area contains a ambulatory care facility. See the commentary to Section 202, definition of “Ambulatory care facility” and Section 907.2.2.1.

The exception does not eliminate the fire alarm system, but rather permits it to be initiated automatically by the sprinkler waterflow switch(es) instead of by the manual fire alarm boxes.

**907.2.2.1 Ambulatory care facilities.** *Fire areas* containing ambulatory care facilities shall be provided with an electronically supervised automatic smoke detection system installed within the ambulatory care facility and in public use areas outside of tenant spaces, including public *corridors* and elevator lobbies.

**Exception:** Buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 provided the occupant notification appliances will activate throughout the notification zones upon sprinkler water flow.

❖ Years ago, few surgical procedures were performed outside of a hospital. Today, complex outpatient sur-

geries conducted outside of a hospital are commonplace. They are performed in facilities often called “day surgery centers” or “ambulatory surgical centers” because patients are able to walk in and walk out the same day. Procedures render care recipients temporarily incapable of self-preservation by application of nerve blocks, sedation or anesthesia; however, they do typically recover quickly.

The IBC identifies health care Group I occupancies as including a 24-hour stay. Without a 24-hour stay, these surgery centers were classified as Group B, which allowed the care providers to render an unlimited number of people incapable of self-preservation with no more protection than a business office. Since these types of facilities contain distinctly different hazards to life safety than other Group B occupancies, they are now required to have a higher level of life safety and fire protection as evidenced by the requirements of this section, as well as Section 903.2.2 and the construction provisions of the code.

This section more specifically states that any time a fire area contains an ambulatory care facility, the fire area should be provided with a supervised smoke detection system in the ambulatory care facility and in public use areas outside of tenant spaces. Therefore, in a medical office building, for example, the ambulatory care facility contained within would have a full coverage system. The other offices in the building would not require smoke detection in the individual tenant spaces but instead in the public areas, such as lobby or lounge areas.

The exception does not eliminate the fire alarm system, but rather permits it to be initiated automatically by the sprinkler water flow switch(es) instead of by manual fire alarm boxes.

**907.2.3 Group E.** A manual fire alarm system that initiates the occupant notification signal utilizing an emergency voice/alarm communication system meeting the requirements of Section 907.5.2.2 and installed in accordance with Section 907.6 shall be installed in Group E occupancies. When *automatic sprinkler systems* or smoke detectors are installed, such systems or detectors shall be connected to the building fire alarm system.

**Exceptions:**

1. A manual fire alarm system is not required in Group E occupancies with an *occupant load* of 50 or less.
2. Emergency voice/alarm communication systems meeting the requirements of Section 907.5.2.2 and installed in accordance with Section 907.6 shall not be required in Group E occupancies with occupant loads of 100 or less, provided that activation of the manual fire alarm system initiates an *approved* occupant notification signal in accordance with Section 907.5.
3. Manual fire alarm boxes are not required in Group E occupancies where all of the following apply:
  - 3.1. Interior *corridors* are protected by smoke detectors.

- 3.2. Auditoriums, cafeterias, gymnasiums and similar areas are protected by *heat detectors* or other *approved* detection devices.
- 3.3. Shops and laboratories involving dusts or vapors are protected by *heat detectors* or other *approved* detection devices.
- 4. Manual fire alarm boxes shall not be required in Group E occupancies where all of the following apply:
  - 4.1. The building is equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.
  - 4.2. The emergency voice/alarm communication system will activate on sprinkler water flow.
  - 4.3. Manual activation is provided from a normally occupied location.

❖ Section 404.2.3 addresses the development and implementation of lockdown plans. These requirements were developed to ensure that the level of life safety inside of the building is not reduced or compromised during a lockdown. In order for a building to safely function in a lockdown condition, the code requires a means of communication between the established central location and each secured area. Section 404.3.3.1 does not prescribe the means of communication, which could include the use of text messages to cell phones/mobile devices, e-mail messages or the use of preestablished audio or visual signals. The provisions in Section 404.2.3 are not specific to Group E occupancies—they are applicable to all occupancies that develop and implement lockdown plans.

Because of concerns of school campus safety serving kindergarten through 12th grade students, specific requirements were put into the 2012 edition of the IBC and the code for enhanced communication between the school administrators, teachers and students when a lockdown plan is activated in Group E occupancies. As a result, emergency voice/alarm communication systems (EV/ACS) are prescribed in Group E occupancies. Previously the code would have permitted the manual fire alarm system to use audible and visible alarm notification appliances and did not require the added capabilities that an EV/ACS provides.

This section sets forth the requirements for automatic fire alarm and detection system requirements in Group E occupancies and prescribes the installation of an EV/ACS as opposed to a traditional horn/strobe occupant notification system.

Exception 1 exempts Group E occupancies from requiring a fire alarm system when the occupant load is less than 50. This would exempt small day care centers that serve children older than 2½ years of age or a small Sunday school classroom at a place of religious worship.

Exception 2 provides relief for smaller schools. If the occupant load is 100 or less, notification is not

required to be via an emergency voice/alarm communication system. A school with 100 occupants only has a few classrooms of children. Communication is simplified and an emergency voice/alarm communication system is considered to be excessive.

Exception 3 exempts manual fire alarm boxes in interior corridors, laboratories, auditoriums, cafeterias, gymnasiums and similar spaces based on the installation of heat/smoke detectors. This is not an exception from the EV/ACS but simply an exemption of locations requiring manual fire alarm boxes. The applicability of Exception 2 is independent of whether an automatic sprinkler system is installed. If an automatic smoke detection system is installed, it must be connected to the building fire alarm system.

Exception 4 allows the omission of the manual fire alarm boxes in Group E occupancies equipped throughout with an automatic sprinkler system if the actuation of the sprinkler system will activate the EV/ACS. See Section 903.2.3 for sprinkler requirements in Group E buildings.

**907.2.4 Group F.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group F occupancies where both of the following conditions exist:

- 1. The Group F occupancy is two or more stories in height.
- 2. The Group F occupancy has a combined *occupant load* of 500 or more above or below the lowest *level of exit discharge*.

**Exception:** Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 and the occupant notification appliances will activate throughout the notification zones upon sprinkler water flow.

❖ This section is intended to apply to large multistory manufacturing facilities. For this reason, a manual fire alarm system would be required only if the building were at least two stories in height and had 500 or more occupants above or below the level of exit discharge. An unlimited area, two-story Group F occupancy complying with Section 507.5 of the IBC would be indicative of an occupancy requiring a manual fire alarm system.

Buildings in compliance with Section 507.5 of the IBC, and large manufacturing facilities in general, however, must be fully sprinklered and would thus be eligible for the exception. The exception does not eliminate the fire alarm system but rather permits it to be initiated automatically by the sprinkler system waterflow switch(es) instead of by the manual fire alarm boxes.

**907.2.5 Group H.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group H-5 occupancies and in occupancies used for the manufacture of organic coatings. An automatic smoke detection system shall be installed for

highly toxic gases, organic peroxides and oxidizers in accordance with Chapters 60, 62 and 63, respectively.

- ❖ Because of the nature and potential quantity of hazardous materials in Group H-5 occupancies, a manual means of activating an occupant notification system is essential for the safety of the occupants. In accordance with Section 2703.11, the activation of the alarm system must initiate a local alarm and transmit a signal to the emergency control station. The manual fire alarm system requirement for the building is in addition to the emergency alarm requirements in Section 2703.12 (see Section 908.2).

Occupancies involved in the manufacture of organic coatings present special hazardous conditions because of the unstable character of the materials, such as nitrocellulose. Good housekeeping and control of ignition sources is critical. Chapter 29 contains additional requirements for organic coating manufacturing processes.

This section also requires an automatic smoke detection system in certain occupancy conditions involving either highly toxic gases or organic peroxides and oxidizers. The need for the automatic smoke detection system may depend on the class of materials and additional levels of fire protection provided. This requirement also assumes the quantity of materials is in excess of the maximum allowable quantities shown in Tables 5003.1.1(1) and 5003.1.1(2).

**907.2.6 Group I.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group I occupancies. An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be provided in accordance with Sections 907.2.6.1, 907.2.6.2 and 907.2.6.3.3.

#### Exceptions:

1. Manual fire alarm boxes in *sleeping units* of Group I-1 and I-2 occupancies shall not be required at *exits* if located at all care providers' control stations or other constantly attended staff locations, provided such stations are visible and continuously accessible and that the distances of travel required in Section 907.4.2.1 are not exceeded.
  2. Occupant notification systems are not required to be activated where private mode signaling installed in accordance with NFPA 72 is *approved* by the *fire code official* and staff evacuation responsibilities are included in the fire safety and evacuation plan required by Section 404.
- ❖ Because the protection and possible evacuation of the occupants in Group I occupancies are most often dependent on the response by care providers, occupancies in Group I must be protected with a manual fire alarm system and in certain instances, as described in Sections 907.2.6.1, 907.2.6.2 and 907.2.6.3, an automatic smoke detection system. In Group I-1, smoke alarms are also required in accordance with Section 907.6.1.1.

It is not the intent of this section to require a smoke detection system throughout all Group I occupancies. Smoke detectors are only generally required in the corridors and in waiting rooms that are open to corridors, unless noted otherwise. IFC Committee Interpretation No. 36-03 makes it clear that the Group I provisions only require a manual fire alarm system with smoke detectors in selected areas.

To reduce the potential for unwanted alarms, manual fire alarm boxes may be located at the care providers' control stations or another constantly attended location.

Exception 1 reduces the likelihood of accidental or malicious false alarm system activations by manual means by allowing the pull stations to be located in a more controlled area. It assumes the approved location is always accessible by care providers and within a distance of travel of 200 feet (60 960 mm).

Exception 2 allows the common practice in Group I occupancies of only notifying the care providers instead of all building occupants in the event of a fire, subject to the approval of the fire code official. In order to have confidence that the actions taken will be appropriate, the code also requires that the responsibilities of the staff be documented in the fire safety and evacuation plan for the facility. These requirements are found in Section 404. This will increase the likelihood for any staff training to be linked to the allowance of private mode signaling.

**907.2.6.1 Group I-1.** An automatic smoke detection system shall be installed in *corridors*, waiting areas open to *corridors* and *habitable spaces* other than *sleeping units* and kitchens. The system shall be activated in accordance with Section 907.5.

#### Exceptions:

1. For Group I-1 Condition 1 occupancies, smoke detection in *habitable spaces* is not required where the facility is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.
  2. Smoke detection is not required for exterior balconies.
- ❖ Occupancies in Group I-1 tend to be compartmentalized into small rooms so that a fire in one area of the building would not easily be noticed by occupants in another part of the building. Therefore, smoke detection is required in areas other than sleeping units and kitchens. Sleeping units are required by Section 907.2.6.1.1 to be equipped with single- and multiple station smoke alarms in accordance with Section 907.2.11.
- Since Group I-1 occupancies may not be supervised by care providers and to reduce the likelihood that a fire within a waiting area open to the corridor or the corridor itself could develop beyond the incipient stage, thereby jeopardizing the building egress, these areas must be equipped with automatic smoke detection.

Exception 1 allows smoke detectors to be eliminated from habitable spaces of Group I-1 Condition 1 occupancies if the building is equipped throughout with an NFPA 13 automatic sprinkler system. The sprinkler system should control any fire and perform occupant notification through actuation of the waterflow switch and subsequent activation of the building alarm notification appliances. A sprinkler system is required for all Group I occupancies in accordance with Section 903.2.6. It should be noted that Group I-1 Condition 1 is the lower risk Group I-1 occupancy where residents are able to evacuate without assistance. See the commentary for Section 308.3 of the IBC.

Exception 2 allows for omitting smoke detectors from exterior balconies for environmental reasons and does not require the installation of an alternative type of detector. The exterior balconies are assumed to be sufficiently open to the atmosphere to readily allow the dissipation of smoke and hot gases.

**907.2.6.1.1 Smoke alarms.** Single- and multiple-station smoke alarms shall be installed in accordance with Section 907.2.11.

❖ As with dwelling units or sleeping units in any occupancy, this section requires that single- and multiple-station smoke alarms be installed in accordance with Section 907.2.11. Section 907.2.11.2 deals specifically with the requirements for Group I-1.

**907.2.6.2 Group I-2.** An automatic smoke detection system shall be installed in *corridors* in Group I-2 Condition 1 facilities and spaces permitted to be open to the *corridors* by Section 407.2 of the *International Building Code*. The system shall be activated in accordance with Section 907.4. Group I-2 Condition 2 occupancies shall be equipped with an automatic smoke detection system as required in Section 407 of the *International Building Code*.

**Exceptions:**

1. *Corridor* smoke detection is not required in smoke compartments that contain *sleeping units* where such units are provided with smoke detectors that comply with UL 268. Such detectors shall provide a visual display on the *corridor* side of each *sleeping unit* and shall provide an audible and visual alarm at the care providers' station attending each unit.
  2. *Corridor* smoke detection is not required in smoke compartments that contain *sleeping units* where *sleeping unit* doors are equipped with automatic door-closing devices with integral smoke detectors on the unit sides installed in accordance with their listing, provided that the integral detectors perform the required alerting function.
- ❖ Automatic smoke detection is required in areas permitted to be open to corridors in occupancies classified as Group I-2 Condition 2 and corridors in Group I-2 Condition 1 occupancies (e.g., nursing homes, long-term care facilities and detoxification facilities). In recognition of quick-response sprinkler technology and the fact that the sprinkler system is electronically supervised, and because the doors to care recipient

sleeping units are continuously supervised by care providers when in the open position, smoke detectors are not required for adequate fire safety in care recipient sleeping units.

In Group I-2 Condition 1 occupancies (e.g., nursing homes long-term care facilities and detoxification facilities), however, some redundancy is appropriate because such facilities typically have less control over furnishings and personal items, thereby resulting in a less predictable and usually higher fire hazard load than a Group I-2 Condition 2 occupancy (hospitals). Also, there is generally less care provider's supervision in these facilities than in other health care facilities and thus less control over care recipient smoking and other fire causes. Therefore, to provide additional protection against fires spreading from the room of origin, smoke detection is required in corridors of nursing homes, long-term care facilities and detoxification facilities.

Smoke detection is not required in corridors of other Group I-2 Condition 2 occupancies except where otherwise specifically required in the code. Similarly, because areas open to the corridor very often are the room of fire origin, and such areas are no longer required by the code to be under visual supervision by care providers, some redundancy to protection by the sprinkler system is requested. Accordingly, all areas open to corridors must be protected by an automatic smoke detection system. This requirement provides an additional level of protection against sprinkler system failures or lapses in care provider supervision.

These requirements are not applicable to Group I-2 Condition 2 occupancies (hospitals). The scope of this section clearly indicates that its provisions are only applicable to detoxification facilities and nursing homes. Hospitals are noted as being subject to the provisions in Section 407.2 of the IBC. IFC Committee Interpretation No. 37-03 addresses this issue. Section 407.2 of the IBC notes that smoke detection is only required for spaces open to corridors, such as waiting areas and mental health treatment areas where patients are not capable of self-preservation (see commentary, Section 407.2 of the IBC).

There are two exceptions to the requirement for an automatic fire detection system in corridors of nursing homes, long-term care facilities and detoxification facilities. Both exceptions provide an alternative method for redundant protection in care recipient sleeping units. For this reason, they provide either a backup to the notification of a fire or containment of fire in the room of origin.

Exception 1 requires smoke detectors in sleeping units that activate both a visual display on the corridor side of the care recipient sleeping unit and a visual and audible alarm at the care provider's station serving or attending the room. Detectors complying with UL 268 are intended for open area protection and for connection to a normal power supply or as part of a fire alarm system. This exception, however, is specifi-

cally designed not to require the detectors to activate the building fire alarm system where approved care recipient sleeping unit smoke detectors are installed and where visual and audible alarms are provided. This is in response to the concern over unwanted alarms. The required alarm signals will not necessarily indicate to care providers that a fire emergency exists because the care provider call system may typically be used to identify numerous conditions within the room.

Exception 2 addresses the situation where smoke detectors are incorporated within automatic door-closing devices. The units are acceptable as long as the required alarm functions are still provided. Such units are usually listed as combination door closer and hold-open devices.

**907.2.6.3 Group I-3 occupancies.** Group I-3 occupancies shall be equipped with a manual fire alarm system and automatic smoke detection system installed for alerting staff.

❖ Because of the evacuation difficulties associated with Group I-3 occupancies and the dependence on adequate staff response, a manual fire alarm system and an automatic fire detection system are required subject to the special occupancy conditions in Sections 907.2.6.3.1 through 907.2.6.3.3. This section recognizes that the evacuation of Group I-3 occupancies depends on an effective staff response. The requirements in Chapter 4 and specifically Section 403.8.3 of the code contain the requirements for an emergency plan, including employee training, staff availability, the need for occupants to notify staff and the need for the proper keys for unlocking doors for staff in Group I-3 occupancies.

**907.2.6.3.1 System initiation.** Actuation of an automatic fire-extinguishing system, *automatic sprinkler system*, a manual fire alarm box or a fire detector shall initiate an approved fire alarm signal that automatically notifies staff.

❖ This section specifies the systems that, upon activation, must initiate the required alarm signal immediately and automatically to the staff so that staff will respond in a timely manner.

**907.2.6.3.2 Manual fire alarm boxes.** Manual fire alarm boxes are not required to be located in accordance with Section 907.4.2 where the fire alarm boxes are provided at staff-attended locations having direct supervision over areas where manual fire alarm boxes have been omitted.

❖ Because of the potential for intentional false alarms and the resulting disruption to the facility, manual fire alarm boxes in Group I-3 occupancies may be either locked or made inaccessible to the occupants.

**907.2.6.3.2.1 Manual fire alarms boxes in detainee areas.** Manual fire alarm boxes are allowed to be locked in areas occupied by detainees, provided that staff members are pres-

ent within the subject area and have keys readily available to operate the manual fire alarm boxes.

❖ The locking of manual fire alarm boxes is permitted only in areas where staff members are present and keys are readily available to them to unlock the boxes, or where the alarm boxes are located in a manned staff location that has direct supervision of the Group I-3 area.

**907.2.6.3.3 Automatic smoke detection system.** An automatic smoke detection system shall be installed throughout resident housing areas, including *sleeping units* and contiguous day rooms, group activity spaces and other common spaces normally accessible to residents.

**Exceptions:**

1. Other *approved* smoke detection arrangements providing equivalent protection, including, but not limited to, placing detectors in exhaust ducts from cells or behind protective guards *listed* for the purpose, are allowed when necessary to prevent damage or tampering.
  2. *Sleeping units* in Use Conditions 2 and 3 as described in Section 308 of the *International Building Code*.
  3. Smoke detectors are not required in *sleeping units* with four or fewer occupants in smoke compartments that are equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.
- ❖ Evacuation of Group I-3 facilities is impractical because of the need to maintain security. An automatic smoke detection system is therefore required to provide early warning of a fire.
- As indicated in Exception 1, the installation of automatic smoke detectors must take into account the need to protect the detector from vandalism by residents. As a result, detectors may have to be located in return air ducts or be protected by a substantial physical barrier.
- Since occupants in Use Condition 2 or 3 are not locked in their sleeping units, Exception 2 reduces the need for smoke detection.
- Exception 3 allows smoke detectors to be omitted in sleeping units housing no more than four occupants on the basis that in a building that is protected throughout with an approved automatic sprinkler system, the system will provide both detection and suppression functions. Group I facilities are assumed to be fully sprinklered throughout in accordance with NFPA 13 as required by Section 903.2.6. The limitation of four occupants reduces the potential fuel load (mattresses, clothes, etc.) and the likelihood of involvement over an extended area.

**907.2.7 Group M.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group M occupancies where one of the following conditions exists:

1. The combined Group M *occupant load* of all floors is 500 or more persons.
2. The Group M *occupant load* is more than 100 persons above or below the lowest *level of exit discharge*.

**Exceptions:**

1. A manual fire alarm system is not required in covered or open mall buildings complying with Section 402 of the *International Building Code*.
  2. Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 and the occupant notification appliances will automatically activate throughout the notification zones upon sprinkler water flow.
- ❖ Group M occupancies have the potential for large numbers of occupants who may not be familiar with their surroundings. The installation of a fire alarm system increases the ability to alert the occupants of a fire. Note that the occupant thresholds must be considered independently. If the total occupant load is 500 or more persons a manual fire alarm system is required. If more than 100 persons are above or below the level of exit discharge, a manual fire alarm system is required.

This section also specifies that the manual fire alarm boxes must, upon activation, provide occupant notification throughout the Group M occupancy.

The extent of fire alarm application is based upon the area in which the Group M occupancy is located. If the building is considered as a separated mixed occupancy then the fire alarm system is only required in the individual occupancy in which the occupant load exceeds the threshold quantity. The rest of the building would not require a fire alarm system. This approach is noted in Section 508.4.1 of the IBC, which states that each separated space must comply with the code based upon the occupancy classification of that portion of the building. If the Group M occupancy was part of a nonseparated mixed-use building, then the alarm system would be required in the entire building in accordance with Section 508.3.1 of the IBC. The determination as to when such a system is required would be based solely upon the Group M occupant load.

Exception 1 recognizes the increased level of fixed automatic protection inherently required in covered and open mall buildings including an automatic sprinkler system, and, possibly, a smoke control system. Covered and open mall buildings are also required to contain an emergency voice/alarm communication system (see Section 907.2.20).

Exception 2 does not eliminate the fire alarm system, but rather allows it to be initiated automatically

by sprinkler system water flow switch(es) instead of by manual fire alarm boxes. Buildings with a fire area containing a Group M occupancy in excess of 12,000 square feet (1115 m<sup>2</sup>) must be equipped with an automatic sprinkler system complying with Section 903.2.6.

**907.2.7.1 Occupant notification.** During times that the building is occupied, the initiation of a signal from a manual fire alarm box or from a waterflow switch shall not be required to activate the alarm notification appliances when an alarm signal is activated at a constantly attended location from which evacuation instructions shall be initiated over an emergency voice/alarm communication system installed in accordance with Section 907.5.2.2.

❖ Occupants in a mercantile occupancy may assume the alarm is a false alarm or act inappropriately and thus delay evacuation of the building. To prevent such a dangerous situation, the manual fire alarm system may be part of an EV/ACS. The signal is to be sent to a constantly attended location on site from which evacuation instructions can be given.

It should be noted that, although the alarm notification alternative allows for the manual use of an EV/ACS, the alternative does not remove the requirement for audible and visual notification devices.

**907.2.8 Group R-1.** Fire alarm systems and smoke alarms shall be installed in Group R-1 occupancies as required in Sections 907.2.8.1 through 907.2.8.3.

❖ Because residents of Group R-1 occupancies may be asleep and are usually transients who are unfamiliar with the building, and because such buildings contain numerous small rooms so that the occupants may not notice a fire in another part of the building, occupancies in Group R-1 must have a manual fire alarm system and an automatic smoke detection system installed throughout. Requirements for single- or multiple-station smoke alarms in sleeping units are contained in Section 907.2.11.1.

**907.2.8.1 Manual fire alarm system.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group R-1 occupancies.

**Exceptions:**

1. A manual fire alarm system is not required in buildings not more than two stories in height where all individual *sleeping units* and contiguous attic and crawl spaces to those units are separated from each other and public or common areas by not less than 1-hour *fire partitions* and each individual *sleeping unit* has an *exit* directly to a *public way*, *egress court* or yard.
2. Manual fire alarm boxes are not required throughout the building where all of the following conditions are met:
  - 2.1. The building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.

2.2. The notification appliances will activate upon sprinkler water flow.

2.3. Not fewer than one manual fire alarm box is installed at an *approved* location.

❖ This section is specific to manual fire alarm systems and requires such systems in all Group R-1 occupancies, with two exceptions.

Exception 1 eliminates the requirement for a manual fire alarm system if the sleeping units have an exit discharging directly to a public way, exit court or yard. Even though the building may be two stories in height, the sleeping units on each floor must have access directly to an approved exit at grade level. The use of an exterior exit access balcony with exterior stairs serving the second floor does not constitute an exit directly at grade. The minimum 1-hour fire-resistance rating required for adequate separation of the sleeping units must be maintained.

Exception 2 does not omit the fire alarm system but rather permits it to be initiated automatically by sprinkler system water flow switch(es) in lieu of manual fire alarm boxes. The sprinkler system must activate the occupant notification system and at least one manual fire alarm box shall be installed at an approved location. See the commentary to Section 907.2 for a discussion of the single manual fire alarm box.

The exceptions do not affect the independent provision in Section 907.2.11 for single- or multiple-station smoke alarms.

**907.2.8.2 Automatic smoke detection system.** An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be installed throughout all interior *corridors* serving *sleeping units*.

**Exception:** An automatic smoke detection system is not required in buildings that do not have interior *corridors* serving *sleeping units* and where each *sleeping unit* has a *means of egress* door opening directly to an *exit* or to an exterior *exit access* that leads directly to an *exit*.

❖ This section requires an automatic smoke detection system within interior corridors. Such systems make use of smoke detectors for alarm initiation in accordance with Section 907.2, with one exception.

The exception provides that automatic fire detectors are not required in motels and hotels that do not have interior corridors and in which sleeping units have a door opening directly to an exterior exit access that leads directly to the exits. The intent of the exception is that the exit access from the sleeping unit door be exterior and not require reentering the building prior to entering the exit. Since the exit access is outside, the need for detectors other than the smoke alarms required by Section 907.2.8.3 in sleeping units is greatly reduced.

**907.2.8.3 Smoke alarms.** Single- and multiple-station smoke alarms shall be installed in accordance with Section 907.2.11.

❖ The actual requirements for single- and multiple-station smoke alarms are located in Section 907.2.11.

That section requires that the single- and multiple-station smoke alarms within sleeping units be connected to the emergency electrical system. Automatic activation of the fire alarm system is avoided to reduce unnecessary alarms within such buildings.

**907.2.9 Group R-2.** Fire alarm systems and smoke alarms shall be installed in Group R-2 occupancies as required in Sections 907.2.9.1 and 907.2.9.3.

❖ This section introduces the fire alarm system and smoke alarm requirements for Group R-2 occupancies. This includes Group R-2 occupancies in general and also Group R-2 college and university buildings.

**907.2.9.1 Manual fire alarm system.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group R-2 occupancies where any of the following conditions apply:

1. Any *dwelling unit* or *sleeping unit* is located three or more stories above the lowest *level of exit discharge*.
2. Any *dwelling unit* or *sleeping unit* is located more than one story below the highest *level of exit discharge* of *exits* serving the *dwelling unit* or *sleeping unit*.
3. The building contains more than 16 *dwelling units* or *sleeping units*.

**Exceptions:**

1. A fire alarm system is not required in buildings not more than two stories in height where all *dwelling units* or *sleeping units* and contiguous attic and crawl spaces are separated from each other and public or common areas by not less than 1-hour *fire partitions* and each *dwelling unit* or *sleeping unit* has an *exit* directly to a *public way*, *egress court* or yard.
  2. Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2 and the occupant notification appliances will automatically activate throughout the notification zones upon a sprinkler water flow.
  3. A fire alarm system is not required in buildings that do not have interior *corridors* serving *dwelling units* and are protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, provided that *dwelling units* either have a *means of egress* door opening directly to an exterior *exit access* that leads directly to the *exits* or are served by open-ended *corridors* designed in accordance with Section 1027.6, Exception 3.
- ❖ The occupants of Group R-2 occupancies are not considered to be as transient as those of Group R-1, which increases the probability that residents can more readily notify each other of a fire. Therefore, Group R-1 occupancies must have a manual fire alarm system with audible and visual notification appliances subject to the exceptions in Section 907.2.8.1, whereas Group R-2 occupancies are

required to have only a manual fire alarm system as stipulated in one of the three listed conditions. The threshold conditions are meant to be applied independently of each other.

Exception 1 eliminates the requirement for a manual fire alarm system if the sleeping units have an exit discharging directly to a public way, exit court or yard. Even though the building may be two stories in height, the sleeping units on each floor must have access directly to an approved exit at grade level. The use of an exterior exit access balcony with exterior stairs serving the second floor does not constitute an exit directly at grade. The minimum 1-hour fire-resistance rating required for adequate separation of the sleeping units must be maintained.

Exception 2 does not omit the fire alarm system but rather permits it to be initiated automatically by sprinkler system water flow switch(es) in lieu of manual fire alarm boxes. The sprinkler system must activate the occupant notification system. This exception does not affect the independent provisions of Section 907.2.11.

Exception 3 allows the omission of a fire alarm system in fully sprinklered buildings (NFPA 13 or 13R) with no interior corridors and that exit directly to an exterior exit access or have open-ended corridors. The important thing to note is that the sprinkler system is not required to activate alarm notification appliances since a fire alarm system would not be required. Only the sprinkler alarms required by Section 903.4 would be required.

**907.2.9.2 Smoke alarms.** Single- and multiple-station smoke alarms shall be installed in accordance with Section 907.2.11.

❖ The actual requirements for single- and multiple-station smoke alarms are located in Section 907.2.11. That section requires that the single- and multiple-station smoke alarms within sleeping units be connected to the emergency electrical system. Automatic activation of the fire alarm system is avoided to reduce unnecessary alarms within such buildings.

**907.2.9.3 Group R-2 college and university buildings.** An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group R-2 occupancies operated by a college or university for student or staff housing in all of the following locations:

1. Common spaces outside of *dwelling units* and *sleeping units*.
2. Laundry rooms, mechanical equipment rooms and storage rooms.
3. All interior corridors serving *sleeping units* or *dwelling units*.

**Exception:** An automatic smoke detection system is not required in buildings that do not have interior corridors serving *sleeping units* or *dwelling units* and where each *sleeping unit* or *dwelling unit* either has a *means of egress* door opening directly to an

exterior *exit access* that leads directly to an *exit* or a *means of egress* door opening directly to an *exit*.

Required smoke alarms in *dwelling units* and *sleeping units* in Group R-2 occupancies operated by a college or university for student or staff housing shall be interconnected with the fire alarm system in accordance with NFPA 72.

❖ This section requires an automatic smoke detection system in Group R-2 occupancies that are operated by a college or university to provide student or staff housing. It also requires the smoke alarms in individual units to be interconnected with the fire alarm system. This interconnection is only for the purpose of making occupants within each unit aware of the fire alarm activation in the building. The intent was not to activate the building fire alarm system by smoke alarms in each unit. This is more restrictive than a Group R-2 occupancy in general as typically the requirements are limited to a manual fire alarm system and smoke alarms in the individual sleeping or dwelling units.

The smoke detection system is focused on common areas, such as interior corridors, lounge areas, laundry, and areas such as mechanical rooms, which could be the source of a fire, especially in these specific types of Group R-2 occupancies.

In a study completed by the New York State Governor's Task Force on Campus Fire Safety it was cited that 43 percent of fires in college dormitories are located in dorm rooms or kitchens, leaving the other 57 percent to be located in areas that would not require smoke detection under the current code. The study also showed that there were approximately 300 fires on college campus over a three-year period while only 160 were reported to the fire department. The Center for Campus Fire Safety states 99 deaths have been "reported" in fires in student housing since 2000.

An NFPA study on student housing showed 3,300 structural fires in dormitories, fraternities, sororities and barracks between 2002 and 2005. Since 1980, there has been an increase of 3 percent in reported fires in dormitory-type occupancies, while there has been a 52-percent decrease in overall reported structural fires.

The requirements in this section are very similar to the recommendations of the study done in New York State. It is important to note that the recommendations for that study were specifically aimed at the properties of the colleges and universities so it was not the study's intent to cover off-campus housing in this particular regard. There were recommendations for off-campus housing, such as sororities and fraternities to have annual inspections. This particular distinction was not addressed in detail during the code development process initially; however, since this is somewhat of a continuation of requirements that were added into Chapter 4 of the 2006 edition of the IFC for emergency preparedness and planning, and those requirements were intended to deal with buildings that were college or university property, it

seemed reasonable to interpret that this requirement is also limited to the buildings that are college or university property and does not apply to Group R-2 occupancies that are not college or university property. This has since been clarified through the code development process and the section now specifically notes that the Group R-2 occupancies are specifically operated by a college or university.

The exception allows for the elimination of the smoke detection system in a specific situation where there are no interior corridors and the occupants essentially exit directly to the outside. The lack of interior corridors and exterior exits reduces the amount of smoke one unit will expose onto another. Note that smoke alarms within the units are still required by Section 907.2.11.2. Note also that it is entirely possible that some areas that are required to have smoke detection may have ambient conditions that warrant a different type of alarm-initiating device. Section 907.4.3 addresses this concern.

**907.2.10 Group R-4.** Fire alarm systems and smoke alarms shall be installed in Group R-4 occupancies as required in Sections 907.2.10.1 through 907.2.10.3.

❖ This section, based on the Group R-2 requirements for manual fire alarm systems and Group I-1 requirements for automatic smoke detection systems, contains manual fire alarm and automatic smoke detection system requirements for new Group R-4 occupancies. Reviewing the occupancy categories in Chapter 3 of the IBC, a Group R-4 can be considered either a small Group I-1 or a Group R-2 with occupants that have special needs or limitations. A further review found that both Group I-1 and Group R-2 occupancies have fire alarm requirements for new buildings, but Group R-4 did not, even though the code required a fire alarm system retroactively in existing Group R-4 occupancies (see Section 1103.7.7).

**907.2.10.1 Manual fire alarm system.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group R-4 occupancies.

**Exceptions:**

1. A manual fire alarm system is not required in buildings not more than two stories in height where all individual *sleeping units* and contiguous attic and crawl spaces to those units are separated from each other and public or common areas by not less than 1-hour *fire partitions* and each individual *sleeping unit* has an *exit* directly to a *public way*, *egress court* or yard.
2. Manual fire alarm boxes are not required throughout the building where all of the following conditions are met:
  - 2.1. The building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.

2.2. The notification appliances will activate upon sprinkler water flow.

2.3. Not fewer than one manual fire alarm box is installed at an *approved* location.

3. Manual fire alarm boxes in resident or patient sleeping areas shall not be required at *exits* where located at all nurses' control stations or other constantly attended staff locations, provided such stations are visible and continuously accessible and that the distances of travel required in Section 907.4.2.1 are not exceeded.

❖ This section is specific to manual fire alarm systems and requires such systems in all Group R-4 occupancies, with three exceptions.

Exception 1 eliminates the requirement for a manual fire alarm system if the sleeping units have an exit discharging directly to a public way, exit court or yard. Even though the building may be two stories in height, the sleeping units on each floor must have access directly to an approved exit at grade level. The use of an exterior exit access balcony with exterior stairs serving the second floor does not constitute an exit directly at grade. The minimum 1-hour fire-resistance rating required for adequate separation of the sleeping units must be maintained.

Exception 2 does not omit the fire alarm system but rather permits it to be initiated automatically by sprinkler system water flow switch(es) in lieu of manual fire alarm boxes. The sprinkler system must activate the occupant notification system and at least one manual fire alarm box shall be installed at an approved location. See the commentary to Section 907.2 for a discussion of the single manual fire alarm box.

Exception 3 reduces the likelihood of accidental or malicious false alarm system activations by manual means by allowing the pull stations to be located in a more controlled area. It assumes the approved location is always accessible by staff and within a distance of travel of 200 feet (60 960 mm).

**907.2.10.2 Automatic smoke detection system.** An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be installed in *corridors*, waiting areas open to *corridors* and *habitable spaces* other than *sleeping units* and kitchens.

**Exceptions:**

1. Smoke detection in *habitable spaces* is not required where the facility is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.
2. An automatic smoke detection system is not required in buildings that do not have interior *corridors* serving *sleeping units* and where each *sleeping unit* has a *means of egress* door opening directly to an *exit* or to an exterior *exit access* that leads directly to an exit.

❖ Occupancies in Group R-4 can be compartmentalized into small rooms so that a fire in one area of the

building would not easily be noticed by occupants in another part of the building. Therefore, smoke detection is required in areas other than sleeping units and kitchens. Sleeping units are required by Section 907.2.10.3 to be equipped with single- and multiple station smoke alarms in accordance with Section 907.2.11.

Since Group R-4 occupancies may not be supervised by staff and to reduce the likelihood that a fire within a waiting area open to the corridor or the corridor itself could develop beyond the incipient stage, thereby jeopardizing the building egress, these areas must be equipped with automatic smoke detection.

Exception 1 allows smoke detectors to be eliminated from habitable spaces if the building is equipped throughout with an NFPA 13 automatic sprinkler system. The sprinkler system should control any fire and perform occupant notification through actuation of the water flow switch and subsequent activation of the building alarm notification appliances. A sprinkler system is required for all Group R occupancies in accordance with Section 903.2.8.

The exception provides that automatic fire detectors are not required in buildings that do not have interior corridors and in which sleeping units have a door opening directly to an exterior exit access that leads directly to the exits. The intent of the exception is that the exit access from the sleeping unit door be exterior and not require reentering the building prior to entering the exit. Since the exit access is outside, the need for detectors other than the smoke alarms required by Section 907.2.10.3 in sleeping units is greatly reduced.

**907.2.10.3 Smoke alarms.** Single- and multiple-station smoke alarms shall be installed in accordance with Section 907.2.11.

- ❖ The actual requirements for single- and multiple-station smoke alarms are located in Section 907.2.11. That section requires that the single- and multiple-station smoke alarms within sleeping units be connected to the emergency electrical system. Automatic activation of the fire alarm system is avoided to reduce unnecessary alarms within such buildings.

**907.2.11 Single- and multiple-station smoke alarms.** *Listed* single- and multiple-station smoke alarms complying with UL 217 shall be installed in accordance with Sections 907.2.11.1 through 907.2.11.6 and NFPA 72.

- ❖ Single- and multiple-station smoke alarms have evolved as one of the most important fire safety features in residential and similar occupancies having sleeping occupants. The value of early fire warning in these occupancies has been repeatedly demonstrated in fires involving both successful and unsuccessful smoke alarm performance.

For successful smoke alarm operation and performance, single- and multiple-station smoke alarms must be listed in accordance with UL 217 and installed to comply with the code and Chapter 11 of NFPA 72, which contains the minimum requirements

for the selection, installation, operation and maintenance of fire warning equipment for use in family living units. These devices are called “smoke alarms” rather than “smoke detectors” because they are independent of a fire alarm system and include an integral alarm notification device.

**907.2.11.1 Group R-1.** Single- or multiple-station smoke alarms shall be installed in all of the following locations in Group R-1:

1. In sleeping areas.
2. In every room in the path of the *means of egress* from the sleeping area to the door leading from the *sleeping unit*.
3. In each story within the *sleeping unit*, including *basements*. For *sleeping units* with split levels and without an intervening door between the adjacent levels, a smoke alarm installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full story below the upper level.

- ❖ Because the occupants of a sleeping unit or suite may be asleep and unaware of a fire developing in the room or in the egress path, single- or multiple-station smoke alarms must be provided in the sleeping unit and in any intervening room between the sleeping unit and the exit access door from the room. If the sleeping unit or suite involves more than one level, a smoke alarm must also be installed on every level. See the commentary to Section 202 definition of “Sleeping unit.”

Smoke alarms are required in split-level arrangements, except those that meet the conditions described in Item 3. In accordance with Section 907.2.11.5, all smoke alarms within a sleeping unit or suite must be interconnected so that actuation of one alarm will actuate the alarms in all smoke alarms within the sleeping unit or suite.

**907.2.11.2 Groups R-2, R-3, R-4 and I-1.** Single or multiple-station smoke alarms shall be installed and maintained in Groups R-2, R-3, R-4 and I-1 regardless of *occupant load* at all of the following locations:

1. On the ceiling or wall outside of each separate sleeping area in the immediate vicinity of bedrooms.
2. In each room used for sleeping purposes.
3. In each story within a *dwelling unit*, including *basements* but not including crawl spaces and uninhabitable attics. In *dwellings* or *dwelling units* with split levels and without an intervening door between the adjacent levels, a smoke alarm installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full story below the upper level.

- ❖ Because the occupants of a dwelling unit may be asleep and unaware of a fire developing in the room or in an area within the dwelling unit that will affect their ability to escape, single- or multiple-station smoke alarms must be installed in every bedroom, in the vicinity of all bedrooms (e.g., hallways leading to

the bedrooms) and on each story of the dwelling unit (see Commentary Figure 907.2.11.2 and the commentary to Section 202 for the definition of "Dwelling unit").

If a sprinkler system was installed throughout the building in accordance with NFPA 13, 13R or 13D, if applicable, smoke alarms would still be required in the bedrooms even if residential sprinklers were used.

Smoke alarms are required in split-level arrangements. As required by Section 907.2.11.5, all smoke alarms within a dwelling unit must be interconnected so that actuation of one alarm will actuate the alarms in all detectors within the dwelling unit.

These provisions do not apply to one- and two-family dwellings and multiple single-family dwellings (townhouses) not more than three stories in height with a separate means of egress that are regulated by the IRC. The IRC is intended to be a stand-alone document but if the residential units do not fall within the scope of the IRC or for other reasons are intended to be subject to this code, then the requirements of this section would apply. IFC Committee Interpretation No. 42-03 addresses this condition and contains additional explanatory information about the IRC and its relationship to the other *International Codes*.

Although the occupants of a sleeping unit in a Group I-1 occupancy may be asleep, they are still considered capable of self-preservation. Regardless, smoke alarms are required in sleeping units. The exception allows single- or multiple-station smoke alarms to be eliminated in the room if an automatic fire detection system that includes in-room system smoke detectors is installed as required by Section 907.2.6.

**907.2.11.3 Installation near cooking appliances.** Smoke alarms shall not be installed in the following locations unless

this would prevent placement of a smoke alarm in a location required by Section 907.2.11.1 or 907.2.11.2:

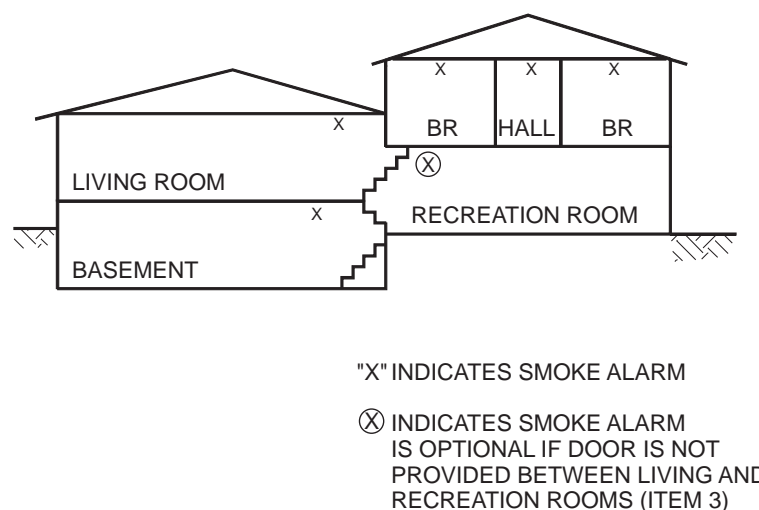
1. Ionization smoke alarms shall not be installed less than 20 feet (6096 mm) horizontally from a permanently installed cooking appliance.
2. Ionization smoke alarms with an alarm-silencing switch shall not be installed less than 10 feet (3048 mm) horizontally from a permanently installed cooking appliance.
3. Photoelectric smoke alarms shall not be installed less than 6 feet (1829 mm) horizontally from a permanently installed cooking appliance.

❖ This requirement is intended to reduce nuisance alarms attributed to locating smoke alarms in close proximity to cooking appliances and bathrooms in which steam is produced. These provisions are based on the findings in the Task Group Report "Minimum Performance Requirements for Smoke Alarm Detection Technology," February 22, 2008, and are consistent with similar requirements included in Section 29.8.3.4 of NFPA 72.

**907.2.11.4 Installation near bathrooms.** Smoke alarms shall be installed not less than 3 feet (914 mm) horizontally from the door or opening of a bathroom that contains a bathtub or shower unless this would prevent placement of a smoke alarm required by Section 907.2.11.1 or 907.2.11.2.

❖ See the commentary for Section 907.2.11.3. Sections 907.2.11.3 and 907.2.11.4 are provided to reduce nuisance alarms.

**907.2.11.5 Interconnection.** Where more than one smoke alarm is required to be installed within an individual *dwelling unit* or *sleeping unit* in Group R or I-1 occupancies, the smoke alarms shall be interconnected in such a manner that the activation of one alarm will activate all of the alarms in the individual unit. Physical interconnection of smoke alarms shall not be required where listed wireless alarms are



**Figure 907.2.11.2**  
**LOCATION OF SMOKE ALARMS IN A DWELLING UNIT**

installed and all alarms sound upon activation of one alarm. The alarm shall be clearly audible in all bedrooms over background noise levels with all intervening doors closed.

- ❖ The installation of smoke alarms in areas remote from the sleeping area will be of minimal value if the alarm is not heard by the occupants. Interconnection of multiple smoke alarms within an individual dwelling unit or sleeping unit is required in order to alert a sleeping occupant of a remote fire within the unit before the combustion products reach the smoke alarm in the sleeping area and thus provide additional time for evacuation.

The term “interconnection” refers to either hard-wired systems or listed wireless systems. UL has listed smoke detectors that use this technology. It is presumed that on safely evacuating the unit or room of fire origin, an occupant will notify other occupants by actuating the manual fire alarm system or using other available means. Section 907.7.1 addresses the testing of the smoke alarms to demonstrate that interconnection of such smoke alarms is properly functioning.

Similar requirements can now be found in the IRC, the *International Existing Building Code*® (IEBC®) and the code for both new and existing buildings to allow interconnection with wireless technology of smoke alarms. All wirelessly interconnected smoke alarms are listed to UL 217 and are classified by NFPA 72 as low-power systems.

**907.2.11.6 Power source.** In new construction, required smoke alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms with integral strobes that are not equipped with battery back-up shall be connected to an emergency electrical system in accordance with Section 604. Smoke alarms shall emit a signal when the batteries are low. Wiring shall be permanent and without a disconnecting switch other than as required for overcurrent protection.

**Exception:** Smoke alarms are not required to be equipped with battery backup where they are connected to an emergency electrical system that complies with Section 604.

- ❖ Smoke alarms are required to use AC as a primary power source and battery power as a secondary source to improve their reliability. For example, during a power outage, the probability of fire is increased because of the use of candles or lanterns for temporary light. Required backup battery power is intended to provide continued functioning of the smoke alarms. Smoke alarms are commonly designed to emit a recurring signal when batteries are low and need to be replaced.

Certain occupancies may already have an emergency electrical system in the building to monitor other building system conditions. The emergency

electrical system provides a level of reliability equivalent to battery backup.

**907.2.11.7 Smoke detection system.** Smoke detectors listed in accordance with UL 268 and provided as part of the building fire alarm system shall be an acceptable alternative to single- and multiple-station *smoke alarms* and shall comply with the following:

1. The fire alarm system shall comply with all applicable requirements in Section 907.
2. Activation of a smoke detector in a *dwelling unit* or *sleeping unit* shall initiate alarm notification in the *dwelling unit* or *sleeping unit* in accordance with Section 907.5.2.
3. Activation of a smoke detector in a *dwelling unit* or *sleeping unit* shall not activate alarm notification appliances outside of the *dwelling unit* or *sleeping unit*, provided that a supervisory signal is generated and monitored in accordance with Section 907.6.6.

- ❖ This section specifically allows the use of an automatic smoke detection system as an alternative to smoke alarms. In the past, when this concept was proposed it was only specifically allowed through alternative method and materials approach (see Section 104.9 of the code) even though in concept it provides the same level of protection. Such systems provide the same safety features necessary for occupants but are simply part of a fire alarm system. Note that if a detector activates within a sleeping or dwelling unit, the occupant notification system is not intended to activate. This is consistent with the operation of smoke alarms. Item 3 specifically requires the notification to be only to occupants of the sleeping unit or dwelling unit.

**907.2.12 Special amusement buildings.** An automatic smoke detection system shall be provided in special amusement buildings in accordance with Sections 907.2.12.1 through 907.2.12.3.

- ❖ Special amusement buildings are buildings in which the means of egress is not readily apparent, is intentionally confounded or is not readily available. Special amusement buildings must also comply with the provisions of Section 411 of the IBC.

The approved automatic smoke detection system is required to provide early warning of a fire. The detection system is required regardless of the presence of staff in the building. The exception recognizes that the ambient conditions in some special amusement buildings may preclude the use of automatic smoke detectors. In those instances, an alternative detection device must be used for early detection of a fire.

**907.2.12.1 Alarm.** Activation of any single smoke detector, the *automatic sprinkler system* or any other automatic fire detection device shall immediately activate an audible and

visible alarm at the building at a constantly attended location from which emergency action can be initiated, including the capability of manual initiation of requirements in Section 907.2.12.2.

❖ Upon activation of either a smoke detector or other automatic fire detection device or the automatic sprinkler system, an alarm must activate both an audible and visible alarm at a constantly attended location. The staff at the location is expected to be capable of then providing the required egress illumination, stopping the conflicting or confusing sounds and distractions and activating the exit marking required by Section 907.2.12.2. The staff is also expected to be capable of preventing additional people from entering the building.

**907.2.12.2 System response.** The activation of two or more smoke detectors, a single smoke detector equipped with an alarm verification feature, the *automatic sprinkler system* or other *approved* fire detection device shall automatically do all of the following:

1. Cause illumination of the *means of egress* with light of not less than 1 footcandle (11 lux) at the walking surface level.
2. Stop any conflicting or confusing sounds and visual distractions.
3. Activate an *approved* directional *exit* marking that will become apparent in an emergency.
4. Activate a prerecorded message, audible throughout the special amusement building, instructing patrons to proceed to the nearest exit. Alarm signals used in conjunction with the prerecorded message shall produce a sound that is distinctive from other sounds used during normal operation.

❖ Once a fire has been detected, measures must be taken to stop the confusion or distractions. Additionally, the egress path must be illuminated and marked. These measures must occur automatically upon detection of the fire or sprinkler water flow. A prerecorded message that can be heard throughout the building instructing the occupants to proceed to the nearest exit must be automatically activated. The message and alarm signals should be designed to prevent panic. The prerecorded message capability is in addition to the EV/ACS requirement of Section 907.2.12.3. The wiring of all devices must comply with NFPA 72.

**907.2.12.3 Emergency voice/alarm communication system.** An emergency voice/alarm communication system, which is also allowed to serve as a public address system, shall be installed in accordance with Section 907.5.2.2 and be audible throughout the entire special amusement building.

❖ Because of the problem associated with evacuating special amusement buildings, an emergency voice/alarm communication system is required (see also Section 907.5.2.2). This section allows the system to also serve as a public address (PA) system to have the capability to alert the occupants of a fire and give

them evacuation instructions. The system must be designed so that once the voice alarm is activated the typical public address function is superseded by the voice alarm. Because a manual override must be provided, it is possible that the same microphone used for the public address can be used for the override. However, a separate action would be necessary so that the override function can be used once the voice alarm is active.

**907.2.13 High-rise buildings.** High-rise buildings shall be provided with an automatic smoke detection system in accordance with Section 907.2.13.1, a fire department communication system in accordance with Section 907.2.13.2 and an emergency voice/alarm communication system in accordance with Section 907.5.2.2.

**Exceptions:**

1. Airport traffic control towers in accordance with Section 907.2.22 of this code and Section 412 of the *International Building Code*.
  2. Open parking garages in accordance with Section 406.5 of the *International Building Code*.
  3. Buildings with an occupancy in Group A-5 in accordance with Section 303.1 of the *International Building Code*.
  4. Low-hazard special occupancies in accordance with Section 503.1.1 of the *International Building Code*.
  5. Buildings with an occupancy in Group H-1, H-2 or H-3 in accordance with Section 415 of the *International Building Code*.
  6. In Group I-1 and I-2 occupancies, the alarm shall sound at a constantly attended location and occupant notification shall be broadcast by the emergency voice/alarm communication system.
- ❖ High-rise buildings require additional fire protection systems because of the difficulties with smoke movement, egress time and fire department access. As a result, this section requires both an automatic fire alarm system and an EV/ACS (see commentary, Section 907.5.2.2). Exceptions 1 through 5 are the same as those in Section 403.1 of the IBC regarding the applicability of the high-rise provisions.
- Exception 1 addresses airport traffic control towers and is based on the limited fuel load and the limited number of persons occupying the tower.
- Open parking garages and places of outdoor assembly (Group A-5) are exempted by Exceptions 2 and 3, respectively, because of the free ventilation to the outside that exists in such structures.
- In Exception 4, low-hazard special industrial occupancies may be exempted when approved by the fire code official. Such buildings should be evaluated based on the occupant load and the hazards of the occupancy and its contents to determine whether the protection features required by Section 403 of the IBC are necessary.
- Buildings with occupancies in Groups H-1, H-2 and H-3 are excluded from the requirements of this sec-

tion by Exception 5 because the fire hazard characteristics of these occupancies have not yet been considered in high-rise buildings.

Exception 6 recognizes the supervised environment typical of institutional uses and the reliance placed on staff to act appropriately in an emergency. As is the case for most voice alarms, the key is in being able to deliver specific information to the people who can affect a safe egress—whether this is the public or employees, or both.

**907.2.13.1 Automatic smoke detection.** Automatic smoke detection in high-rise buildings shall be in accordance with Sections 907.2.13.1.1 and 907.2.13.1.2.

❖ This section simply introduces the fire alarm and detection system requirements for high-rise buildings.

**907.2.13.1.1 Area smoke detection.** Area smoke detectors shall be provided in accordance with this section. Smoke detectors shall be connected to an automatic fire alarm system. The activation of any detector required by this section shall activate the emergency voice/alarm communication system in accordance with Section 907.5.2.2. In addition to smoke detectors required by Sections 907.2.1 through 907.2.10, smoke detectors shall be located as follows:

1. In each mechanical equipment, electrical, transformer, telephone equipment or similar room that is not provided with sprinkler protection.
2. In each elevator machine room, machinery space, control room and control space and in elevator lobbies.

❖ Automatic smoke detectors are required in all high-rise buildings in certain locations so that a fire will be detected in its early stages of development. The detectors must be connected to the automatic fire alarm system and be capable of initiating operation of the EV/ACS.

This section divides the automatic smoke detection requirement into two categories. Smoke detectors must be installed in rooms that are not typically occupied. This includes rooms used for mechanical equipment, electrical equipment, transformer equipment and telephone equipment where such rooms do not have automatic sprinkler protection. In most cases, these rooms will have sprinkler protection by virtue of being in a high-rise building and will therefore not require smoke detectors. However, in elevator machine rooms, machinery spaces, control rooms, control spaces and elevator lobbies, smoke detectors are required regardless of sprinkler protection.

Note that smoke detection and smoke alarms may be required based upon occupancy related requirements elsewhere in Section 907.2.

**[M] 907.2.13.1.2 Duct smoke detection.** Duct smoke detectors complying with Section 907.3.1 shall be located as follows:

1. In the main return air and exhaust air plenum of each air-conditioning system having a capacity greater than 2,000 cubic feet per minute (cfm) (0.94 m<sup>3</sup>/s). Such

detectors shall be located in a serviceable area downstream of the last duct inlet.

2. At each connection to a vertical duct or riser serving two or more stories from a return air duct or plenum of an air-conditioning system. In Group R-1 and R-2 occupancies, a smoke detector is allowed to be used in each return air riser carrying not more than 5,000 cfm (2.4 m<sup>3</sup>/s) and serving not more than 10 air-inlet openings.

❖ Smoke detectors must be installed in the main return air and exhaust air plenum of each air-conditioning system having a design capacity exceeding 2,000 cubic feet per minute (cfm) (0.94 m<sup>3</sup>/s). Systems with design capacities equal to or less than 2,000 cfm (0.94 m<sup>3</sup>/s) are exempt from this requirement because their small size limits their capacity for spreading smoke to parts of the building not already involved with fire.

The area that could be served by a 2,000-cfm (0.94 m<sup>3</sup>) system (approximately 5 tons of cooling capacity) is comparatively small; therefore, the distribution of smoke in a system of that size would be minimal. Smoke detectors must be located so that they monitor the total airflow within the system. If a single detector is unable to sample the total airflow at all times, then multiple detectors are required. The smoke detectors must be made accessible for maintenance and inspection. Many failures and false alarms are caused by a lack of maintenance and cleaning of the smoke detectors.

Consistent with Section 606.2.3 of the IMC, return air risers serving two or more stories must have smoke detectors installed at each story. Item 2 allows permits the use of a single listed smoke detector in each return air riser in a Group R-1 or R-2 occupancy if the capacity of each riser does not exceed 5,000 cfm (2.4 m<sup>3</sup>/s) and does not serve more than 10 air-inlet openings. This alternative recognizes that it is not as necessary in buildings dedicated to residential occupancies only to monitor the return air from each story prior to intermixing the return air in the common riser.

**907.2.13.2 Fire department communication system.** Where a wired communication system is *approved* in lieu of an emergency responder radio coverage system in accordance with Section 510, the wired fire department communication system shall be designed and installed in accordance with NFPA 72 and shall operate between a *fire command center* complying with Section 508, elevators, elevator lobbies, emergency and standby power rooms, fire pump rooms, areas of refuge and inside *interior exit stairways*. The fire department communication device shall be provided at each floor level within the *interior exit stairway*.

❖ High-rise buildings have posed a challenge to the traditional communication systems used by the fire service for fire-to-ground communications to assist fire ground officers in communicating with the fire fighters

working in various areas of the building. Where testing using the building's public safety communications system required by Section 510 of the code shows that the signal strengths are not satisfactory, Section 510.1, Exception 1 allows for the alternative of installation of a wired communication system designed in accordance with this section. The system must be capable of operating between the fire command center and every elevator, elevator lobby, emergency/standby power room, fire pump room, area of refuge and exit stairway. Note that this section does not offer specific criteria as to what constitutes an acceptable wired communication system or its components. It could be a component of an emergency voice/alarm communication system that complies with Section 907.5.2.2 or a building's telephone system. In any event, when applying Section 510.1, Exception 1 and this section, the concurrent approval of the fire and building code officials is required.

**907.2.14 Atriums connecting more than two stories.** A fire alarm system shall be installed in occupancies with an atrium that connects more than two stories, with smoke detection in locations required by a rational analysis in Section 909.4 and in accordance with the system operation requirements in Section 909.17. The system shall be activated in accordance with Section 907.5. Such occupancies in Group A, E or M shall be provided with an emergency voice/alarm communication system complying with the requirements of Section 907.5.2.2.

- ❖ Buildings containing an atrium that connects more than two stories are to be equipped with a fire alarm system that can be used to notify building occupants to begin evacuating in case of a fire. The other critical part of such fire alarm systems is to activate the smoke control system. The system is to be activated by smoke detection designed and installed in accordance with the rational analysis as required in Section 909.4. More specifically, smoke control systems are engineered systems that are activated by carefully placed and zoned smoke detection. If improperly designed and installed, the system may not be effective. For instance, wrongly placed or inappropriate smoke detection technology may not activate fast enough and the smoke control system would be overwhelmed. This section goes on to state that the alarm system must be initiated in accordance with Section 907.5, which requires that in buildings containing an atrium, the alarm system is to be initiated by the sprinkler system and any automatic or manual fire alarm-initiating devices found in the atrium as well as elsewhere in the building. It does not intend to require certain features to be installed within the atrium but rather is simply requiring that any such features present initiate the occupant notification system. It would not necessarily be appropriate to also initiate the smoke control system upon activation of the alarm system within a building containing an atrium (see Section 909.12.3). The alarm system needs to be carefully zoned in such buildings to avoid an inappropriate activation of the smoke control system from a

space not associated with the atrium.

Groups A, E and M must have an emergency voice/alarm communication system that complies with Section 907.5.2.2 because of the number of persons to be evacuated and the lack of familiarity with the location of exits that is typical of occupants in Groups A and M.

**907.2.15 High-piled combustibile storage areas.** An automatic smoke detection system shall be installed throughout *high-piled combustibile storage* areas where required by Section 3206.5.

- ❖ Section 3206.5 requires an automatic fire detection system in high-piled combustibile storage areas depending on the commodity class, the size of the high-piled storage area and the presence of an automatic sprinkler system. High-piled storage is the storage of Class I through IV commodities in piles, bin boxes, on pallets or in racks more than 12 feet (3658 mm) high or for high-hazard commodities stored higher than 6 feet (1829 mm). Chapter 32 and NFPA 13 contain additional requirements for all high-piled storage conditions.

**907.2.16 Aerosol storage uses.** Aerosol storage rooms and general-purpose warehouses containing aerosols shall be provided with an *approved* manual fire alarm system where required by this code.

- ❖ Section 3206.5 requires an automatic fire detection system in high-piled combustibile storage areas depending on the commodity class, the size of the high-piled storage area and the presence of an automatic sprinkler system. High-piled storage is the storage of Class I through IV commodities in piles, bin boxes, on pallets or in racks more than 12 feet (3658 mm) high or for high-hazard commodities stored higher than 6 feet (1829 mm). Chapter 32 and NFPA 13 contain additional requirements for all high-piled storage conditions.

**907.2.17 Lumber, wood structural panel and veneer mills.** Lumber, wood structural panel and veneer mills shall be provided with a manual fire alarm system.

- ❖ Any facility using mechanical methods to process wood into finished products produces debris and the potential for combustibile dust. Such facilities include mills that produce solid wood lumber and wood veneers as well as those that manufacture structural wood panels such as waferboard, oriented strandboard, composite wood panels or plywood. Good housekeeping and control of ignition sources are therefore essential. To aid in the quick evacuation of occupants in an emergency, Section 2804.2.1 requires a manual fire alarm system in lumber, wood structural panel and veneer mills that contain product dryers because of their potential as a source of ignition. A manual fire alarm system is not required, however, if the dryers and all other potential sources of ignition are protected by a supervised automatic sprinkler system.

**907.2.18 Underground buildings with smoke control systems.** Where a smoke control system is installed in an underground building in accordance with the *International Building Code*, automatic smoke detectors shall be provided in accordance with Section 907.2.18.1.

❖ As indicated in Section 405.5.2 of the IBC, each compartment of an underground building must have a smoke control/exhaust system that can be activated both automatically and manually. Floor levels more than 60 feet (18 288 mm) below the lowest level of exit discharge must be compartmented. Compartmentation is a key element in the egress and fire access plan for floor areas in an underground building. The smoke control system must not only facilitate egress during a fire, but also improve fire department access to the fire source by maintaining visibility that is otherwise impossible given the inability of the fire service to manually ventilate the underground portion of the building. (see the commentary to Section 405.4.1 of the IBC).

**907.2.18.1 Smoke detectors.** Not fewer than one smoke detector *listed* for the intended purpose shall be installed in all of the following areas:

1. Mechanical equipment, electrical, transformer, telephone equipment, elevator machine or similar rooms.
2. Elevator lobbies.
3. The main return and exhaust air plenum of each air-conditioning system serving more than one story and located in a serviceable area downstream of the last duct inlet.
4. Each connection to a vertical duct or riser serving two or more floors from return air ducts or plenums of heating, ventilating and air-conditioning systems, except that in Group R occupancies, a *listed* smoke detector is allowed to be used in each return air riser carrying not more than 5,000 cfm (2.4 m<sup>3</sup>/s) and serving not more than 10 air inlet openings.

❖ Automatic smoke detectors are required in certain locations in all underground buildings so that a fire will be detected in its early stages of development. Underground buildings are similar to high-rise buildings in that they present an unusual hazard by being virtually inaccessible to exterior fire department suppression and rescue operations with the increased potential to trap occupants inside the structure. For this reason, the smoke detector location requirements for underground buildings are similar to those in Section 907.2.13.1 for high-rise buildings (see commentary, Section 907.2.13.1).

The requirement for a smoke detector in the main return and exhaust air plenum of an air-conditioning system in an underground building, however, differs from that of a high-rise building in that it is not a function of capacity [2,000 cfm (0.94 m<sup>3</sup>/s)] but rather a function of whether the system serves more than one floor level. There is more concern over the threat of smoke movement from floor to floor because the

products of combustion cannot be vented directly to the atmosphere.

**907.2.18.2 Alarm required.** Activation of the smoke control system shall activate an audible alarm at a constantly attended location.

❖ The audible alarm is required to notify qualified personnel immediately that the smoke control system has been activated and to put emergency procedures into action quickly.

**907.2.19 Deep underground buildings.** Where the lowest level of a structure is more than 60 feet (18 288 mm) below the finished floor of the lowest *level of exit discharge*, the structure shall be equipped throughout with a manual fire alarm system, including an emergency voice/alarm communication system installed in accordance with Section 907.5.2.2.

❖ The ability to communicate and offer warning of a fire can increase the time available for egress from the building. Underground structures located more than 60 feet (18 288 mm) below the level of exit discharge must therefore have a manual fire alarm system. An EV/ACS is also required as part of this system (see commentary, Section 907.5.2.2).

**907.2.20 Covered and open mall buildings.** Where the total floor area exceeds 50,000 square feet (4645 m<sup>2</sup>) within either a covered mall building or within the perimeter line of an open mall building, an emergency voice/alarm communication system shall be provided. Emergency voice/alarm communication systems serving a mall, required or otherwise, shall be accessible to the fire department. The system shall be provided in accordance with Section 907.5.2.2.

❖ Because of the potentially large number of occupants and their unfamiliarity with their surroundings, an EV/ACS, accessible by the fire department, is required to aid in evacuation of covered mall buildings exceeding 50,000 square feet (4645 m<sup>2</sup>) in total floor area or an open mall exceeding 50,000 square feet (4645 m<sup>2</sup>) measured within the perimeter lines of the open mall. Anchor stores are not included as part of the covered or open mall building (see commentary, Section 202 definition of "Covered mall building").

**907.2.21 Residential aircraft hangars.** Not fewer than one single-station smoke alarm shall be installed within a residential aircraft hangar as defined in Chapter 2 of the *International Building Code* and shall be interconnected into the residential smoke alarm or other sounding device to provide an alarm that will be audible in all sleeping areas of the *dwelling*.

❖ Residential aircraft hangars are assumed to be on the same property as a one- or two-family dwelling. Section 412.5 of the IBC contains additional requirements for the construction of residential aircraft hangars. The hangar could be located immediately adjacent to the dwelling unit if it is separated by 1-hour fire-resistance-rated construction. Because of the potentially close proximity of the aircraft and its flammability and fuel source, at least one smoke alarm is required in the hangar that is interconnected

to the residential smoke alarms. It should be noted, however, that the requirement for a smoke alarm is also applicable to residential aircraft hangars that are detached from the dwelling unit. Because a minimum separation distance is not specified, a fire in the hangar could still present a serious fire hazard to the dwelling unit.

**907.2.22 Airport traffic control towers.** An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be provided in airport control towers in accordance with Sections 907.2.22.1 and 907.2.22.2.

**Exception:** Audible appliances shall not be installed within the control tower cab.

❖ Airport traffic control towers must be designed to comply with Section 412.3 of the IBC. These structures are unique in that they can be built to excessive heights and are often permitted to have one exit stairway. Section 412.3 of the IBC does require that airport traffic control towers with an occupied floor more than 35 feet above fire department vehicle access be equipped throughout with an automatic sprinkler system. The requirements for detection systems and associated occupant notification are addressed based on whether the airport traffic control tower is equipped throughout with an automatic sprinkler system and whether multiple exits are provided.

The exception recognizes the sensitive nature of the operations that take place in the cab located at the top of the tower and prohibits the installation of audible alarm notification devices there. Notification of occupants within the cab is to be by visual notification appliances only.

**907.2.22.1 Airport traffic control towers with multiple exits and automatic sprinklers.** Airport traffic control towers with multiple *exits* and equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 shall be provided with smoke detectors in all of the following locations:

1. Airport traffic control cab.
2. Electrical and mechanical equipment rooms.
3. Airport terminal radar and electronics rooms.
4. Outside each opening into *interior exit stairways*.
5. Along the single *means of egress* permitted from observation levels.
6. Outside each opening into the single *means of egress* permitted from observation levels.

❖ This section addresses airport traffic control towers that are equipped throughout with an automatic sprinkler system and provide multiple exits. The requirements are less restrictive than Section 907.2.22.2 because two important safety aspects are provided.

The first three items address occupiable or equipment-related rooms where the fires are more likely to start. The last two items address the paths of egress. Item 4 requires one detector outside each entrance to

the interior stairway. Item 5 is specific to providing detection along the entire means of egress path from the observation levels.

**907.2.22.2 Other airport traffic control towers.** Airport traffic control towers with a single *exit* or where sprinklers are not installed throughout shall be provided with smoke detectors in all of the following locations:

1. Airport traffic control cab.
2. Electrical and mechanical equipment rooms.
3. Airport terminal radar and electronics rooms.
4. Office spaces incidental to the tower operation.
5. Lounges for employees, including sanitary facilities.
6. *Means of egress*.
7. Accessible utility shafts.

❖ This section addresses airport traffic control towers that have only a single exit or where an automatic sprinkler system is not provided. Essentially all the items addressed are the areas permitted in an airport traffic control tower in accordance with Section 412.3. Items 1 through 3 are the same as Section 907.2.22.1. These are the critical occupiable spaces and equipment spaces where fires have the greatest affect on the operation of airport traffic control towers. Since this is a single exit tower and possibly not equipped throughout with an automatic sprinkler system, other occupiable areas such as offices and lounges for employees must also provide smoke detection. Since there are limited exits or no systems able to control the fire, early warning of a fire becomes more critical. Item 6 requires smoke detection along the means of egress path. The intent is to address the exit access path leading to the interior exit stairway. Finally, Item 7 addresses potential for fires in any utility shaft that may be accessible to building occupants.

**907.2.23 Battery rooms.** An automatic smoke detection system shall be installed in areas containing stationary storage battery systems with a liquid capacity of more than 50 gallons (189 L).

❖ Stationary lead-acid battery systems are commonly used for standby power, emergency power or uninterrupted power supplies. The release of hydrogen gas during battery system operation is usually minimal. Adequate ventilation will disperse the small amounts of liberated hydrogen. Because standby power and emergency power systems control many important building emergency systems and functions, a supervised automatic smoke-detection system is required for early warning notification of a hazardous condition. Section 608 contains additional requirements, including the need for safety venting; room enclosure requirements; spill control and neutralization provisions; ventilation criteria; signage and seismic protection. Section 509 of the IBC also requires that such rooms in certain occupancies be separated by one hour construction.

**907.3 Fire safety functions.** Automatic fire detectors utilized for the purpose of performing fire safety functions shall be connected to the building's fire alarm control unit where a fire alarm system is required by Section 907.2. Detectors shall, upon actuation, perform the intended function and activate the alarm notification appliances or activate a visible and audible supervisory signal at a constantly attended location. In buildings not equipped with a fire alarm system, the automatic fire detector shall be powered by normal electrical service and, upon actuation, perform the intended function. The detectors shall be located in accordance with NFPA 72.

❖ When the code requires installation of automatic fire detectors to perform a specific function, such as elevator recall or smokeproof enclosure ventilation, or when detectors are installed to comply with a permitted alternative, such as door-closing devices, these detectors must be connected to the building's automatic fire alarm system if the building is required by the code to have such a system.

In addition to performing its intended function (for example, closing a door), if a detector is activated, it must also activate either the building alarm devices (if one is present) or a supervisory signal at a constantly attended location. This requirement recognizes that these detectors and the devices they control are part of the building fire protection system and are expected to perform as designed. If they are connected to a fire alarm system, they will have the supervision necessary for operational reliability. If they are not connected to and supervised by a fire alarm system, they still must be supervised through the constantly attended location.

An exception is provided for fire safety function detectors in buildings not required to have a fire alarm system. The fire safety function detectors must be powered by the building electrical system and be located as required by NFPA 72. Without this exception, these detectors could not be expected to perform as intended because there would be no power supply.

**907.3.1 Duct smoke detectors.** Smoke detectors installed in ducts shall be *listed* for the air velocity, temperature and humidity present in the duct. Duct smoke detectors shall be connected to the building's fire alarm control unit when a fire alarm system is required by Section 907.2. Activation of a duct smoke detector shall initiate a visible and audible supervisory signal at a *constantly attended location* and shall perform the intended fire safety function in accordance with this code and the *International Mechanical Code*. In facilities that are required to be monitored by a supervising station, duct smoke detectors shall report only as a supervisory signal and not as a fire alarm. They shall not be used as a substitute for required open area detection.

**Exceptions:**

1. The supervisory signal at a constantly attended location is not required where duct smoke detectors activate the building's alarm notification appliances.

2. In occupancies not required to be equipped with a fire alarm system, actuation of a smoke detector shall activate a visible and an audible signal in an *approved* location. Smoke detector trouble conditions shall activate a visible or audible signal in an *approved* location and shall be identified as air duct detector trouble.

❖ It is not the intent of this section to send a signal to the fire department or to activate the alarm notification devices within a building. Instead, this section requires that a supervisory signal be sent to a constantly attended location. Smoke detectors must be connected to a fire alarm system where such systems are installed. Connection to the fire alarm system will activate a visible and audible supervisory signal at a constantly attended location, which will alert building supervisory personnel that a smoke alarm has activated and will also provide electronic supervision of the duct detectors, thereby indicating any problems that may develop in the detector system circuitry or power supply.

Exception 1 allows activation of the building alarm notification appliances in place of a supervisory signal. Causing the occupant notification system to sound would alert the occupants of the building that an alarm condition exists within the air distribution system, thereby performing the same function as a supervisory signal sent to a constantly attended location.

Exception 2 recognizes the fact that not all buildings are required to have a fire alarm system. A visible and audible signal must be activated at an approved location that will alert building supervisory personnel to take action. Additionally, the duct smoke detectors must be electronically supervised to indicate trouble (system fault) in the detector system circuitry or power supply. A trouble condition must activate a distinct visible or audible signal at a location that will alert the responsible personnel.

**907.3.2 Delayed egress locks.** Where delayed egress locks are installed on *means of egress* doors in accordance with Section 1010.1.9.7, an automatic smoke or heat detection system shall be installed as required by that section.

❖ This section alerts the code user to additional requirements in Section 1010.1.9.7 that tie the operation of egress doors into the activation of an automatic fire detection system. A smoke or heat detection system is required to unlock delayed egress locks upon activation. The heat detection system can be the sprinkler system. For example, Section 1010.1.4.3 requires horizontal sliding doors used as a component of the means of egress, where required to be rated, to be self-closing or automatic-closing upon smoke detection. Also, electrically locked egress doors in occupancies as required by Section 1010.1.9.8 must be capable of being automatically unlocked by activation of an automatic fire detection system, if one is installed.

**907.3.3 Elevator emergency operation.** Automatic fire detectors installed for elevator emergency operation shall be installed in accordance with the provisions of ASME A17.1 and NFPA 72.

❖ This section provides correlation with Section 607.1 by making it clear that automatic fire detection devices used to initiate Phase I emergency recall of elevators are to be installed in accordance with both ASME A17.1 and NFPA 72.

**907.3.4 Wiring.** The wiring to the auxiliary devices and equipment used to accomplish the fire safety functions shall be monitored for integrity in accordance with NFPA 72.

❖ In order to provide a reasonable level of integrity and reliability to the installation of automatic fire detection devices and related equipment installed to perform various fire safety functions in accordance with Section 907.3, this section requires that all wiring interconnecting such devices and equipment be monitored for integrity in accordance with NFPA 72.

**907.4 Initiating devices.** Where manual or automatic alarm initiation is required as part of a fire alarm system, the initiating devices shall be installed in accordance with Sections 907.4.1 through 907.4.3.1.

❖ This section introduces Sections 907.4.1 through 907.4.3 which contain requirements for the various types of manual or automatic fire alarm initiating devices.

**907.4.1 Protection of fire alarm control unit.** In areas that are not continuously occupied, a single smoke detector shall be provided at the location of each fire alarm control unit, notification appliance circuit power extenders and supervising station transmitting equipment.

**Exception:** Where ambient conditions prohibit installation of smoke detector, a *heat detector* shall be permitted.

❖ This section requires a smoke detector at the fire alarm control unit. This is consistent with Section 10.4.4 of NFPA 72. This smoke detector will activate the fire alarm control unit and allow it to either notify occupants or transmit a signal to a remote monitoring location before the fire impairs the fire alarm control unit. The exception parallels Section 907.4.3 by allowing a heat detector to be installed in lieu of a smoke detector in areas where the ambient environment is hostile to smoke detectors and could lead to unwanted alarm activations. This exception is also allowed by NFPA 72.

**907.4.2 Manual fire alarm boxes.** Where a manual fire alarm system is required by another section of this code, it shall be activated by fire alarm boxes installed in accordance with Sections 907.4.2.1 through 907.4.2.6.

❖ This section specifies the requirements for manual fire alarm boxes that are part of a required manual fire alarm system.

**907.4.2.1 Location.** Manual fire alarm boxes shall be located not more than 5 feet (1524 mm) from the entrance to each

*exit*. In buildings not protected by an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2, additional manual fire alarm boxes shall be located so that the *exit access* travel distance to the nearest box does not exceed 200 feet (60 960 mm).

❖ Manual fire alarm boxes must be located in the path of egress and be readily accessible to the occupants. They must be located within 5 feet (1524 mm) of the entrance to each exit on every story of the building. This would include the need to locate manual fire alarm boxes near each horizontal exit, as well as entrances to stairs and exit doors to the exterior.

Manual fire alarm boxes are located near exits so that an adequate number of devices are available in the path of egress to transmit an alarm in a timely manner. These locations also encourage the actuation of a manual fire alarm box on the fire floor prior to entering the stair, resulting in the alarm being received from the actual fire floor and not another floor along the path of egress.

The location also presumes that individuals will be evacuating the area where the fire originated. When evacuation of the fire area is unlikely, consideration could be given to putting manual fire alarm boxes in more convenient places. Examples of such instances would be officer stations in Group I-3 occupancies and care provider stations in Group I-2 occupancies.

The 200-foot (60 960 mm) travel distance limitation is consistent with the exit access travel distance permitted for most nonsprinklered occupancies. If the 200-foot (60 960 mm) travel distance to a manual fire alarm box is exceeded, even in a fully sprinklered building, additional manual fire alarm boxes would be required.

**907.4.2.2 Height.** The height of the manual fire alarm boxes shall be not less than 42 inches (1067 mm) and not more than 48 inches (1372 mm) measured vertically, from the floor level to the activating handle or lever of the box.

❖ Manual fire alarm boxes must be reachable by the occupants of the building. They must also be mounted high enough to reduce the likelihood of damage or false alarms from something accidentally striking the device. Therefore, manual fire alarm boxes must be mounted a minimum of 42 inches (1067 mm) and a maximum of 48 inches (1372 mm) above the floor level. The 48-inch (1372 mm) measurement corresponds to the maximum unobstructed side-reach height by a person in a wheelchair.

**907.4.2.3 Color.** Manual fire alarm boxes shall be red in color.

❖ Manual fire alarm boxes are to be painted or manufactured in a distinctive and traditional red color to provide a visual cue to help building occupants identify the device.

**907.4.2.4 Signs.** Where fire alarm systems are not monitored by a supervising station, an *approved* permanent sign shall be

installed adjacent to each manual fire alarm box that reads: WHEN ALARM SOUNDS—CALL FIRE DEPARTMENT.

**Exception:** Where the manufacturer has permanently provided this information on the manual fire alarm box.

❖ This section has limited application because, as indicated in Section 907.6.6, fire alarm systems generally must be monitored by an approved supervising station. When a system is not monitored, such as possibly a fire alarm system that is not required by code, adequate signage must be displayed to tell occupants what response actions must be taken. Most building occupants assume that when an alarm device is activated, the fire department will automatically be notified as well. The sign must be conspicuously located next to the manual fire alarm box unless the signage is mounted on the manual fire alarm box itself by the manufacturer.

**907.4.2.5 Protective covers.** The *fire code official* is authorized to require the installation of *listed* manual fire alarm box protective covers to prevent malicious false alarms or to provide the manual fire alarm box with protection from physical damage. The protective cover shall be transparent or red in color with a transparent face to permit visibility of the manual fire alarm box. Each cover shall include proper operating instructions. A protective cover that emits a local alarm signal shall not be installed unless *approved*. Protective covers shall not project more than that permitted by Section 1003.3.3.

❖ Although manual fire alarm boxes must be readily available to all occupants in buildings required to have a manual fire alarm system, this section allows the use of protective covers if they are approved by the fire code official. Protective covers are commonly used to reduce either the potential for intentional false alarms or vandalism. They also provide protection in locations where the manual fire alarm boxes may be exposed to physical damage, such as in gymnasiums, indoor tennis courts and the like.

**907.4.2.6 Unobstructed and unobscured.** Manual fire alarm boxes shall be accessible, unobstructed, unobscured and visible at all times.

❖ This section addresses the concern that manual fire alarm boxes be kept clear and unobstructed. It is recommended that a minimum of 3 feet (914 mm) be kept clear but more may be needed. NFPA 72 addresses the need for manual fire alarm boxes to be unobstructed in Section 17.14.8.2 and states that manual fire alarm boxes be conspicuous, unobstructed and accessible. This requirement will assist during the design, construction, inspection and future maintenance of manual fire alarm boxes when they are located where they will be provided with enough space to access and will not be obstructed.

**907.4.3 Automatic smoke detection.** Where an automatic smoke detection system is required it shall utilize smoke detectors unless ambient conditions prohibit such an installation. In spaces where smoke detectors cannot be utilized due

to ambient conditions, *approved automatic heat detectors* shall be permitted.

❖ Smoke detectors must be used, except when ambient conditions would prohibit their use. This section would allow a heat detector to be installed in lieu of a smoke detector in areas where the ambient environment is hostile to smoke detectors and could lead to unwanted alarm activations. The smoke detector manufacturer's literature will identify the limitations on the use of smoke detectors, including environmental conditions such as humidity, temperature and airflow.

**907.4.3.1 Automatic sprinkler system.** For conditions other than specific fire safety functions noted in Section 907.3, in areas where ambient conditions prohibit the installation of smoke detectors, an *automatic sprinkler system* installed in such areas in accordance with Section 903.3.1.1 or 903.3.1.2 and that is connected to the fire alarm system shall be *approved* as automatic heat detection.

❖ This section states that automatic heat detection is not required when buildings are fully sprinklered in accordance with NFPA 13 or 13R. The presence of a sprinkler system exempts areas where a heat detector can be installed in place of a smoke detector, such as in storage or furnace rooms. The sprinkler head in this case essentially acts as a heat detection device. Note that this provision does not apply to the fire safety functions indicated in Section 907.3.

**907.5 Occupant notification systems.** A fire alarm system shall annunciate at the fire alarm control unit and shall initiate occupant notification upon activation, in accordance with Sections 907.5.1 through 907.5.2.3.3. Where a fire alarm system is required by another section of this code, it shall be activated by:

1. Automatic fire detectors.
2. Automatic sprinkler system waterflow devices.
3. Manual fire alarm boxes.
4. Automatic fire-extinguishing systems.

**Exception:** Where notification systems are allowed elsewhere in Section 907 to annunciate at a constantly attended location.

❖ This section makes it clear that fire alarm system activation begins first by activating the fire alarm control unit and then by notifying the occupants of an alarm condition and then goes on to introduce all of the components of an occupant notification system contained in Sections 907.5.1 through 907.5.2.3.3.

It also lists the system components that are to act as alarm initiation devices. The exception is a recognition that there are places in the code where an alternative to occupant notification is an alarm notification at a constantly attended location. The exception is intended to clarify the code so that there is no question as to whether this general provision for alarm activation is superseded by the other sections addressing the alarm notification at a constantly attended location.

**907.5.1 Presignal feature.** A presignal feature shall not be installed unless *approved* by the *fire code official* and the fire department. Where a presignal feature is provided, a signal shall be annunciated at a constantly attended location *approved* by the fire department, so that occupant notification can be activated in the event of fire or other emergency.

❖ A presignal feature on a fire alarm system allows the occupant notification devices to activate in selected, constantly attended locations only and from which human intervention is required to activate a general occupant notification signal. Alternatively, this feature can be programmed to delay the general alarm notification for more than one minute before it will automatically be activated by the control panel. In either presignal scenario, remote transmission of the alarm signal to the fire department is immediate. See NFPA 72 for additional information on the presignal feature.

Improper use of the presignal feature has been a contributing factor in several multiple-death fire incidents. In most instances, the staff failed to activate the general alarm quickly and the occupants of the building were unaware of the fire. Therefore, the use of a presignal feature is discouraged by the code. A presignal feature may be used only if it is approved by the fire code official and the fire department.

**907.5.2 Alarm notification appliances.** Alarm notification appliances shall be provided and shall be *listed* for their purpose.

❖ The code requires that fire alarm systems be equipped with approved alarm notification appliances so that in an emergency, the fire alarm system will notify the occupants of the need for evacuation or implementation of the fire emergency plan. Alarm notification devices required by the code are of two general types: visible and audible. Except for voice/alarm signaling systems, once the system has been activated, all visible and audible alarms are required to activate. Voice/alarm signaling systems are special signaling systems that are activated selectively in response to specific emergency conditions.

**907.5.2.1 Audible alarms.** Audible alarm notification appliances shall be provided and emit a distinctive sound that is not to be used for any purpose other than that of a fire alarm.

**Exceptions:**

1. Audible alarm notification appliances are not required in critical care areas of Group I-2 Condition 2 occupancies that are in compliance with Section 907.2.6, Exception 2.
2. A visible alarm notification appliance installed in a nurses' control station or other continuously attended staff location in a Group I-2 Condition 2 suite shall be an acceptable alternative to the installation of audible alarm notification appliances throughout the suite in Group I-2 Condition 2 occupancies that are in compliance with Section 907.2.6, Exception 2.

3. Where provided, audible notification appliances located in each occupant evacuation elevator lobby in accordance with Section 3008.9.1 of the *International Building Code* shall be connected to a separate notification zone for manual paging only.

❖ To attract the attention of building occupants, audible alarms must be distinctive, using a sound that is unique to the fire alarm system and used for no other purpose than alerting occupants to a fire emergency. Other emergencies, such as tornados, etc., must be signaled by another sound different from the fire signal.

Exception 1 recognizes that the occupants in critical care areas of Group I-2 occupancies are usually incapacitated. The audible alarms may have the effect of unnecessarily disrupting the care recipients specific term who are most likely not capable of self-preservation. Likewise, audible alarms in operating theaters of hospitals could be hazardous because an alarm activation could startle a surgeon during a delicate procedure. Critical care areas are also assumed to be adequately staffed at all times. Section 907.2.6 Exception 2 allows the use of private mode signaling in accordance with NFPA 72 and also requires that the staff evacuation responsibilities are included in the fire safety and evacuation plan. See commentary for Section 907.2.6. In private mode, as permitted by Section 907.2.6, there is still a requirement for an audible alarm notification from appliances, though at a much lower decibel level meant to alert staff of the alarm activation. Allowing the audible alarm to be eliminated from critical care areas (operating rooms) in exchange for a visual notification device is also not appropriate since the visual signal device also creates a distraction in critical care areas that may not be able to immediately stop a patient procedure. The emergency action plan would include provisions for alerting of critical area staff and the actions to be taken.

Exception 2 allows hospital care suites to eliminate audible alarms where visible alarm notification appliances are located at a continuously attended staff location or nurses control station. In a suite arrangement, the "control area" is the centrally manned location for staff monitoring patients in the separate rooms. An alarm indicator at this location will alert staff for response in a more effective and efficient manner. Similar to Exception 1, audible alarms can unnecessarily disrupt the care recipients. In addition, simply providing visible alarm notification throughout the suite is not appropriate. The patient's evacuation depends on staff, since they are not capable of self-preservation. As with Exception 1, compliance with Exception 2 to Section 907.2.6 would be required in order to take advantage of this exception.

Exception 3 is intended to address the concern that automatic emergency voice/alarm messages do not interfere with operation of the two-way communica-

tion associated with the occupant evacuation elevators. Live voice messages would be appropriate in the lobbies.

**907.5.2.1.1 Average sound pressure.** The audible alarm notification appliances shall provide a sound pressure level of 15 decibels (dBA) above the average ambient sound level or 5 dBA above the maximum sound level having a duration of not less than 60 seconds, whichever is greater, in every occupiable space within the building.

❖ To attract the attention of building occupants, this section requires that the distinctive audible alarms must be capable of being heard above the ambient noise level in a space. The indicated levels are considered the minimum pressure differential that will be perceivable by most people. It prescribes that the sound pressure level (SPL) for notification appliances shall be a minimum of 15 decibels measured in the A-scale (dBA) above the ambient SPL or 5 dBA above the maximum SPL in every space that can be occupied in a building. These SPLs are based on a minimum 1-minute measurement period. SPLs for Group R and I-1 occupancies, mechanical rooms and other occupancies are no longer stipulated as they had been in previous editions of the IBC.

The values mandated in Section 907.5.2.1.1 in previous editions of the code were not consistent with the notification appliance SPL requirements in NFPA 72. NFPA 72 requirements for the audible notification appliances are based on if the devices emit alert or evacuation tones, voice messages or audible notifications for exit markings. The provisions in Section 907.5.2.1.1 would apply to all notification appliances designed to operate in either public- or private-mode. In sleeping areas, the minimum SPL is no longer specified in Section 907.5.2.1.1; however, for smoke alarms, Section 907.2.11 and NFPA 72 require a minimum 75 dBA SPL at the pillow.

Also note that the 2010 American with Disabilities Act Standard for Accessible Design has an exception for medical care facilities following industry practice that will allow a dependence upon staff. The activation of either audible or visible alarms could be detrimental to the care recipients in locations like operating rooms and intensive or critical care units.

**907.5.2.1.2 Maximum sound pressure.** The maximum sound pressure level for audible alarm notification appliances shall be 110 dBA at the minimum hearing distance from the audible appliance. Where the average ambient noise is greater than 95 dBA, visible alarm notification appliances shall be provided in accordance with NFPA 72 and audible alarm notification appliances shall not be required.

❖ In no case may the sound pressure level exceed 110 dBA at the minimum hearing distance from the audible appliance. This is consistent with Americans with Disabilities Act (ADA) requirements. Sound pressures above that level can cause pain or even permanent hearing loss. In such cases, audible alarms are not required to be installed but visual alarms would be necessary to compensate for the lack of audibility.

It should also be noted that in certain work areas, the Occupational Safety and Health Administration (OSHA) requires employees to wear hearing protection, possibly preventing them from hearing an audible alarm. Additionally, the noise factor in these areas is high enough that an audible alarm may not be discernible. In these areas, as well as in others, the primary method of indicating a fire can be by a visible signal. Employees must be capable of identifying such a signal as indicating a fire.

**907.5.2.2 Emergency voice/alarm communication systems.** Emergency voice/alarm communication systems required by this code shall be designed and installed in accordance with NFPA 72. The operation of any automatic fire detector, sprinkler waterflow device or manual fire alarm box shall automatically sound an alert tone followed by voice instructions giving *approved* information and directions for a general or staged evacuation in accordance with the building's fire safety and evacuation plans required by Section 404. In high-rise buildings, the system shall operate on at least the alarming floor, the floor above and the floor below. Speakers shall be provided throughout the building by paging zones. At a minimum, paging zones shall be provided as follows:

1. Elevator groups.
2. *Interior exit stairways.*
3. Each floor.
4. *Areas of refuge* as defined in Chapter 2.

**Exception:** In Group I-1 and I-2 occupancies, the alarm shall sound in a constantly attended area and a general occupant notification shall be broadcast over the overhead page.

❖ The primary purpose of an EV/ACS is to provide dedicated manual and automatic facilities for the origination, control and transmission of information and instructions pertaining to a fire alarm emergency to the occupants of a building. This section identifies that notification speakers are required throughout the building with a minimum of one speaker in each paging zone when an EV/ACS is required. The system may sound a general alarm or be a selective system in which only selected areas of the building receive the alarm indication for staged evacuation. See Chapter 4 for evacuation plan requirements. The intent is to provide the capability to send out selective messages to individual areas; however, it does not prohibit the same message to be sent to all areas. In high-rise buildings, a minimum area of notification must include the alarming floor and the floors above and below it.

This section also identifies the minimum paging zone arrangement. This does not preclude further zone divisions for logical staged evacuation in accordance with an approved evacuation plan.

This section also indicates that the emergency voice/alarm system is to be initiated as all other fire alarm systems are initiated. The functional operation of the system begins with an alert tone (usually 3 to

10 seconds in duration) followed by the evacuation signal (message). It is important to remember that the voice alarm system is not an “audible alarm.” It has its own specific criteria for installation and approval according to NFPA 72. Consequently, the sound pressure requirements for audible alarms do not apply to voice alarm systems. For voice alarm systems, the intent is communication and an understanding of what is being said, not volume.

The exception is similar to the one to Section 907.5.2.1 and recognizes the supervised environment typical of institutional uses and the reliance placed on staff to act appropriately in an emergency. As is the case for most voice alarms, the key is in being able to deliver specific information to the people who can affect a safe egress—whether this is the public or employees, or both.

**907.5.2.2.1 Manual override.** A manual override for emergency voice communication shall be provided on a selective and all-call basis for all paging zones.

❖ The intent of this section is to provide the ability to transmit live voice instructions over any previously initiated signals or pre-recorded messages for all zones. This would include the ability to override the voice message at once throughout the building or to be able to select individual paging zones for the message override.

**907.5.2.2.2 Live voice messages.** The emergency voice/ alarm communication system shall have the capability to broadcast live voice messages by paging zones on a selective and all-call basis.

❖ This would include the ability to provide the live voice message at once throughout the building or to be able to select individual paging zones to receive the message. Speakers used for background music must not be used unless specifically listed for fire alarm system use. NFPA 72 has additional requirements for the placement, location and audibility of speakers used as part of an emergency voice/alarm communication system.

**907.5.2.2.3 Alternate uses.** The emergency voice/ alarm communication system shall be allowed to be used for other announcements, provided the manual fire alarm use takes precedence over any other use.

❖ In certain circumstances which should be approved by the fire code officials, the emergency voice/alarm communications system could be used to convey information other than fire alarm-related items. This could include severe weather warnings that might require evacuation or relocation, lockdown instructions (see commentary, Section 404.2.3) and similar approved messages. In the event of such usage, the system must respond immediately to manual fire alarm box activations.

**907.5.2.2.4 Emergency voice/alarm communication captions.** Where stadiums, arenas and grandstands are required to caption audible public announcements in accordance with Section 1108.2.7.3 of the *International Building Code*, the

emergency/voice alarm communication system shall be captioned. Prerecorded or live emergency captions shall be from an *approved* location constantly attended by personnel trained to respond to an emergency.

❖ This provision links the EV/ACS with the requirements for captioning in Section 1108.2.7.3 of the IBC. Section 1108.2.7.3 of the IBC requires that stadiums, arenas and grandstands have 15,000 fixed seats to provide captioning for audible announcements (see commentary, Section 907.2.1.2).

**907.5.2.2.5 Emergency power.** Emergency voice/ alarm communications systems shall be provided with emergency power in accordance with Section 604. The system shall be capable of powering the required load for a duration of not less than 24 hours, as required in NFPA 72.

❖ Because the emergency voice/alarm communication system is a critical aid in evacuating the building, the system must be connected to an approved emergency power source complying with Section 604. The section also clarifies that the duration of the load for EV/ACS is a minimum of 24 hours.

**907.5.2.3 Visible alarms.** Visible alarm notification appliances shall be provided in accordance with Sections 907.5.2.3.1 through 907.5.2.3.3.

**Exceptions:**

1. Visible alarm notification appliances are not required in *alterations*, except where an existing fire alarm system is upgraded or replaced, or a new fire alarm system is installed.
2. Visible alarm notification appliances shall not be required in *exits* as defined in Chapter 2.
3. Visible alarm notification appliances shall not be required in elevator cars.
4. Visual alarm notification appliances are not required in critical care areas of Group I-2 Condition 2 occupancies that are in compliance with Section 907.2.6, Exception 2.

❖ This section contains alarm system requirements for occupants who are hearing impaired. Visible alarm notification appliances are to be installed in conjunction with the audible devices and located and oriented so that they will display alarm signals throughout a space. It is not the intent of the code to offer visible alarm signals as an option to audible alarm signals. Both are required. However, the code acknowledges conditions when audible alarms may be of little or no value, such as when the ambient sound level exceeds 105 dBA. In such cases, Section 907.5.2.1, similar to NFPA 72, allows for visible alarm notification appliances in the area.

Exception 1 states that visible alarm devices are not required in previously approved existing fire alarm systems or as part of minor alterations to existing fire alarm systems. Extensive modifications to an existing fire alarm system such as an upgrade or replacement would require the installation of visible alarm devices even if the previous existing system neither had them

nor required them. The main reason is a combination of simple economics and practical application. Many existing systems that do not have visible signal devices do not have the wiring capability to include such devices in their small alterations. To make the necessary changes to the existing system virtually a total replacement of the existing system may need to take place. In many cases this is cost prohibitive. Thus, if the alteration is small, the system can be left as is, without the visual devices. The second consideration is scope. If the alteration involves only a limited area, it could be confusing to have part of the area equipped with visual devices and part without. This is not good practice, as the alarm could be confusing. If an entire floor is being altered, then it becomes subject to consideration for an upgrade to an alarm system with visual devices. If only an office is being remodeled, then the implication is that the upgrade to visual devices may not be warranted. This determination will be subjective in many cases and should be applied based on the life safety benefit and financial expenses involved and whether adequate audible devices are present for full coverage.

In Exception 2, visible alarm devices are not required in exit elements because of the potential distraction during evacuation. Exits, as defined in Chapter 2, could include interior exit stairways or exit passageways but not exit access corridors. In tall buildings, exiting may be phased based on alarm zone. If the alarm floor and adjacent floors are notified of the emergency but the remainder of the building is not, then a visual device in the stairway would be confusing to those people who may not be coming from the alarm floor.

Previously, some jurisdictions were requiring visible alarm notification appliances to be installed in elevator cars since there was no exception in the code or NFPA 72 to allow omission of this type of notification appliance in elevator cars. Exception 3 eliminates any confusion regarding the need to install visible notification appliances in elevator cars. The rationale for not installing visible notification appliances in elevator cars is the same as for interior exit stairways; high light intensity from these notification appliances may cause confusion and disorientation. Also, elevator passengers are “captive” in that they cannot respond to such devices until the elevator arrives at its destination or is recalled by the Phase I emergency operation feature, which could lead to passenger panic.

Exception 4 was added to eliminate visual alarm notification appliances in critical care areas of Group I-2 Condition 2 occupancies (hospitals) due to the hazards they may pose to the occupants. Such occupancies already have staff procedures in place during

fires that more than compensate for visual alarm notification appliances. In addition, in these areas of the hospital the patients are not typically ambulatory. This allowance includes specific requirements for detailing of the staff evacuation responsibilities based on the requirements in Section 907.2.6. See also commentary to Exception 1 of Section 907.5.2.1.

**907.5.2.3.1 Public use areas and common use areas.** Visible alarm notification appliances shall be provided in *public use areas* and *common use areas*.

**Exception:** Where employee work areas have audible alarm coverage, the notification appliance circuits serving the employee work areas shall be initially designed with not less than 20-percent spare capacity to account for the potential of adding visible notification appliances in the future to accommodate hearing-impaired employee(s).

❖ Visible alarm notification appliances must provide coverage in all areas open to the public, as well as all shared or common areas (e.g., corridors, public restrooms, shared offices, classrooms, medical exam rooms, etc.). Areas where visible alarm notification appliances are not required include private offices, mechanical rooms or similar spaces. The intent with this section is to replicate the provisions included in the Americans with Disabilities Act *Accessibility Guidelines for Buildings and Facilities (ADAAG)*.

The exception allows employee work areas to provide only for spare capacity on notification circuits to allow for those with hearing impairments to be accommodated as necessary. This spare capacity is intended to eliminate the potential for overloading notification circuits when a hearing-impaired person is hired and needs to be accommodated, but reduces the initial construction cost as such alarm notification appliances may not be necessary in every situation.

**907.5.2.3.2 Groups I-1 and R-1.** Group I-1 and R-1 *dwelling units* or *sleeping units* in accordance with Table 907.5.2.3.2 shall be provided with a visible alarm notification appliance, activated by both the in-room smoke alarm and the building fire alarm system.

❖ Fire alarm systems in Group I-1 and R-1 sleeping accommodations must be equipped with visible alarms to the extent stated in Table 907.6.2.3.3. The visible alarm notification devices in these rooms are to be activated by both the required in-room smoke alarm and the building fire alarm system. All visible alarm notification appliances in a building, however, need not be activated by individual room detectors. It is not a requirement that the accessible sleeping units be provided with visible alarm notification appliances even though some elderly patients or residents may be both mobility and hearing impaired.

**TABLE 907.5.2.3.2  
VISIBLE ALARMS**

NUMBER OF SLEEPING UNITS	SLEEPING ACCOMMODATIONS WITH VISIBLE ALARMS
6 to 25	2
26 to 50	4
51 to 75	7
76 to 100	9
101 to 150	12
151 to 200	14
201 to 300	17
301 to 400	20
401 to 500	22
501 to 1,000	5% of total
1,001 and over	50 plus 3 for each 100 over 1,000

❖ This table specifies the minimum number of sleeping units that are to be equipped with visible and audible alarms. The numbers are based on the total number of sleeping accommodations in the facility. The requirements in this table are intended to be consistent with the ADAAG.

**907.5.2.3.3 Group R-2.** In Group R-2 occupancies required by Section 907 to have a fire alarm system, all *dwelling units* and *sleeping units* shall be provided with the capability to support visible alarm notification appliances in accordance with Chapter 10 of ICC A117.1. Such capability shall be permitted to include the potential for future interconnection of the building fire alarm system with the unit smoke alarms, replacement of audible appliances with combination audible/visible appliances, or future extension of the existing wiring from the unit smoke alarm locations to required locations for visible appliances.

❖ At some time during the life of a Group R-2 building, one or more persons who are hearing impaired or deaf may reside in any given unit. As such, Group R-2 occupancies that are required to be equipped with a fire alarm system are also required to have the capability to support visual alarm notification appliances in accordance with Chapter 10 of ICC A117.1. This section is intended to provide guidance as to what is meant by “capability.” If a hearing-impaired occupant moves into the dwelling unit, the audible alarm notification appliances are simply replaced with visual alarm notification appliances. The intent is if one or more hearing impaired individuals move into a dwelling unit or sleeping unit within a Group R-2 occupancy, the circuit serving the occupant alarm notification appliances must be capable of supplying the necessary amperage to provide the required power to the listed visual alarm notification device. The intent is to design the fire alarm and detection system so that the occupant notification appliance circuit can accommodate a limited number of visual alarm notification appliances operating at the required minimum amperage.

Note that this requirement includes all dwelling and

sleeping units, not just those classified as either Type A or B as defined in Chapter 2 of the IBC. Sections 1006.2 through 1006.4.4 of ICC A117.1 address smoke and fire alarm system requirements as they pertain to accessible communication features. More specifically, Section 1006.2 of ICC A117 states that when unit smoke detection is provided, it shall provide audible notification appliances in compliance with NFPA 72. Section 1006.3 of ICC A117 is focused upon buildings where fire alarm systems are provided. If a fire alarm system is provided in the building, ICC A117.1 requires that the wiring be extended to a point within the unit in the vicinity of the smoke alarm or smoke detection system. Based upon the type of unit and the strategy used by the designer, this location may vary. Section 1006.4 of ICC A117 addresses the visible alarm notification appliance requirements specifically and has various issues it addresses, as follows:

1. Complies with Section 702 of ICC A117.1, which focuses on the requirements of NFPA 72 and that such notification devices be hardwired.
2. Addresses the fact that all visible notification devices be activated within the unit either when the smoke alarms in the unit activate or when that portion of the building fire alarm system in that portion of the building activate.
3. Allows the same visible notification for the smoke alarms in the unit and the building fire alarm system.
4. Prohibits the use of the visible notification for anything other than the operation of the smoke alarms in the unit or the building fire alarm system.

In terms of the specific capability requirements this section provides direction as to what may be meant by bringing the wiring to the unit. There has been confusion in the past and it has been interpreted that all units are required to be pre-wired for visible appliances, which was not the intent of ICC A117.1. More specifically, now the requirements provide essentially three options for future capability, as follows:

- Potential for future interconnection of the building fire alarm system with the unit smoke alarms.
- Replacement of audible appliance with combination audible/visible appliances.
- Extension of wiring from the unit smoke alarm locations to required locations of visible appliances.

It is important to remember that the location of visible notification devices, if installed, are driven by the requirements of NFPA 72 and may vary the approach taken, based upon the configuration of the space.

**907.6 Installation and monitoring.** A fire alarm system shall be installed and monitored in accordance with Sections 907.6.1 through 907.6.6.2 and NFPA 72.

❖ This section specifies the requirements for fire alarm system installation and monitoring and also references the installation requirements of NFPA 72.

**907.6.1 Wiring.** Wiring shall comply with the requirements of NFPA 70 and NFPA 72. Wireless protection systems utilizing radio-frequency transmitting devices shall comply with the special requirements for supervision of low-power wireless systems in NFPA 72.

❖ Wiring for fire alarm systems must be installed so that it is secure and will function reliably in an emergency. The code requires that the wiring for fire alarm systems meet the requirements of NFPA 70 and NFPA 72. This requirement is in addition to the general requirements for electrical installations set forth in Chapter 27 of the IBC. For reliability, systems that use radio-frequency transmitting devices for signal transmission are required to have supervised transmitting and receiving equipment that conforms to the special requirements contained in NFPA 72. This requirement is in addition to the general requirements for supervision in Section 907.6.6.

**907.6.2 Power supply.** The primary and secondary power supply for the fire alarm system shall be provided in accordance with NFPA 72.

**Exception:** Backup power for single-station and multiple-station smoke alarms as required in Section 907.2.11.6.

❖ The operation of fire alarm systems is essential to life safety in buildings and must be reliable in the event the normal power supply fails. For proper operation of fire alarm systems, this section requires that the primary and secondary power supplies comply with NFPA 72. This is in addition to the general requirements for electrical installations in Chapter 27 of the IBC. NFPA 72 offers three alternatives for secondary supply: a 24-hour storage battery; storage batteries with a 4-hour capacity; and a generator or multiple generators.

NFPA 72 requires that the primary and secondary power supplies for remotely located control equipment essential to the system operation must conform to the requirements for primary and secondary power supplies for the main system. Also, NFPA 72 contains requirements for monitoring the integrity of primary power supplies and requires a backup power supply.

**907.6.3 Initiating device identification.** The fire alarm system shall identify the specific initiating device address, location, device type, floor level where applicable and status including indication of normal, alarm, trouble and supervisory status, as appropriate.

**Exceptions:**

1. Fire alarm systems in single-story buildings less than 22,500 square feet (2090 m<sup>2</sup>) in area.

2. Fire alarm systems that only include manual fire alarm boxes, waterflow initiating devices and not more than 10 additional alarm-initiating devices.
3. Special initiating devices that do not support individual device identification.
4. Fire alarm systems or devices that are replacing existing equipment.

❖ Current technology makes identification of alarm initiating devices much easier. This section takes advantage of this technology to improve the ability of emergency responders to rapidly identify the location and status of initiating devices at the time of an emergency. It will also help identify problematic alarm initiating devices and thus reduce nuisance alarms. It also eliminates the requirements for providing zone indication of system status. This is considered particularly important in high-rise buildings, where the number of initiating devices and the geometry of the building warrant a need for point monitoring of individual devices, which is not currently accommodated by single floor zones.

This section allows the fire code official the flexibility to not require individual detection device identification in smaller buildings where the source of alarm and trouble signals can be more easily determined.

The 22,500 square foot limitation noted in Exception 1 relates to the size of a typical fire alarm zone (see Section 907.6.4) and represents a small building. Exception 2 addresses manual fire alarm systems in which the location of initiation may not be an indicator of where the fire actually is or an automatic sprinkler waterflow alarm initiating device which could be annunciating an entire building. Along with a very limited number of other alarm initiating devices, Exception 3 recognizes that some devices will not work with this requirement. Finally, Exception 4 provides flexibility to existing system replacement. Replacement should be encouraged and requiring identification of alarm initiating device locations is considered onerous.

**907.6.3.1 Annunciation.** The initiating device status shall be annunciated at an *approved* on-site location.

❖ This section specifically notes that the alarm initiating device status of trouble versus alarm needs to be provided in an approved location to enable rapid identification of problematic devices or alarm conditions by first responders.

**907.6.4 Zones.** Each floor shall be zoned separately and a zone shall not exceed 22,500 square feet (2090 m<sup>2</sup>). The length of any zone shall not exceed 300 feet (91 440 mm) in any direction.

**Exception:** *Automatic sprinkler system* zones shall not exceed the area permitted by NFPA 13.

❖ Since the fire alarm system also aids emergency personnel in locating the fire, the system must be zoned

to shorten response time to the fire location. Zoning is also critical if the fire alarm system initiates certain other fire protection systems or control features, such as smoke control systems.

At a minimum, each floor of a building must constitute one zone of the system. If the floor area exceeds 22,500 square feet (2090 m<sup>2</sup>), additional zones per floor are required. The maximum length of a zone is 300 feet (91 440 mm).

The exception states that NFPA 13 defines the maximum areas to be protected by one sprinkler system and that the sprinkler system need not be designed to meet the 22,500-square-foot (2090 m<sup>2</sup>) area limitations for a fire alarm system zone. For example, NFPA 13 permits a sprinkler system riser in a light-hazard occupancy to protect an area of 52,000 square feet (4831 m<sup>2</sup>) per floor. In accordance with the exception, a single water flow switch, and consequently a single fire alarm system zone, would be acceptable. If other alarm-initiating devices are present on the floor, they would need to be zoned separately to meet the 22,500-square-foot (2098 m<sup>2</sup>) limitation.

It is not intended that this section apply to sprinkler systems. This section only applies where a fire alarm system is required in accordance with Section 907. Unless the building is categorized as a high rise and must comply with Section 907.6.4.2, the code does not mandate the zoning of sprinkler systems per floor. With today's fully addressable fire alarm systems, each detector effectively becomes its own zone. The intent with zoning is to identify and limit the search area for fire alarm systems. Addressable devices will indicate the precise location of the alarm condition, thereby eliminating the need for the zoning contemplated by this section when approved by the fire code official in accordance with Section 104.9.

**907.6.4.1 Zoning indicator panel.** A zoning indicator panel and the associated controls shall be provided in an *approved* location. The visual zone indication shall lock in until the system is reset and shall not be canceled by the operation of an audible alarm-silencing switch.

❖ The zoning indicator panel, which can be the fire alarm control unit or a separate fire alarm annunciator panel (FAAP), must be installed in a location approved by the fire code official. One of the key considerations in determining panel placement is whether or not the panel is located to permit ready access by emergency responders. Once an alarm-initiating device within a zone has been activated, the annunciation of the zone must lock in until the system is reset.

**907.6.4.2 High-rise buildings.** In high-rise buildings, a separate zone by floor shall be provided for each of the following types of alarm-initiating devices where provided:

1. Smoke detectors.
2. Sprinkler waterflow devices.

3. Manual fire alarm boxes.

4. Other *approved* types of automatic fire detection devices or suppression systems.

❖ High-rise buildings must have a separate zone by floor for each indicated type of alarm-initiating device. Although this feature may be desirable in all buildings, the incremental cost difference is substantially higher in low-rise buildings in which basic fire alarm systems are installed. State-of-the-art fire alarm systems installed in high-rise buildings are addressable and by their nature automatically provide this minimum zoning.

**907.6.5 Access.** Access shall be provided to each fire alarm device and notification appliance for periodic inspection, maintenance and testing.

❖ Automatic fire detectors, especially smoke detectors, require periodic cleaning to reduce the likelihood of malfunction. Section 907.8 and NFPA 72 require inspection and testing at regular intervals. Access to perform the required inspections, necessary maintenance and testing is a particularly important consideration for those detectors that are installed within a concealed space, such as an air duct.

**907.6.6 Monitoring.** Fire alarm systems required by this chapter or by the *International Building Code* shall be monitored by an *approved* supervising station in accordance with NFPA 72.

**Exception:** Monitoring by a supervising station is not required for:

1. Single- and multiple-station smoke alarms required by Section 907.2.11.
2. Smoke detectors in Group I-3 occupancies.
3. *Automatic sprinkler systems* in one- and two-family dwellings.

❖ Fire alarm systems required by Section 907 or the IBC are required to be electrically supervised by one of the methods prescribed in NFPA 72.

Exception 1 exempts single- and multiple-station smoke alarms from being supervised due to the potential for unwanted false alarms.

Exception 2 recognizes a similar problem in Group I-3 occupancies. Accordingly, due to the concern over unwanted alarms, smoke detectors in Group I-3 occupancies need only sound an approved alarm signal that automatically notifies staff (see Section 907.2.6.3.1). Smoke detectors in such occupancies are typically subject to misuse and abuse, and frequent unwanted alarms would negate the effectiveness of the system.

Exception 3 clarifies that sprinkler systems in one- and two-family dwellings are not part of a dedicated fire alarm system and are typically designed in accordance with NFPA 13D, which does not require electrical supervision.

**907.6.6.1 Automatic telephone-dialing devices.** Automatic telephone-dialing devices used to transmit an emergency alarm shall not be connected to any fire department telephone number unless *approved* by the fire chief.

- ❖ Upon initiation of an alarm, supervisory or trouble signal, an automatic telephone-dialing device takes control of the telephone line for the reliability of transmission of all signals. The device, however, must not be connected to the fire department telephone number unless specifically approved by the fire department because that could disrupt any potential emergency (911) calls. NFPA 72 contains additional guidance on such devices including digital alarm-communicator systems.

**907.6.6.2 Termination of monitoring service.** Termination of fire alarm monitoring services shall be in accordance with Section 901.9.

- ❖ This section is simply an editorial cross-reference to highlight Section 901.9, which affects the monitoring requirements of Section 907.6.6 (see commentary, Section 901.9).

**907.7 Acceptance tests and completion.** Upon completion of the installation, the fire alarm system and all fire alarm components shall be tested in accordance with NFPA 72.

- ❖ A complete performance test of the fire alarm system must be conducted to determine that the system is operating as required by the code. The acceptance test must include a test of each circuit, alarm-initiating device, alarm notification appliance and any supplementary functions, such as activation of closers and dampers. The operation of the primary and secondary (emergency) power supplies must also be tested, as well as the supervisory function of the control panel. Section 901.5 assigns responsibility for conducting the acceptance tests to the owner or the owner's representative.

NFPA 72 contains specific acceptance test procedures. Additional guidance on periodic testing and inspection can be also obtained from Section 907.8 and NFPA 72.

**907.7.1 Single- and multiple-station alarm devices.** When the installation of the alarm devices is complete, each device and interconnecting wiring for multiple-station alarm devices shall be tested in accordance with the smoke alarm provisions of NFPA 72.

- ❖ To determine that smoke alarms have been properly installed and are ready to function as intended, they must be actuated during an acceptance test. The test also confirms that interconnected detectors will operate simultaneously as required. The responsibility for conducting the acceptance tests rests with the owner or the owner representative as stated in Section 901.5.

**907.7.2 Record of completion.** A record of completion in accordance with NFPA 72 verifying that the system has been

installed and tested in accordance with the *approved* plans and specifications shall be provided.

- ❖ In accordance with NFPA 72, this section requires a written statement from the installing contractor that the fire alarm system has been tested and installed in compliance with the approved plans and the manufacturer's specifications. Any deviations from the approved plans or the applicable provisions of NFPA 72 are to be noted in the record of completion.

**907.7.3 Instructions.** Operating, testing and maintenance instructions and record drawings ("as built") and equipment specifications shall be provided at an *approved* location.

- ❖ To permit adequate testing, maintenance and trouble-shooting of the installed fire alarm system, an owner's manual with complete installation instructions must be kept on site or in another approved location. The instructions include a description of the system, operating procedures and testing and maintenance requirements.

**907.8 Inspection, testing and maintenance.** The maintenance and testing schedules and procedures for fire alarm and fire detection systems shall be in accordance with Sections 907.8.1 through 907.8.5 and NFPA 72. Records of inspection, testing and maintenance shall be maintained.

- ❖ Fire alarms and fire detection systems are to be inspected, tested and maintained in accordance with Sections 907.8.1 through 907.8.5 and the applicable requirements of NFPA 72. It is the building owner's responsibility to keep these systems operable at all times.

**907.8.1 Maintenance required.** Where required for compliance with the provisions of this code, devices, equipment, systems, conditions, arrangements, levels of protection or other features shall thereafter be continuously maintained in accordance with applicable NFPA requirements or as directed by the *fire code official*.

- ❖ Periodic maintenance keeps systems in good working order or allows repair of defects discovered during inspections or testing. Because specialized tools and training are needed, only properly trained technicians or specialists should perform required periodic maintenance. Most maintenance is required only as needed, but many manufacturers suggest or require regular periodic replacement of parts subject to wear or abuse.

**907.8.2 Testing.** Testing shall be performed in accordance with the schedules in NFPA 72 or more frequently where required by the *fire code official*. Records of testing shall be maintained.

**Exception:** Devices or equipment that are inaccessible for safety considerations shall be tested during scheduled shutdowns where *approved* by the *fire code official*, but not less than every 18 months.

- ❖ NFPA 72 includes schedules for testing frequencies of fire alarm and fire detection systems and their

components. Periodic tests that follow standardized methods are intended to confirm the results of inspections, determine that all components function properly and that systems meet their original design specifications. Tools, devices or equipment are usually required to perform tests. Because tests are more detailed than inspections, they are usually done only once or twice per year in most cases. Some tests, however, may be required as frequently as bimonthly or quarterly. Because specialized knowledge and equipment are required, tests must usually be performed by technicians or specialists trained in the test methods involved.

Although Section 907.8.2 specifically addresses testing, NFPA 72 also contains schedules for visual inspection frequencies. An inspection consists of a visual check of a system or device to verify it is in operating condition and free from visible defects or damage.

Obvious damage and the general condition of the system must always be noted and recorded. Partly because of their cursory nature, inspections are conducted more frequently than tests and maintenance. Because special knowledge and tools are not required, inspections may be done by any competent person.

The exception recognizes the impracticality of testing every device or piece of equipment related to a fire alarm or fire detection system. Some devices may be inaccessible for safety considerations, such as those in continuous process operations. Testing, however, must be done during scheduled shutdowns.

**907.8.3 Smoke detector sensitivity.** Smoke detector sensitivity shall be checked within one year after installation and every alternate year thereafter. After the second calibration test, where sensitivity tests indicate that the detector has remained within its *listed* and marked sensitivity range (or 4-percent obscuration light grey smoke, if not marked), the length of time between calibration tests shall be permitted to be extended to not more than 5 years. Where the frequency is extended, records of detector-caused nuisance alarms and subsequent trends of these alarms shall be maintained. In zones or areas where nuisance alarms show any increase over the previous year, calibration tests shall be performed.

❖ Usually, changes in detector sensitivity are caused by inadequate maintenance. Regular sensitivity testing is intended to determine whether detectors require recalibration, maintenance or replacement. This section prescribes the intervals for testing smoke detector sensitivity. Where two successful tests have been conducted, the frequency of the calibration tests can be extended to a maximum of five years. This interval extension recognizes the stability of both the environment and the detector. However, if nuisance alarms occur during this time interval extension, calibration tests may be needed because of potential changes in the environment where the detector is located or in the performance of the detector itself.

**907.8.4 Sensitivity test method.** To verify that each smoke detector is within its *listed* and marked sensitivity range, it shall be tested using one of the following methods:

1. A calibrated test method.
2. The manufacturer's calibrated sensitivity test instrument.
3. *Listed* control equipment arranged for the purpose.
4. A smoke detector/control unit arrangement whereby the detector causes a signal at the control unit where the detector's sensitivity is outside its acceptable sensitivity range.
5. Another calibrated sensitivity test method acceptable to the *fire code official*.

Detectors found to have a sensitivity outside the *listed* and marked sensitivity range shall be cleaned and recalibrated or replaced.

**Exceptions:**

1. Detectors *listed* as field adjustable shall be permitted to be either adjusted within the *listed* and marked sensitivity range and cleaned and recalibrated or they shall be replaced.
  2. This requirement shall not apply to single-station smoke alarms.
- ❖ This section prescribes acceptable test methods to verify that each smoke detector is within its listed and marked sensitivity range; any of the listed test methods may be used.

With regard to a calibration test method, many manufacturers have designed their devices to be tested by the application of a magnet at a test point on the outside of the detector. This activates a reed switch or pulls a fine wire into the detection chamber to simulate a predetermined level of obscuration.

Another test method may require that a test device such as a key-type tool be inserted in a test port. This either activates a test switch or produces the desired level of obscuration directly.

One detector manufacturer supplies an interface device for connecting a volt-ohm-amp meter to a test port. Pressing a button on the interface device permits a direct reading of detector chamber voltage in an alarm condition.

Other detectors must be removed and inserted in or connected to a device used to calibrate and test the device. The calibrated sensitivity test instrument must satisfy the manufacturer's recommendation for a specific detector.

Addressable/analog-type detectors produce direct readings of the chamber voltage by the control unit. Many of these systems permit sensitivity adjustments within acceptable limits from the control unit as well. This test method essentially allows remote sensitivity testing.

A system control/detector combination unit detects changes in the environment and in the detector by

comparing current readings to previously stored information in the memory of the control unit. Significant changes would indicate that the stability of either the environment or the detector has changed and that further maintenance or recalibration is required.

Any other method or device that permits the user to check the voltage drop across a smoke detection chamber is acceptable subject to the approval of the fire code official. Test devices should be manufactured and supplied by the smoke detector manufacturer.

Exception 1 recognizes that some smoke detectors may be listed as being field-adjustable. If, however, such devices cannot be adjusted to their listed sensitivity, then they must be replaced.

Exception 2 exempts single station smoke alarms from sensitivity testing because these devices are not designed with the same level of technical sophistication as system smoke detectors. Smoke alarm manufacturers also recommend that the devices be discarded and replaced at regular intervals to reduce the likelihood of failure.

**907.8.4.1 Sensitivity testing device.** Smoke detector sensitivity shall not be tested or measured using a device that administers an unmeasured concentration of smoke or other aerosol into the detector.

❖ Functional testing using smoke or a smoke substitute, such as aerosols, must comply with the manufacturer's recommended test procedures. A precisely measured amount of smoke or other aerosol product must be used to adequately determine detector sensitivity. Some detector manufacturers do not accept testing with aerosol products and void detector warranties when this product is used. The functional test method selected should not permanently affect detector performance.

**907.8.5 Inspection, testing and maintenance.** The building owner shall be responsible to maintain the fire and life safety systems in an operable condition at all times. Service personnel shall meet the qualification requirements of NFPA 72 for inspection, testing and maintenance of such systems. Records of inspection, testing and maintenance shall be maintained.

❖ This section clearly indicates that it is the responsibility of the building owner to maintain all fire alarm systems in proper working order. Often, an outside agency that employs adequately trained personnel will provide any maintenance and testing that is needed. NFPA 72 contains additional guidance on the qualifications for service personnel. Some examples include factory trained and certified individuals; individuals certified for fire alarm by the NICET or other individuals tested and certified by the local authority. Proper maintenance of fire alarm systems is essential so that the systems will perform as intended.

Inspection and test records provide a means for determining compliance with the requirements of the code. Inspectors should be prepared to determine

that inspection, test and maintenance logs are accurate and complete. Records must include the nature of the activity or service performed; when the activity occurred; who performed the activity and who witnessed testing or approved the work upon completion.

**907.9 Where required in existing buildings and structures.** An approved fire alarm system shall be provided in existing buildings and structures where required in Chapter 11.

❖ Retroactive requirements for fire alarms are found in Section 1103.7. All the retroactive code requirements are found in Chapter 11 for convenience and to help with consistent enforcement.

## SECTION 908 EMERGENCY ALARM SYSTEMS

**908.1 Group H occupancies.** Emergency alarms for the detection and notification of an emergency condition in Group H occupancies shall be provided as required in Chapter 50.

❖ Emergency alarm systems provide indication and warning of emergency situations involving hazardous materials. An emergency alarm system is required in all Group H occupancies as indicated in Sections 5004.9 and 5005.4.4 as well as Group H-5 HPM facilities as indicated in Section 908.2. The Group H occupancy classification assumes the storage or use of hazardous materials exceeds the maximum allowable quantities specified in Tables 5003.1.1(1) and 5003.1.1(2).

An emergency alarm system should include an emergency alarm-initiating device outside each interior door of hazardous material storage areas, a local alarm device and adequate supervision.

Even though ozone gas-generator rooms (Section 908.4), repair garages (Section 908.5) and refrigeration systems (Section 908.6) are not typically classified as Group H occupancies, the potential hazards associated with these occupancy conditions are great enough to require additional means of early warning detection.

**908.2 Group H-5 occupancy.** Emergency alarms for notification of an emergency condition in an HPM facility shall be provided as required in Section 2703.12. A continuous gas detection system shall be provided for HPM gases in accordance with Section 2703.13.

❖ In addition to hazardous material storage areas as regulated by Section 5004.9, Section 2703.12.1 also requires emergency alarms for service corridors, exit access corridors and interior exit stairways because of the potential transport of hazardous materials through these areas. Section 2703.13 requires a continuous gas detection system for early detection of leaks in areas where HPM gas is used. Gas detection systems are required to initiate a local alarm and

transmit a signal to the emergency control station upon detection (see commentary, Sections 2703.12 and 2703.13).

**908.3 Highly toxic and toxic materials.** Where required by Section 6004.2.2.10, a gas detection system shall be provided for indoor storage and use of highly toxic and toxic *compressed gases*.

- ❖ A gas detection system in the room or area utilized for indoor storage or the use of highly toxic or toxic gases provides early notification of a leak that is occurring before the escaping gas reaches hazardous exposure concentration levels. The exception recognizes that certain toxic compressed gases do not pose a severe exposure hazard. Those toxic gases whose properties under standard conditions are still below the 8-hour weighted average concentration for the permitted exposure limit (PEL) are exempt from the requirement for a gas detection system.

This section also specifies the discharge requirements for treatment system performance to establish a maximum allowable concentration of highly toxic or toxic gases at the point of discharge to the atmosphere. The concentration level of one-half the immediately dangerous to life and health (IDLH) limit represents a minimum acceptable level of dilution at the point of discharge where the location of discharge is away from the general public. Where the treatment system processes more than one type of compressed gas, the maximum allowable concentration must be based on the release rate, quantity and IDLH for the gas that poses the worst-case release scenario.

**908.4 Ozone gas-generator rooms.** A gas detection system shall be provided in ozone gas-generator rooms in accordance with Section 6005.3.2.

- ❖ To monitor the potential buildup of dangerous levels of ozone, a gas detection system is required to, upon actuation, shut off the generator and sound a local alarm. Ozone gas generators are commonly used in water treatment applications. The ozone gas-generator room should not be a normally occupied area or be used for the storage of combustibles or other hazardous materials. Section 6005 contains additional requirements for ozone gas generators.

**908.5 Repair garages.** A flammable-gas detection system shall be provided in repair garages for vehicles fueled by nonodorized gases in accordance with Section 2311.7.2.

- ❖ As indicated in Section 2311.7.2, an approved flammable-gas detection system is required for garages used for repair of vehicles fueled by nonodorized gases, such as hydrogen and nonodorized LNG. To prevent a hazardous potential buildup of flammable gas caused by normal leakage and use conditions, the flammable-gas detection system is required to activate when the level of flammable gas exceeds 25 percent of the lower explosive limit (LEL) (see commentary, Section 2311.7.2).

**908.6 Refrigeration systems.** Refrigeration system machinery rooms shall be provided with a refrigerant detector in accordance with Section 606.9.

- ❖ A refrigerant-specific detector is required for leak detection, early warning and actuation of emergency exhaust systems. Because most general machinery rooms are unoccupied for long periods of time, a refrigeration leak may go undetected, allowing a buildup of refrigerant that can pose a threat to building occupants and the maintenance personnel who must enter the machinery room. Also, the refrigerants may or may not be detectable by the sense of smell, depending on the chemical nature and concentration in the air of the refrigerant. This can be especially critical when a toxic refrigerant is used in the refrigeration system (see commentary, Section 606.8). Even where the refrigerant is not toxic, sufficient quantities can displace oxygen and create an untenable environment. Detection is necessary to avoid a condition where the oxygen level drops below safe levels.

**908.7 Carbon dioxide (CO<sub>2</sub>) systems.** Emergency alarm systems in accordance with Section 5307.5.2 shall be provided where required for compliance with Section 5307.5.

- ❖ This is simply cross references to requirements in Chapter 53 related to the danger of CO<sub>2</sub> asphyxiation and intended to address fatal CO<sub>2</sub> poisoning incidents in restaurants where CO<sub>2</sub> leaked from large storage tanks for beverage mixing and displaced oxygen in these areas. See the commentary to Section 5307.5.

## SECTION 909 SMOKE CONTROL SYSTEMS

**909.1 Scope and purpose.** This section applies to mechanical or passive smoke control systems where they are required for new buildings or portions thereof by provisions of the *International Building Code* or this code. The purpose of this section is to establish minimum requirements for the design, installation and acceptance testing of smoke control systems that are intended to provide a tenable environment for the evacuation or relocation of occupants. These provisions are not intended for the preservation of contents, the timely restoration of operations or for assistance in fire suppression or overhaul activities. Smoke control systems regulated by this section serve a different purpose than the smoke- and heat-venting provisions found in Section 910. Mechanical smoke control systems shall not be considered exhaust systems under Chapter 5 of the *International Mechanical Code*.

- ❖ This section is clarifying the intent of smoke control provisions, which is to provide a tenable environment to occupants during evacuation and relocation and not to protect the contents, enable timely restoration of operations or facilitate fire suppression and overhaul activities. There are provisions for high rise buildings in Section 403.4.7 of the IBC that are focused upon the removal of smoke for post fire and overhaul operations which is very different than the

smoke control provisions in Section 909. Another element addressed in this section is that smoke control systems serve a different purpose than smoke and heat vents (see Section 910). This eliminates any confusion that smoke and heat vents can be used as a substitution for smoke control. Additionally, a clarification is provided to note that smoke control systems are not considered an exhaust system in accordance with Chapter 5 of the IMC. This is due to the fact that such systems are unique in their operation and are not necessarily designed to exhaust smoke but are focused upon tenability for occupants during egress. It should be noted that the smoke control provisions are duplicated in Chapter 5 of the IMC.

It is important to note that these provisions only apply when smoke control is required by other sections of the code. The code requires smoke management within atrium spaces (see Section 404.5 of the IBC) and underground buildings (see Section 405.5 of the IBC). High-rise facilities require smokeproof exit enclosures in accordance with Sections 909.20 of the IBC and 1019.1.8 (see Section 403.5.4 of the IBC). Also, covered mall buildings that contain atriums that connect more than two stories require smoke control (see Section 402.7.2 of the IBC).

Section 909 focuses primarily on mechanical smoke control systems but there are many instances within the code where smoke is required to be managed in a passive way through the use of concepts such as smoke compartments. Smoke compartments are formed through the use of smoke barriers in accordance with Section 709 of the IBC. Smoke barriers can be used simply as a passive smoke management system or can be a design component of a mechanical smoke control system in accordance with Section 909. Some examples of occupancies requiring passive systems include hospitals, nursing and similar facilities (Group I-2 occupancies) and detention facilities (Group I-3 occupancies) (see Sections 407.5 and 408.6 of the IBC).

In some cases, mechanical smoke control in accordance with Section 909 is allowed as an option for compliance. More specifically if a Group I-3 contains windowless areas of the facility natural or mechanical smoke management is required (see Section 408.9 of the IBC).

In the last several years, smoke control provisions have become more complex. The reason is related to the fact that smoke is a complex problem, while a generic solution of six air changes has repeatedly and scientifically been shown to be inadequate. Six air changes per hour does not take into account factors such as buoyancy; expansion of gases; wind; the geometry of the space and of communicating spaces; the dynamics of the fire, including heat release rate; the production and distribution of smoke and the interaction of the building systems.

Smoke control systems can be either passive or active. Active systems are sometimes referred to as mechanical. Passive smoke control systems take

advantage of smoke barriers surrounding the zone in which the fire event occurs or high bay areas that act as reservoirs to control the movement of smoke to other areas of the building. Active systems utilize pressure differences to contain smoke within the event zone or exhaust flow rates sufficient to slow the descent of the upper-level smoke accumulation to some predetermined position above necessary exit paths through the event zone. On rare occasions, there is also a possibility of controlling the movement of smoke horizontally by opposed airflow, but this method requires a specific architectural geometry to function properly that does not create an even greater hazard.

Essentially, there are three methods of mechanical or active smoke control that can be used separately or in combination within a design: pressurization, exhaust and, in rare and very special circumstances, opposed airflow.

Of course, all of these active approaches can be used in combination with the passive method.

Typically, the mechanical pressurization method is used in high-rise buildings when pressurizing stairways and for zoned smoke control. Pressurization is not practical in large open spaces such as atriums or malls, since it is difficult to develop the required pressure differences due to the large volume of the space.

The exhaust method is typically used in large open spaces such as atriums and malls. As noted, the pressurization method would not be practical within large spaces. The opposed airflow method, which basically uses a velocity of air horizontally to slow the movement of smoke, is typically applied in combination with either a pressurization method or exhaust method within hallways or openings into atriums and malls.

The application of each of these methods will be dependent on the specifics of the building design. Smoke control within a building is fundamentally an architecturally driven problem. Different architectural geometries first dictate the need or lack thereof for smoke control, and then define the bounds of available solutions to the problem.

**909.2 General design requirements.** Buildings, structures, or parts thereof required by the *International Building Code* or this code to have a smoke control system or systems shall have such systems designed in accordance with the applicable requirements of Section 909 and the generally accepted and well-established principles of engineering relevant to the design. The *construction documents* shall include sufficient information and detail to describe adequately the elements of the design necessary for the proper implementation of the smoke control systems. These documents shall be accompanied with sufficient information and analysis to demonstrate compliance with these provisions.

❖ This section simply states that when smoke control systems are required by the code, the design is required to be in accordance with the provisions of

this section. As noted in the commentary to Section 909.1, there are instances within the code that have smoke management systems that are purely passive in nature and do not reference Section 909.

This section stresses that such designs need to follow “generally accepted and well-established principles of engineering relevant to the design,” essentially requiring a certain level of qualifications in the applicable areas of engineering to prepare such designs. The primary engineering disciplines tend to be fire engineering and mechanical engineering. It should be noted that each state in the U.S. typically requires minimum qualifications to undertake engineering design. Two important resources when designing smoke control systems are the International Code Council’s (ICC) *Guide to Smoke Control in the 2006 IBC* and *American Society of Heating, Refrigerating and Air-Conditioning Engineers’ (ASHRAE) Design of Smoke Management Systems*. Additionally, Section 909.8 requires the use of NFPA 92 for the design of smoke control systems using the exhaust method. This standard has many relevant aspects beyond the design that are beneficial. In particular, Annex B provides resources in terms of determination of fire size for design. ICC’s *Guide to Smoke Control in the 2006 IBC* also provides guidance on design fires.

A key element covered in this section is the need for detailed and clear construction documents so that the system is installed correctly. In most complex designs, the key to success is appropriate communication to the contractors as to what needs to be installed. The more complex a design becomes, the more likely there is to be construction errors. Most smoke control systems are complex, which is why special inspections in accordance with Section 909.3 and Chapter 17 of the IBC are critical for smoke control systems. Additionally, in order for the design to be accepted, analyses and justifications need to be provided in enough detail to evaluate for compliance. Adequate documentation is critical to the commissioning, inspection, testing and maintenance of smoke control systems and significantly contributes to the overall reliability and effectiveness of such systems.

**909.3 Special inspection and test requirements.** In addition to the ordinary inspection and test requirements that buildings, structures and parts thereof are required to undergo, smoke control systems subject to the provisions of Section 909 shall undergo special inspections and tests sufficient to verify the proper commissioning of the smoke control design in its final installed condition. The design submission accompanying the *construction documents* shall clearly detail procedures and methods to be used and the items subject to such inspections and tests. Such commissioning shall be in accordance with generally accepted engineering practice and, where possible, based on published standards for the particular testing involved. The special inspections and tests

required by this section shall be conducted under the same terms as in Section 1704 of the *International Building Code*.

❖ Due to the complexity and uniqueness of each design, special inspection and testing must be conducted. The designer needs to provide specific recommendations for special inspection and testing within his or her documentation. In fact, the code specifies in Chapter 17 of the IBC that special inspection agencies for smoke control have expertise in fire protection engineering, mechanical engineering and certification as air balancers. Since the designs are unique to each building, there probably will not be a generic approach available to inspect and test such systems. The designer can and should, however, use any available published standards or guides when developing the special inspection and testing requirements for that particular design. ICC’s *Guide to Smoke Control in the 2006 IBC* provides some background on such inspections. Also, ASHRAE Guideline 5 is a good starting place but only as a general outline. In addition, NFPA 92A and NFPA 92B also have extensive testing, documentation and maintenance requirements that may be a good resource. NFPA 92B is referenced in Section 909.8 for the design of smoke control systems using the exhaust method. Each system will require a unique commissioning plan that can be developed only after careful and thoughtful examination of the final design and all of its components and interrelationships. Generally, these provisions may be included in design standards or engineering guides.

**909.4 Analysis.** A rational analysis supporting the types of smoke control systems to be employed, the methods of their operations, the systems supporting them and the methods of construction to be utilized shall accompany the *construction documents* submission and include, but not be limited to, the items indicated in Sections 909.4.1 through 909.4.7.

❖ This section indicates that simply determining airflow, exhaust rates and pressures to maintain tenable conditions is not adequate. There are many factors that could alter the effectiveness of a smoke control system, including stack effect, temperature effect of fire, wind effect, heating, ventilating and air-conditioning (HVAC) system interaction and climate, as well as the placement, quantity of inlets/outlets and velocity of supply and exhaust air. These factors are addressed in the sections that follow. Additionally, the duration of operation of any smoke control system is mandated at a minimum of 20 minutes or 1.5 times the egress time, whichever is less. The code cannot reasonably anticipate every conceivable building arrangement and condition the building may be subject to over its life and must depend on such factors being addressed through a rational analysis.

**909.4.1 Stack effect.** The system shall be designed such that the maximum probable normal or reverse stack effect will not adversely interfere with the system’s capabilities. In deter-

mining the maximum probable stack effect, altitude, elevation, weather history and interior temperatures shall be used.

❖ Stack effect is the tendency for air to rise within a heated building when the temperature is colder on the exterior of the building. Reverse stack effect is the tendency for air to flow downward within a building when the interior is cooler than the exterior of the building. This air movement can affect the intended operation of a smoke control system. If stack effect is great enough, it may overcome the pressures determined during the design analyses and allow smoke to enter areas outside the zone of origin (see Commentary Figure 909.4.1).

**909.4.2 Temperature effect of fire.** Buoyancy and expansion caused by the design fire in accordance with Section 909.9 shall be analyzed. The system shall be designed such that these effects do not adversely interfere with the system’s capabilities.

❖ This section requires that the design account for the effect temperature may have on the success of the system. When air or any gases are heated, they will expand. This expansion makes the gases lighter and, therefore, more buoyant. The buoyancy of hot gases is important when the design is to exhaust such gases from a location in or close to the ceiling; therefore, if sprinklers are part of the design, as required by Section 909, the gases may be significantly cooler than an unsprinklered fire, making it more difficult to remove the smoke and alter the plume dynamics. The fact that air expands when heated needs to be accounted for in the design.

When using the pressurization method, the expansion of hot gases needs to be accounted for, since it will take a larger volume of air to create the necessary pressure differences to maintain the area of fire origin in negative pressure. The expansion of the gases has the effect of pushing the hot gases out of the area of fire origin. Since sprinklers will tend to cool the gases, the effect of expansion is lower. The pressure differences required in Section 909.6.1 are

specifically based on a sprinklered building. If the building is nonsprinklered, higher pressure differences may be required. The minimum pressure difference for certain unsprinklered ceiling height buildings is as follows:

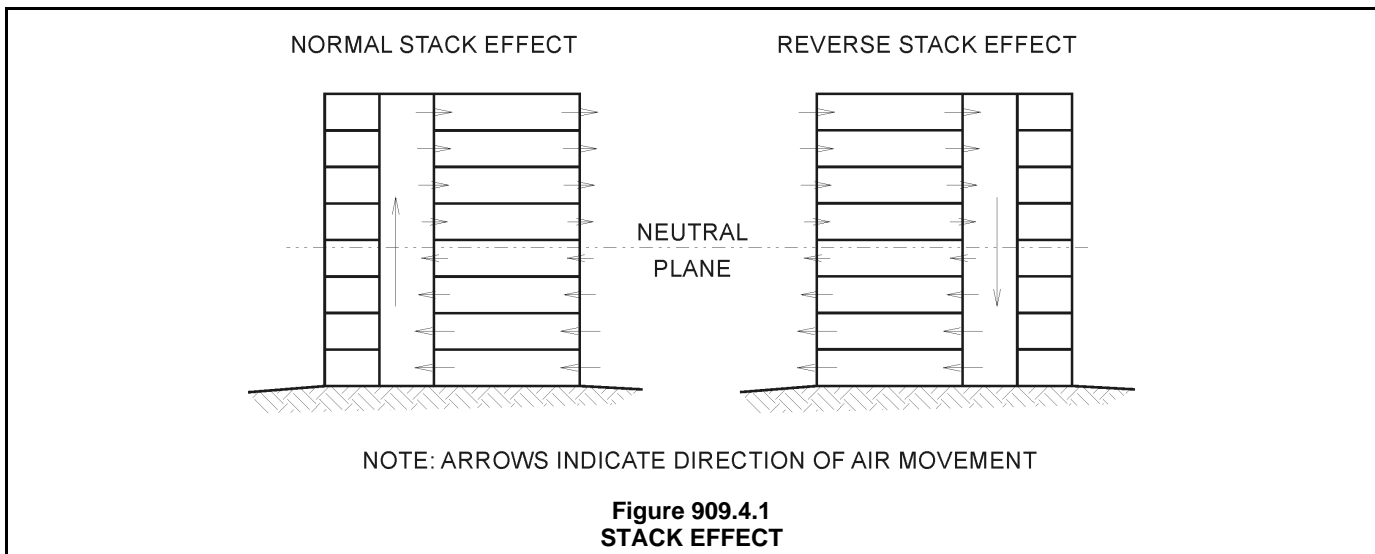
Ceiling height (feet)	Minimum pressure difference (inch water gage)
9	0.10
15	0.14
21	0.18

This is a very complex issue that needs to be part of the design analysis. It needs to address the type and reaction of the fire protection systems, ceiling heights and the size of the design fire.

**909.4.3 Wind effect.** The design shall consider the adverse effects of wind. Such consideration shall be consistent with the wind-loading provisions of the *International Building Code*.

❖ The effect of wind on a smoke control system within a building is very complex. It is generally known that wind exerts a load upon a building. The loads are looked at as windward (positive pressure) and leeward (negative pressure). The velocity of winds will vary based on the terrain and the height above grade; therefore, the height of the building and surrounding obstructions will have an effect on these velocities. These pressures alter the operation of fans, especially propeller fans, thus altering the pressure differences and airflow direction in the building. There is not an easy solution to dealing with these effects. In fact, little research has been done in this area.

It should be noted that in larger buildings a wind study is normally undertaken for the structural design. The data from those studies can be used in the analysis of the effects on the pressures and airflow within the building with regard to the performance of the smoke control system.



**909.4.4 Systems.** The design shall consider the effects of the heating, ventilating and air-conditioning (HVAC) systems on both smoke and fire transport. The analysis shall include all permutations of systems status. The design shall consider the effects of the fire on the heating, ventilating and air-conditioning systems.

❖ If not properly configured to shut down or be included as part of the design, the HVAC system can alter the smoke control design. More specifically, if dampers are not provided between smoke zones within the HVAC system ducts, smoke could be transported from one zone to another. Additionally, if the HVAC system places more supply air than assumed for the smoke control system design, the velocity of the air may adversely affect the fire plume or a positive pressure may be created. Generally, an analysis of the smoke control design and the HVAC system in all potential modes should occur and be noted within the design documentation as well as incorporated into inspection, testing and maintenance procedures. This is critical as these systems need to be maintained and tested to help ensure that they operate and shut down systems as required.

**909.4.5 Climate.** The design shall consider the effects of low temperatures on systems, property and occupants. Air inlets and exhausts shall be located so as to prevent snow or ice blockage.

❖ This section is focused on properly protecting equipment from weather conditions that may affect the reliability of the design. For instance, extremely cold or hot air may damage critical equipment within the system when pulled directly from the outside. Some listings of duct smoke detectors are for specific temperature ranges; therefore, placing such detectors within areas exposed to extreme temperatures may void the listing. Also, the equipment and air inlets and outlets should be designed and located so as to not collect snow and ice that could block air from entering or exiting the building.

**909.4.6 Duration of operation.** All portions of active or engineered smoke control systems shall be capable of continued operation after detection of the fire event for a period of not less than either 20 minutes or 1.5 times the calculated egress time, whichever is greater.

❖ The intent of the smoke control provisions is to provide a tenable environment for occupants to either evacuate or relocate to a safe place. Evacuation and relocation activities include notifying occupants, possible investigation time for occupants, decision time and the actual travel time. In order to achieve this goal, the code has established 20 minutes or 1.5 times the calculated egress time, whichever is greater, as a minimum time for evacuation or relocation. Basically, this allows a designer to undertake an analysis to more closely determine the necessary time required. The code provides a safety factor of 1.5 times the egress time to account for uncertainty related to human behavior. It is stressed that the 20-

minute duration as well as the calculated egress time, whichever approach is chosen, begins after the detection of the fire event and notification to the building occupants to evacuate has occurred, since occupants need to be alerted before evacuation can occur. The calculation of evacuation time needs to include delays with notification and the start of evacuation (i.e., premovement time, etc.). It is stressed that the code states 20 minutes or 1.5 times the egress time, whichever is greater (i.e., 20 minutes is a minimum). Egress of occupants can be addressed through hand calculations or through the use of computerized egress models. Some of the more advanced models can address a variety of factors, including the building layout, different sizes of people, different movement speeds and different egress paths available. With these types of programs, the actual time can be even more precisely calculated. Of course it is cautioned that in many cases these models provide the optimal time for egress. The safety factor of 1.5 within the code is intended to address many of these uncertainties.

Note that this section applies to all types of smoke control designed in accordance with Section 909. Also, most smoke control systems will typically have the ability to run for much longer than 20 minutes as they are on standby power and may be able to continue to achieve the tenability goals.

System response as required in Section 909.17 needs to be accounted for when determining the ability of the smoke control system to keep the smoke layer interface at the appropriate level (see commentary, Section 909.17).

**909.4.7 Smoke control system interaction.** The design shall consider the interaction effects of the operation of multiple smoke control systems for all design scenarios.

❖ The focus of this section is related to the interaction of multiple mechanical smoke control systems by asking for a specific analysis of the interaction of such systems similar to that required for the interaction of HVAC systems. Where hoistway pressurization is chosen as an option for compliance with the hoistway opening protection requirements, the potential exists for a pressurized stair system to also be present. These two systems need to be able to operate at the same time without a negative impact on either system. It is also possible that an atrium with a smoke control system is located in a building containing a stair pressurization system.

**909.5 Smoke barrier construction.** *Smoke barriers* required for passive smoke control and a smoke control system using the pressurization method shall comply with Section 709 of the *International Building Code*. *Smoke barriers* shall be constructed and sealed to limit leakage areas exclusive of protected openings. The maximum allowable leakage area shall be the aggregate area calculated using the following leakage area ratios:

1. Walls:  $A/A_w = 0.00100$

2. Interior *exit stairways* and *ramps* and *exit passageways*:  $A/A_w = 0.00035$
3. Enclosed *exit access stairways* and *ramps* and all other shafts:  $A/A_w = 0.00150$
4. Floors and roofs:  $A/A_F = 0.00050$

where:

$A$  = Total leakage area, square feet ( $m^2$ ).

$A_F$  = Unit floor or roof area of barrier, square feet ( $m^2$ ).

$A_w$  = Unit wall area of barrier, square feet ( $m^2$ ).

The leakage area ratios shown do not include openings due to gaps around doors and operable windows. The total leakage area of the *smoke barrier* shall be determined in accordance with Section 909.5.1 and tested in accordance with Section 909.5.2.

❖ Part of the strategy of smoke control systems, particularly smoke control systems using the pressurization method (often termed zoned smoke control) is the use of smoke barriers to divide a building into separate smoke zones (or compartments). This strategy is used in both passive and mechanical systems. It should be noted that not all walls, ceilings or floors would be considered smoke barriers. Only walls that designate separate smoke zones within a building need to be constructed as smoke barriers. This section is simply providing requirements for walls, floors and ceilings that are used as smoke barriers. It should be noted that it is possible that a smoke control system utilizing the exhaust method may not need to utilize a smoke barrier to divide the building into separate smoke zones; therefore, the evaluation of barrier construction and leakage area may not be necessary and as noted are primarily focused on designs using the pressurization method.

In order for smoke to not travel from one smoke zone to another, specific construction requirements are necessary in accordance with the code. It should be noted that openings such as doors and windows are dealt with separately within Section 909.5.3 from openings such as cracks or penetrations.

**909.5.1 Total leakage area.** Total leakage area of the barrier is the product of the *smoke barrier* gross area multiplied by the allowable leakage area ratio, plus the area of other openings such as gaps around doors and operable windows.

❖ It is impossible for walls and floors to be constructed that are completely free from openings that may allow the migration of smoke; therefore, leakage needs to be compensated for within the design by calculating the leakage area of walls, ceilings and floors. The factors provided in Section 909.5, which originate from ASHRAE's provisions on leaky buildings, are used to calculate the total leakage area. The total leakage area is then used in the design process to determine the proper amount of air to create the required pressure differences across these surfaces that form smoke zones.

Additionally, Section 909.5 provides ratios to determine the maximum allowable leakage in walls, interior

exit stairways, shafts, floors and roofs. These leakage areas are critical in determining whether the proper pressure differences are provided when utilizing the pressurization method of smoke control. Pressure differences will decrease as the openings get larger.

**909.5.2 Testing of leakage area.** Compliance with the maximum total leakage area shall be determined by achieving the minimum air pressure difference across the barrier with the system in the smoke control mode for mechanical smoke control systems utilizing the pressurization method. Compliance with the maximum total leakage area of passive smoke control systems shall be verified through methods such as door fan testing or other methods, as *approved* by the *fire code official*.

❖ These leakage criteria need to be evaluated through testing. For the case of a pressurization system, pressure differences need to be verified when the system is in smoke control mode. In the case of passive smoke control systems, pressure testing through tests such as the door fan method is necessary.

**909.5.3 Opening protection.** Openings in *smoke barriers* shall be protected by automatic-closing devices actuated by the required controls for the mechanical smoke control system. Door openings shall be protected by fire door assemblies complying with Section 716.5.3 of the *International Building Code*.

**Exceptions:**

1. Passive smoke control systems with automatic-closing devices actuated by spot-type smoke detectors *listed* for releasing service installed in accordance with Section 907.3.
2. Fixed openings between smoke zones that are protected utilizing the airflow method.
3. In Group I-1 Condition 2, Group I-2 and ambulatory care facilities, where a pair of opposite-swinging doors are installed across a corridor in accordance with Section 909.5.3.1, the doors shall not be required to be protected in accordance with Section 716 of the *International Building Code*. The doors shall be close-fitting within operational tolerances and shall not have a center mullion or undercuts in excess of  $3/4$ -inch (19.1 mm) louvers or grilles. The doors shall have head and jamb stops and astragals or rabbets at meeting edges and, where permitted by the door manufacturer's listing, positive-latching devices are not required.
4. In Group I-2 and ambulatory care facilities, where such doors are special-purpose horizontal sliding, accordion or folding door assemblies installed in accordance with Section 1010.1.4.3 and are automatic closing by smoke detection in accordance with Section 716.5.9.3 of the *International Building Code*.
5. Group I-3.
6. Openings between smoke zones with clear ceiling heights of 14 feet (4267 mm) or greater and bank-

down capacity of greater than 20 minutes as determined by the design fire size.

- ❖ Similar to concerns of smoke leakage between smoke zones, openings may compromise the necessary pressure differences between smoke zones. Openings in smoke barriers, such as doors and windows, must be either constantly or automatically closed when the smoke control system is operating. This section requires that doors be automatically closed through the activation of an automatic closing device linked to the smoke control system. Essentially, when the smoke control system is activated, all openings are automatically closed. This most likely would mean that the mechanism that activates the smoke control system would also automatically close all openings. The smoke control system will be activated by a specifically zoned smoke detection or sprinkler system as required by Sections 909.12.3 and 909.12.4.

In terms of actual opening protection, Section 909.5.2 is simply referring the user to Section 716.5.3 of the IBC for specific construction requirements for doors located in smoke barriers. Note that smoke barriers are different from fire barriers, since the intended measure of performance is different. One is focused on fire spread from the perspective of heat, the other from the perspective of smoke passage. Smoke barriers do require a 1-hour fire-resistance rating.

There are several exceptions to this particular section. Exception 1 is specifically for passive systems. Passive systems, as noted, are systems in which there is no use of mechanical systems. Instead, the system operates primarily upon the configuration of barriers and layout of the building to provide smoke control. Passive systems can use spot-type detectors to close doors that constitute portions of a smoke barrier. Essentially, this means a full fire alarm system would not be required. Instead, single station detectors would be allowed to close the doors. Such doors would need to fail in the closed position if power is lost. The specifics as to approved devices would be found in NFPA 72.

Exception 2 is based on the fact that some systems take advantage of the opposed airflow method such that smoke is prevented from migrating past the doors. Therefore, since the design already accounts for potential smoke migration at these openings through the use of air movement, it is unnecessary to require the barrier to be closed.

Exception 3 is specifically related to the unique requirements for Group I-1 Condition 2, I-2 and ambulatory care occupancies. Essentially, a very specific alternative, which meets the functional needs of these occupancy types, is provided. Opposite swinging doors are allowed without meeting the specific requirements of Section 716. Note that Group I-2 and ambulatory care facilities do utilize the concept of smoke compartments which is a form of a passive smoke control system. The requirements of this sec-

tion are focused on openings in smoke barriers that need to close on activation of a pressurization system.

Exception 4 provides a specific allowance for horizontal sliding doors in Group I-2 Condition 2 occupancies and ambulatory care occupancies. These doors are commonly used in such occupancies and have very specific installation requirements in Section 1010.1.4.3. These doors are an alternative to pivoted or side-hinged swinging type doors. This exception does require compliance with Section 716.5.9.3 for automatic closing upon detection of smoke.

Exception 5 allows an exemption from the automatic-closing requirements for all Group I-3 occupancies. This is related to the fact that facilities that have occupants under restraint or with specific security restrictions have unique requirements in accordance with Section 408 of the code. These requirements accomplish the intent of providing reliable barriers between each smoke zone since, for the most part, such facilities will have a majority of doors closed and in a locked position due to the nature of the facility. The staff very closely controls these types of facilities.

Exception 6 relates to the behavior of smoke. The assumption is that smoke rises due to the buoyancy of hot gases, and if the ceiling is sufficiently high, the smoke layer will be contained for a longer period of time before it begins to move into the next smoke zone. Therefore, it is not as critical that the doors automatically close. This allowance is dependent on the specific design fire for a building. See Section 909.9 for more information on design fire determination. Different size design fires create different amounts of smoke that, depending on the layout of the building, may migrate in different ways throughout the building. This section mandates that smoke cannot begin to migrate into the next smoke zone for at least 20 minutes. This is consistent with the 20-minute minimum duration of operation of smoke control systems required in Section 909.4.6. It should be noted that a minimum of 14-foot (4267 mm) ceilings are required to take advantage of this exception. This exception would require an engineering analysis.

**909.5.3.1 Group I-1 Condition 2, Group I-2 and ambulatory care facilities.** In Group I-1 Condition 2, Group I-2 and ambulatory care facilities, where doors are installed across a corridor, the doors shall be automatic closing by smoke detection in accordance with Section 716.5.9.3 of the *International Building Code* and shall have a vision panel with fire-protection-rated glazing materials in fire-protection-rated frames, the area of which shall not exceed that tested.

- ❖ Part of the alternative allowed for horizontal sliding doors in Exception 3 of Section 909.5.3 for Group I-1 Condition 2, Group I-2 and ambulatory care facilities is the requirement that vision panels be provided. These vision panels need to be approved fire-protection-rated glazing and be within frames of a size that does not exceed the frame size that was used for testing of the glazing.

**909.5.3.2 Ducts and air transfer openings.** Ducts and air transfer openings are required to be protected with a minimum Class II, 250°F (121°C) smoke damper complying with Section 717 of the *International Building Code*.

❖ Another factor that adds to the reliability of smoke barriers is the protection of ducts and air transfer openings within smoke barriers. Left open, these openings may allow the transfer of smoke between smoke zones. These ducts and air transfer openings most often are part of the HVAC system. Damper operation and the reaction with the smoke control system will be evaluated during acceptance testing. It should be noted that there are duct systems used within a smoke control design that are controlled by the smoke control system and should not automatically close upon detection of smoke via a smoke damper.

It should be noted that a smoke damper works differently than a fire damper. Fire dampers react to heat via a fusible link, while smoke dampers activate upon the detection of smoke. The smoke dampers used should be rated as Class II, 250°F (121°C). The class of the smoke damper refers to its level of performance relative to leakage. The temperature rating is related to its ability to withstand the heat of smoke resulting from a fire. It should be noted that although smoke barriers are only required to utilize smoke dampers, there may be many instances where a fire damper is also required. For instance, the smoke barrier may also be used as a fire barrier. Also, Section 717.5.3 of the IBC would require penetration of shafts to contain both a smoke and fire damper. Therefore, in some cases both a smoke damper and fire damper would be required. There are listings specific to combination smoke and fire dampers.

More specific requirements about dampers can be found in Chapter 7 of the IBC and Chapter 6 of the IMC.

**909.6 Pressurization method.** The primary mechanical means of controlling smoke shall be by pressure differences across *smoke barriers*. Maintenance of a tenable environment is not required in the smoke-control zone of fire origin.

❖ There are several methods or strategies that may be used to control smoke movement. One of these methods is pressurization, wherein the system primarily utilizes pressure differences across smoke barriers to control the movement of smoke. Basically, if the area of fire origin maintains a negative pressure, then the smoke will be contained to that smoke zone. A typical approach used to obtain a negative pressure is to exhaust the fire floor. This is a fairly common practice in high-rise buildings. Interior exit stairways also utilize the concept of pressurization by keeping the interior exit stairways under positive pressure. The pressurization method in large open spaces, such as malls and atria, is impractical since it would take a large quantity of supply air to create the necessary pressure differences. It should be noted

that pressurization is mandated as the primary method for mechanical smoke control design but this is related to the primary methods historically used for smoke control in high rise buildings. Currently high-rise buildings do not require smoke control. Airflow and exhaust methods are only allowed when appropriate. The exhaust method is the most commonly applied method due to the use of the atrium provisions in Section 404.5 of the IBC.

The pressurization method does not require that tenable conditions be maintained in the smoke zone where the fire originates. Maintaining this area tenable would be impossible, based on the fact that pressures from the surrounding smoke zones would be placing a negative pressure within the zone of origin to keep the smoke from migrating.

Pressurization is used often with interior exit stairways. This method provides a positive pressure within the interior exit stairways to resist the passage of smoke. Stair pressurization is one method of compliance for stairways in high-rise or underground buildings where the floor surface is located more than 75 feet (22 860 mm) above the lowest level of fire department vehicle access or more than 30 feet (9144 mm) below the floor surface of the lowest level of exit discharge. It should be noted that there are two methods found in the code that address smoke movement—smokeproof enclosures or pressurized stairs. A smokeproof enclosure requires a certain fire-resistance rating along with access through a ventilated vestibule or an exterior balcony. The vestibule can be ventilated in two ways: using natural ventilation or mechanical ventilation as outlined in Sections 909.20.3 and 909.20.4 of the IBC. The pressurization method requires a sprinklered building and a minimum pressure difference of 0.15 inch (37 Pa) of water and a maximum of 0.35 inch (87 Pa) of water. These pressure differences are to be available with all doors closed under maximum stack pressures (see Sections 909.20 of the IBC and 1023.11 of the code for more details).

As noted, the pressurization method utilizes pressure differences across smoke barriers to achieve control of smoke. Sections 909.6.1 and 909.6.2 provide the criteria for smoke control design in terms of minimum and maximum pressure differences.

In summary, the pressurization method is used in two ways. The first is through the use of smoke zones where the zone of origin is exhausted, creating a negative pressure. The second is stair pressurization that creates a positive pressure within the stair to avoid the penetration of smoke. Note that the code allows the use of a smokeproof enclosure instead of pressurization.

**909.6.1 Minimum pressure difference.** The minimum pressure difference across a *smoke barrier* shall be 0.05-inch water gage (0.0124 kPa) in fully sprinklered buildings.

In buildings allowed to be other than fully sprinklered, the smoke control system shall be designed to achieve pressure

differences not less than two times the maximum calculated pressure difference produced by the design fire.

- ❖ The minimum pressure difference is established as 0.05-inch water gage (12 Pa) in fully sprinklered buildings. This particular criterion is related to the pressures needed to overcome buoyancy and the pressures generated by the fire, which include expansion. This particular criterion is based upon a sprinklered building. The pressure difference would need to be higher in a building that is not sprinklered. Additionally, the pressure difference needs to be provided based upon the possible stack and wind effects present.

**909.6.2 Maximum pressure difference.** The maximum air pressure difference across a *smoke barrier* shall be determined by required door-opening or closing forces. The actual force required to open *exit* doors when the system is in the smoke control mode shall be in accordance with Section 1010.1.3. Opening and closing forces for other doors shall be determined by standard engineering methods for the resolution of forces and reactions. The calculated force to set a side-hinged, swinging door in motion shall be determined by:

$$F = F_{dc} + K(WA\Delta P)/2(W - d) \quad \text{(Equation 9-1)}$$

where:

$A$  = Door area, square feet ( $m^2$ ).

$d$  = Distance from door handle to latch edge of door, feet (m).

$F$  = Total door opening force, pounds (N).

$F_{dc}$  = Force required to overcome closing device, pounds (N).

$K$  = Coefficient 5.2 (1.0).

$W$  = Door width, feet (m).

$\Delta P$  = Design pressure difference, inches of water (Pa).

- ❖ The maximum pressure difference is based primarily upon the force needed to open and close doors. The code establishes maximum opening forces for doors. This maximum opening force cannot be exceeded, taking into account the pressure differences across a doorway in a pressurized environment. Essentially, based on the opening force requirements of Section 1010.1.3, the maximum pressure difference can be calculated in accordance with Equation 9-1. In accordance with Chapter 10, the maximum opening force of a door has three components, including:

- Door latch release:  
Maximum of 15 pounds (67 N)
- Set door in motion:  
Maximum of 30 pounds (134 N)
- Swing to full open position:  
Maximum of 15 pounds (67 N)

Equation 9-1 is used to calculate the total force to set the door into motion when in the smoke control mode; therefore, the limiting criteria would be 30 pounds (134 N). It should be noted that although the accessibility requirements related to door opening

force are more restrictive in Section 404.2.8 of ICC A117.1 fire doors do not require compliance with these requirements.

### 909.6.3 Pressurized stairways and elevator hoistways.

Where stairways or elevator hoistways are pressurized, such pressurization systems shall comply with Section 909 as smoke control systems, in addition to the requirements of Section 909.21 of this code and Section 909.20 of the *International Building Code*.

- ❖ The purpose of this section is to clarify that pressurized stairways and pressurized hoistways are smoke control systems and must be addressed in the same way that a pressurization system in accordance with Section 909.6 addresses such systems. This would require compliance with various sections but in particular the requirements for a rational analysis in accordance with Section 909.4.

**909.7 Airflow design method.** Where *approved* by the *fire code official*, smoke migration through openings fixed in a permanently open position, which are located between smoke control zones by the use of the airflow method, shall be permitted. The design airflow shall be in accordance with this section. Airflow shall be directed to limit smoke migration from the fire zone. The geometry of openings shall be considered to prevent flow reversal from turbulent effects. Smoke control systems using the airflow method shall be designed in accordance with NFPA 92.

- ❖ This method is only allowed when approved by the fire code official. As the title states, this method utilizes airflow to avoid the migration of smoke across smoke barriers. This has been referred to as opposed airflow. Specifically, this method is suited for the protection of smoke migration through doors and related openings fixed in a permanently open position. This method consists of providing a particular velocity of air based upon the temperature of the smoke and the height of the opening. The temperature of the smoke will depend on the design fire that is established for the particular building. The higher the temperature of the smoke and the larger the opening, the higher the velocity necessary to maintain the smoke from migrating into the smoke zone. It should be noted that the airflow method seldom works for large openings, since the velocity to oppose the smoke becomes too high. This method tends to work better for smaller openings, such as pass-through windows. Reference is made to NFPA 92 to determine the minimum velocity required to limit smoke spread.

**909.7.1 Prohibited conditions.** This method shall not be employed where either the quantity of air or the velocity of the airflow will adversely affect other portions of the smoke control system, unduly intensify the fire, disrupt plume dynamics or interfere with exiting. In no case shall airflow toward the fire exceed 200 feet per minute (1.02 m/s). Where the calculated airflow exceeds this limit, the airflow method shall not be used.

- ❖ The airflow method has a limitation on maximum velocity. This limitation is because air may distort the

flame and cause additional entrainment and turbulence; therefore, having a high velocity of air entering the zone of fire origin has the potential of increasing the amount of smoke produced. The velocity may also interact with other portions of the smoke control design. For instance, the pressure differences in other areas of the building may be altered, which may exceed the limitations of Sections 909.6.1 and 909.6.2. This section requires that when a velocity of over 200 feet per minute (1.02 m/sec) is calculated, the airflow method is not allowed. The solution may result in requiring a barrier such as a wall or door.

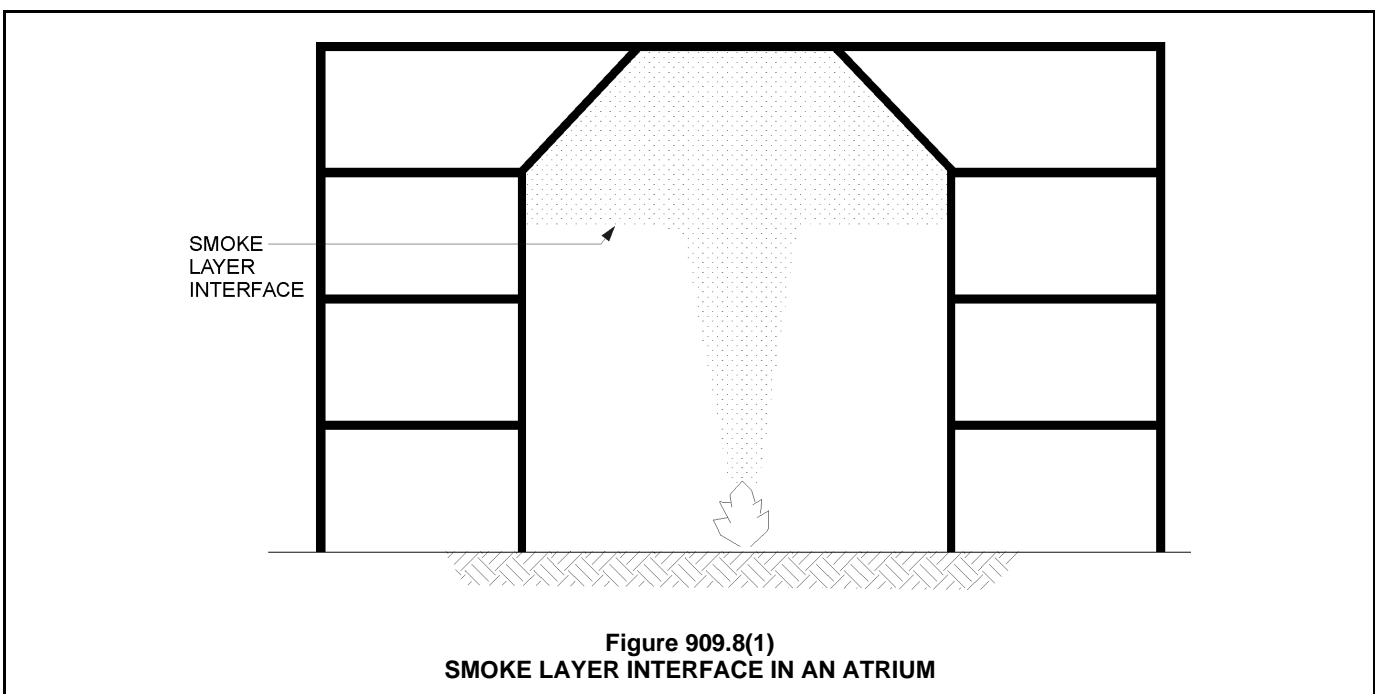
If the airflow design method is chosen to protect areas communicating with an atrium, the air added to the smoke layer needs to be accounted for in the exhaust rate.

**909.8 Exhaust method.** Where *approved* by the fire code official, mechanical smoke control for large enclosed volumes, such as in atriums or malls, shall be permitted to utilize the exhaust method. Smoke control systems using the exhaust method shall be designed in accordance with NFPA 92.

❖ This method is only allowed when approved by the building official. The primary application of the exhaust method is in large spaces, such as atriums and malls and is the most widely used method in the IBC. The strategy of this method is to keep the smoke layer at a certain level within the space. This is primarily accomplished through exhausting smoke. The amount of exhaust depends upon the design fire [see Commentary Figure 909.8(1)]. Essentially, fires produce different amounts and properties of smoke based on the material being burned, size of the fire and the placement of the fire; therefore, NFPA 92 is referenced for the design of such systems. NFPA 92

presents several ways to address the control of smoke, which includes the use of the following tools:

- Scale Modeling (Small scale testing)—Utilizes the concept of scaling to allow small scale tests to be conducted to understand the smoke movement within a space.
  - Benefits—More realistic understanding of smoke movement in spaces with unusual configurations or projections than algebraic calculations.
  - Disadvantages—Expensive and the application of results is limited to the uniqueness of the space being analyzed.
- Algebraic Calculations—Empirically derived (based upon testing) modeling in its simplest form.
  - Benefits—Simple, cost-effective analysis.
  - Disadvantages—Limited applicability due to the range of values they were derived from, only appropriate with certain types of design fires, typically over conservative outputs that increase equipment needs, equipment costs and can impact aesthetics and architectural design.
- Computer Modeling [Computational fluid dynamics (CFD) or zone models]—Combination of theory and empirical values to determine the smoke movement and fire induced conditions within a space and effectiveness of the smoke control system.
  - Benefits—More realistic understanding of smoke movement in spaces with unusual configurations or projections and less expensive than scale modeling. Helps sig-



nificantly in designing smoke control systems tailored to spaces and achieving cost-effective designs, and can help limit the impact to architectural design.

- Disadvantages—Computing time and cost can be longer than algebraic calculations but benefits typically outweigh this disadvantage. Early planning is important and can limit these adverse impacts.

In terms of computer modeling, as noted, there are essentially two methods that include zone models and CFD models. Zone models are based upon the unifying assumption that in any room or space where the effects of the fire are present there are distinct layers (hot upper layer, cool lower layer). In real life such distinct layers do not exist. Some examples of zone models used in such applications include Consolidated Model of Fire Growth And Smoke Transport (C-FAST) and Available Safe Egress Time (ASET). See Section 3-7 of the *SFPE Handbook of Fire Protection Engineering* for further information. CFD models take this much further and actually divide the space into thousands or millions of interconnected “cells” or “fields.” The model then evaluates the fire dynamics and heat and mass in each individual cell and how it interacts with those adjacent to it. The use of such models becomes more accurate with more numerous and smaller cells but the computing power and expertise required is much higher than for zone models. As noted the use of either types of models can be advantageous but such use must be undertaken by someone qualified. Proper review and verification of the input and output is critical. The most popular model in the area of CFD with regard to fire is the Fire Dynamics Simulator

(FDS) developed by NIST. Other models such as Fluent are sometimes used (Fluent Inc.).

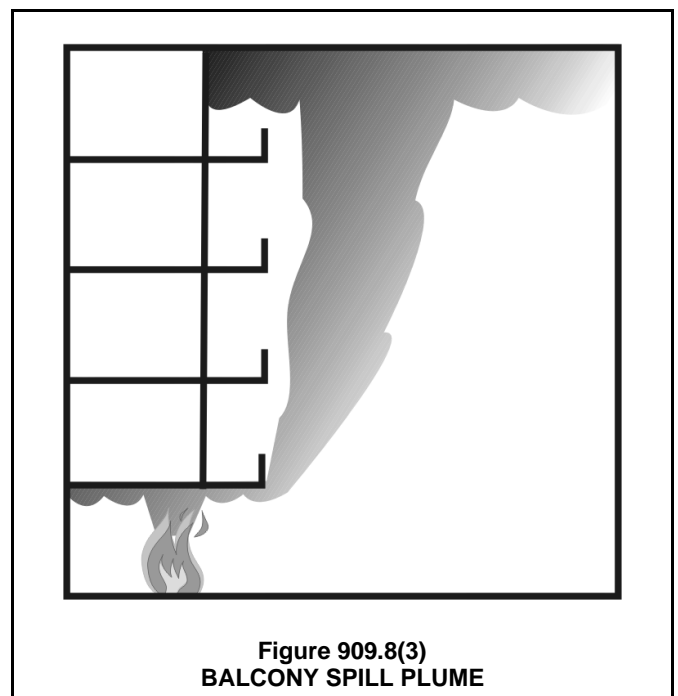
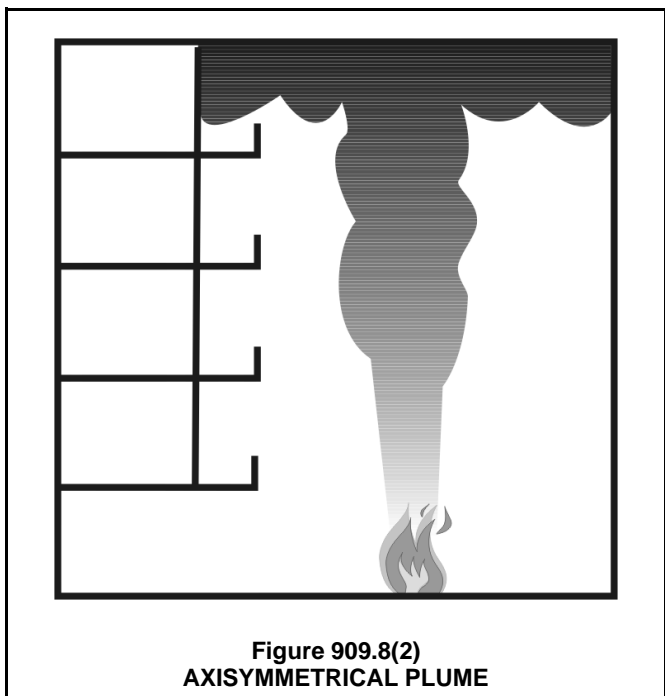
Depending upon the space being evaluated some design strategies may provide a better evaluated approach than others. Past editions of the IBC smoke control provisions for the exhaust method mandated the use of the algebraic methods with a steady fire. This of course also mandated a mechanical system be used whereas NFPA 92 allows an overall review of smoke layer movement and whether the design goals, which in this case are mandated by the code, can be met. Therefore, if it can be shown that the smoke layer interface can be held at the 6 feet (1829 mm) as mandated in Section 909.8.1 for the design operation time required by Section 909.4.6 without mechanical ventilation then the space would comply with Section 909. NFPA 92 presents several design approaches. This allows more flexibility in design than that found in previous editions of the IBC.

NFPA 92B as a standard does not set the minimum smoke layer interface height or duration for system operation. Such criteria is found within Sections 909.8.1 and 909.4.6, respectively. See the commentary for those sections.

If the algebraic approach is used, consideration of three types of fire plumes may be required to determine which one is the most demanding in terms of smoke removal needs based upon the space being assessed. They include:

Axisymmetric plumes—Smoke rises unimpeded by walls, balconies or similar projections [see Commentary Figure 909.8(2)].

Balcony spill plumes—Smoke flows under and around edges of a horizontal projection [see Commentary Figure 909.8(3)].



Window plumes—Smoke flows through an opening into a large-volume space [see Commentary Figure 909.8(4)].

It should be noted that prior to the reference to NFPA 92 in the code, the balcony spill and window plume calculations had been eliminated from the smoke control requirements of the code due to concerns with the applicability of those calculations. The major difference is that NFPA 92 does not mandate the use of such equations as did previous editions of the IBC. The use of such equations will depend upon the design fires agreed upon for the particular design and whether an algebraic approach is chosen. These equations are used to determine a mass flow rate of smoke to ultimately determine the required exhaust volume for that space. If the potential for a balcony or window spill plumes are known to exist within the space, then appropriate measures need to be taken to address these, as they typically result in more onerous exhaust and supply requirements. Part of the reason for the initial deletion of these equations was the fact that such scenarios are not as likely or their impact is significantly reduced in sprinklered buildings. There is also some concern with the applicability of the balcony spill plume equation in a variety of applications. These potential fire scenarios and resulting plumes may further the need to undertake a CFD analysis to address such hazards more appropriately and effectively.

Another key aspect that NFPA 92 included within the algebraic methods is equations to determine that a minimum number of exhaust inlets are available to prevent plugholing. Plugholing occurs when air from below the smoke layer is pulled through the smoke

layer into the smoke exhaust inlets. As such, if plugholing occurs, some of the fan capacity is used to exhaust air rather than smoke and thus can affect the ability to maintain the smoke layer at or above the design height. Scale modeling and computer fire modeling would demonstrate these potential problems during the testing and analysis, respectively [see Commentary Figure 909.8(5)].

It should be noted that this section specifically references NFPA 92 for the design of smoke control using the exhaust method. Therefore the

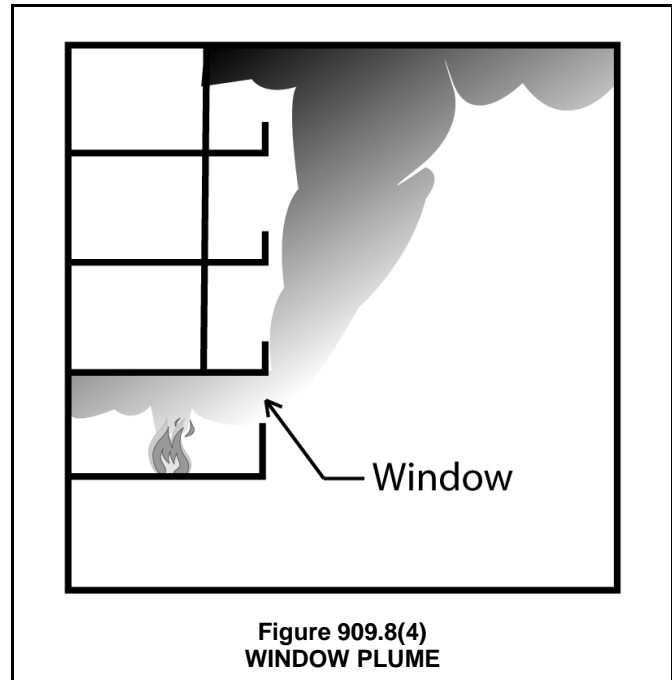


Figure 909.8(4)  
WINDOW PLUME

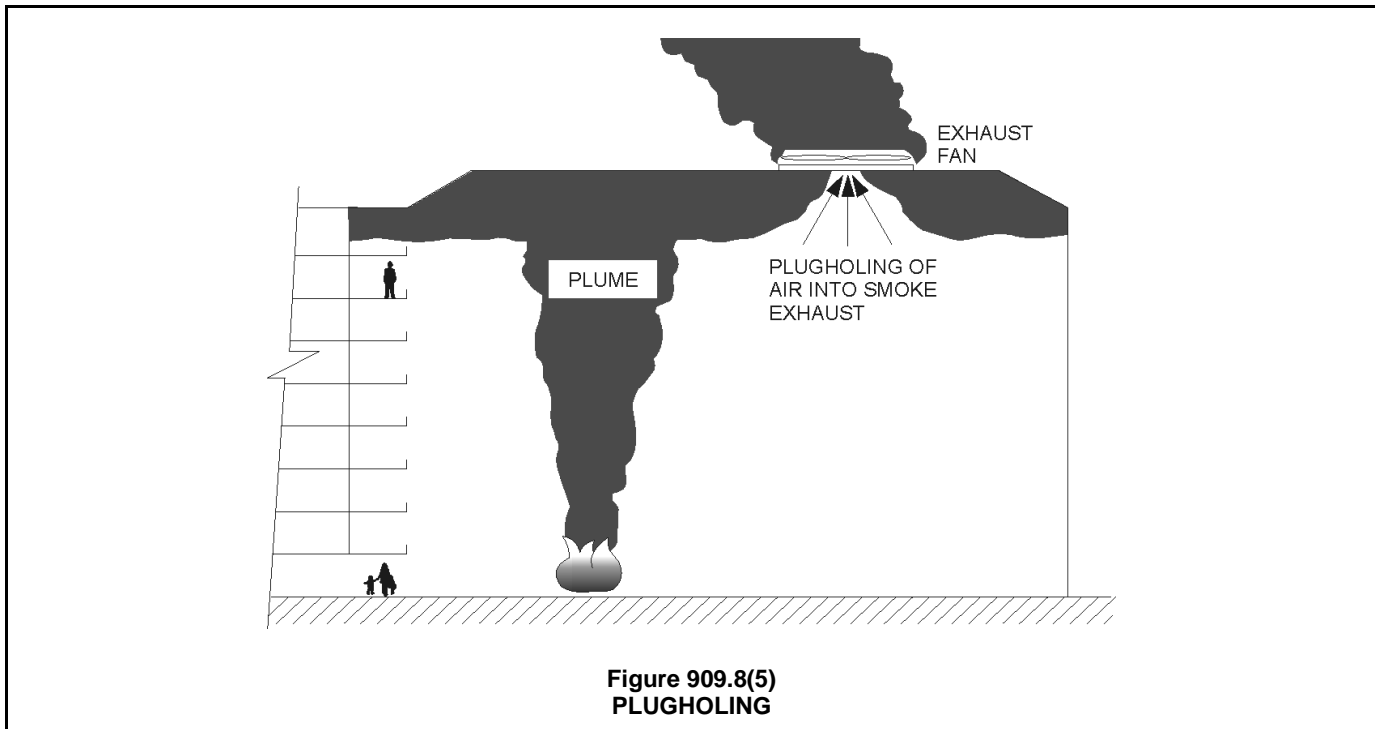


Figure 909.8(5)  
PLUGHOLING

requirements in NFPA 92 related to testing, documentation and maintenance would not be applicable though they may be a good resource. Equipment and controls would be part of the design; therefore, related provisions of NFPA 92 would apply. Generally the IBC addresses equipment and controls in a similar fashion.

**909.8.1 Smoke layer.** The height of the lowest horizontal surface of the smoke layer interface shall be maintained not less than 6 feet (1829 mm) above a walking surface that forms a portion of a required egress system within the smoke zone.

❖ The design criteria to be used when applying NFPA 92B is to maintain the smoke layer interface at least 6 feet (1829 mm) above any walking surface that is considered part of the required egress within the particular smoke zone, such as an atrium, for 20 minutes or 1.5 times the calculated egress time (see Section 909.4.6). Chapter 10 considers the majority of occupiable space as part of the means of egress system. Also keep in mind that the criteria of 6 feet (1829 mm) does not apply just to the main floor surface of the mall or atrium but to any level where occupants may be exposed (for example, balconies) see Commentary Figure 909.8.1(1).

The code uses the terminology “lowest horizontal surface of the accumulating smoke layer interface.”

NFPA 92 has several definitions related to smoke layer, which include the following:

**Smoke layer.** The accumulated thickness of smoke below a physical or thermal barrier.

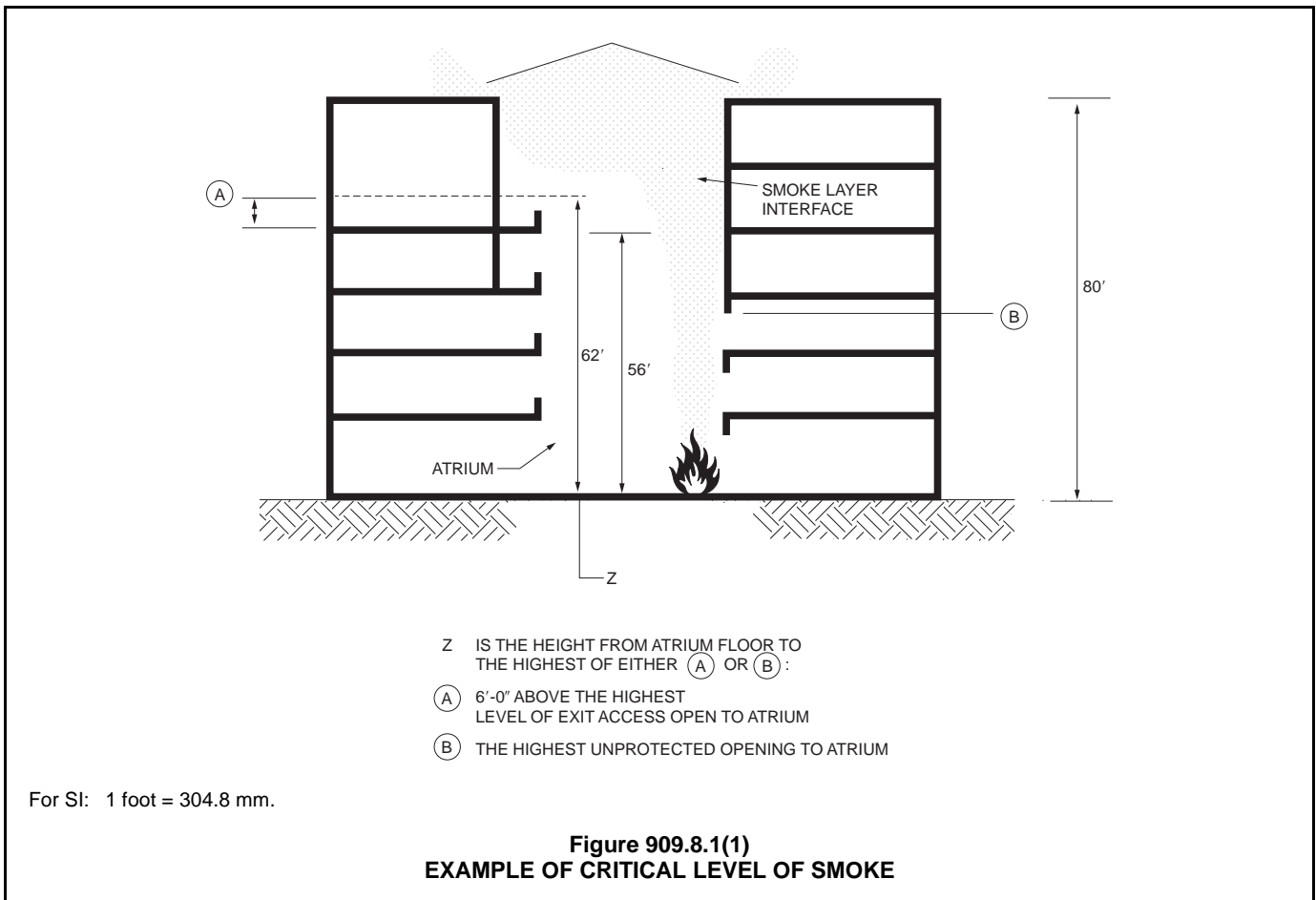
**Smoke layer interface.** The theoretical boundary between a smoke layer and the smoke-free air. (Note: This boundary is at the beginning of the transition zone.)

**First indication of smoke.** The boundary between the transition zone and the smoke-free air.

**Transition zone.** The layer between the smoke layer interface and the first indication of smoke in which the smoke layer temperature decreases to ambient.

The transition zone may be several feet thick (large open space) or may barely exist (small area with intense fire) [see also Commentary Figure 909.8.1(2)].

NFPA 92 provides algebraic equations to determine first indication of smoke but is limited to very specific conditions such as a uniform cross section, specific aspect ratios, steady or unsteady fires and no smoke exhaust operating. When using algebraic equations for smoke layer interface looking



at different types of plumes the smoke layer interface terminology is used and the user enters the desired smoke layer interface height. Zone models use simplifying assumptions so the layers are distinct from one another. In contrast, when CFD or scale modeling is used, the data must be analyzed to verify that the smoke layer interface is located at or above the 6 feet (1829 mm) during the event. This is not a simple analysis as CFD and scale modeling provide more detail on actual smoke behavior; therefore, the location of the smoke layer interface may not be initially clear without some level of analysis. Again it depends on the depth of the transition layer. This may require reviewing tenability within the transition zone. Tenability limits need to be agreed upon by the stakeholders involved. Using CFD or scale modeling would likely need to occur through the alternative methods and materials section (Section 104.9) due to the need to review tenability limits. It should be noted that NFPA 92 Annex A suggests that there are methods to determine where the smoke layer interface and first indication of smoke are located when undertaking CFD and scale modeling using a limited number of point measurements.

Also, Section 909.8.1 specifies a minimum distance for the smoke layer interface from any walking surface whereas Section 4.5.4.2 of NFPA 92 has provisions that simply allows the analysis to demonstrate tenability regardless of where the layer height is located above the floor. Defining tenability can be more difficult as there is not a standard definition as to what is considered tenable. Any design using that approach would need to be addressed through Section 104.9.

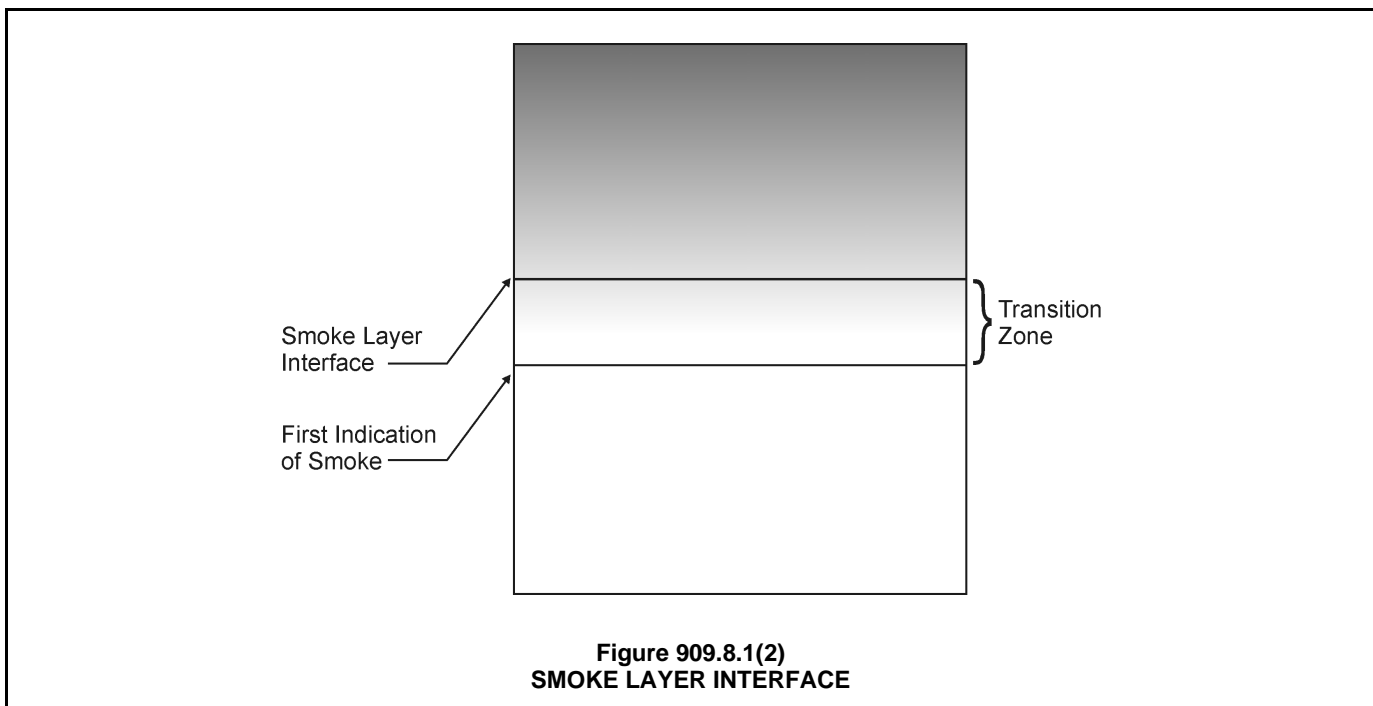
Note that the response time of the system

components (detection, activation, ramp up time, shutting down HVAC, opening/closing doors and dampers, etc.) needs to be accounted for when analyzing the location of the smoke layer interface in relation to the duration of operations stated in Section 909.4.6 (see commentary, Section 909.17).

**909.9 Design fire.** The design fire shall be based on a rational analysis performed by the registered design professional and approved by the fire code official. The design fire shall be based on the analysis in accordance with Section 909.4 and this section.

❖ The design fire is the most critical element in the smoke control system design. The fire is what produces the smoke to be controlled by the system; thus, the size of the fire directly impacts the quantity of smoke being produced. This section ensures that the design fire be determined through a rational analysis by a registered design professional with knowledge in this area. Such professionals should have experience in the area of fire dynamics, fire engineering and general building design, including mechanical systems. When determining the design fire, the designer should work with various stakeholders to determine the types of hazards and combustible materials (fire scenarios) on a permanent as well as temporary basis (i.e., Christmas/holiday decorative materials or scenery, temporary art exhibits) that may be present throughout the use of the building once occupied. Those hazards then need to be translated to potential design fires to be used when determining the smoke layer interface height for the duration as determined by Section 909.4.6. See the commentary for Section 909.9.3 for potential sources when determining design fires.

This section also does not mandate the type of fire



**Figure 909.8.1(2)**  
**SMOKE LAYER INTERFACE**

(i.e., steady versus unsteady). A steady fire assumes a constant heat release rate over a period of time, where unsteady fires do not. An unsteady fire includes the growth and decay phases of the fire, as well as the peak heat release rate. An unsteady fire will hit a peak heat release rate when burning in the open, like an axisymmetric fire. An unsteady fire is a more realistic view of how fires actually burn. It should be noted that fires can be a combination of unsteady and steady fires when the sufficient fuel is available. In other words, the fire initially grows (unsteady) then reaches a steady state and burns for sometime at a particular heat release rate before decay occurs.

Design fire information should therefore typically include growth rate, peak heat release rate, duration and decay as well as information related to fire locations and products of combustion yield (CO, smoke, etc.) that are produced by the various design fires that are deemed credible for the space.

To provide an order of magnitude of fire sizes obtained from various combustibles, the following data from fire tests is provided. The following heat release rates, found in Section 3, Chapter 3-1 of the 4th edition of the *SFPE Handbook of Fire Protection Engineering*, are peak heat release rates:

Plastic trash bags/paper trash:

Approximately 120-350 kw

Latex foam pillow:

Approximately 120 kw

Dry Douglas fir Christmas tree:

Approximately 3000 kw at 20 percent moisture

Polyurethane foam (PVC Ticking material) Mattress:

approximately 2630 kw

Plywood wardrobe:

approximately 2900-6,400 kw

**909.9.1 Factors considered.** The engineering analysis shall include the characteristics of the fuel, fuel load, effects included by the fire and whether the fire is likely to be steady or unsteady.

❖ This section simply provides more detail on the factors that should be taken under consideration when determining the design fire size. To determine the appropriate fire size, an engineering analysis is necessary that takes into account the following elements: fuel (potential burning rates), fuel load (how much), effects included by the fire (smoke particulate size and density), steady or unsteady (burn steadily or simply peak and dissipate) and likelihood of sprinkler activation (based on height and distance from the fire).

**909.9.2 Design fire fuel.** Determination of the design fire shall include consideration of the type of fuel, fuel spacing and configuration.

❖ The design fire size may also be affected by surrounding combustibles, which may have the effect of increasing the fire size. More specifically, there is

concern that if sufficient separation is not maintained between combustibles, then a larger design fire is likely. The code does not provide extensive detail on this as such determination is left to the rational analysis undertaken by the design professional. NFPA 92B provides one method in which you determine the critical separation distance,  $R$ . This is based upon fire size and the critical radiant heat flux for nonpiloted ignition. Nonpiloted ignition means the radiated heat from the fire without direct flame contact will ignite adjacent combustibles.

**909.9.3 Heat-release assumptions.** The analysis shall make use of best available data from *approved* sources and shall not be based on excessively stringent limitations of combustible material.

❖ This section is merely stressing the fact that data obtained for use in a rational analysis needs to come from relevant and appropriate sources. Data can be obtained from groups such as the NIST or from Annex B of NFPA 92B. Data from fire tests is available and is a good resource for such analysis. As noted earlier, such data is not prevalent [see also Chapter 8 (“Analysis of Design Fires”) of the *Guide to Smoke Control in the 2006 IBC* and Section 3, Chapter 3-1 of the *SFPE Handbook of Fire Protection Engineering*].

**909.9.4 Sprinkler effectiveness assumptions.** A documented engineering analysis shall be provided for conditions that assume fire growth is halted at the time of sprinkler activation.

❖ This section raises a few questions regarding activation of sprinklers and their impact on the fire both in terms of their ability to “control” as well as “extinguish” a fire. The first is concerning an assumption that sprinklers will immediately control the fire as soon as they are activated (i.e., control results in limiting further growth and maintaining the heat release rate at approximately the same fire size as when the sprinklers activated). This assumption may be true in some cases, but for high ceilings the sprinkler may not activate or may be ineffective. Sprinklers may be ineffective in high spaces, since by the time they are activated the fire is too large to control. Essentially, the fire plume may push away and evaporate the water before it actually reaches the seat of the fire. Additionally the fire may be shielded from sprinkler spray so that insufficient quantities of water reach the fuel. These are common problems with high-piled storage as well as other fires including retail and has been shown in actual tests. Also, if the fire becomes too large before the sprinklers are activated, the available water supply and pressure for the system may be compromised. Additionally, based on the layout of the room and the movement of the fire effluents, the wrong sprinklers could be activated, which leads to a larger fire size and depletion of the available water supply and pressure.

Another issue is whether the sprinklers “control” or “extinguish” the fire. Typical sprinklers are assumed

only to control fires as opposed to extinguishing them. Sprinklers may be able to extinguish the fire, but it should not automatically be assumed. A fire that is controlled will achieve steady state and maintain a certain fire size, which is very different from a fire that is actually extinguished.

Based upon these concerns, each scenario needs to be looked at individually to determine whether sprinklers would be effective in halting the growth or extinguishing the fire. More specifically, the evaluation should include droplet size, density and area of coverage and should also be based on actual test results.

**909.10 Equipment.** Equipment including, but not limited to, fans, ducts, automatic dampers and balance dampers shall be suitable for their intended use, suitable for the probable exposure temperatures that the rational analysis indicates, and as approved by the fire code official.

❖ Section 909.10 and subsequent sections are primarily related to the reliability of the system components to provide a smoke control system that works according to the design. One of the largest concerns when using smoke control provisions is the overall reliability of the system. Such systems have many different components, such as smoke and fire dampers; fans; ducts and controls associated with such components. The more components a system has, the less reliable it becomes. In fact, one approach in providing a higher level of reliability is utilizing the normal building systems such as the HVAC to provide the smoke control system. Basically, systems used every day are more likely to be working appropriately, since they are essentially being tested daily; however, there are many components that are specific to the smoke control system, such as exhaust fans in an atrium or the smoke control panel.

Also, there is not a generic prescriptive set of requirements as to how all smoke control system elements should operate, since each design may be fairly unique. The specifics on operation of such a system need to be included within the design and construction documents. Most components used in smoke control systems are elements used in many other applications such as HVAC systems; therefore, the basic mechanisms of a fan used in a smoke control system may not be different, although they may be applied differently.

**909.10.1 Exhaust fans.** Components of exhaust fans shall be rated and certified by the manufacturer for the probable temperature rise to which the components will be exposed. This temperature rise shall be computed by:

$$T_s = (Q_c/mc) + (T_a) \quad \text{(Equation 9-2)}$$

where:

$c$  = Specific heat of smoke at smoke layer temperature, Btu/lb°F • (kJ/kg • K).

$m$  = Exhaust rate, pounds per second (kg/s).

$Q_c$  = Convective heat output of fire, Btu/s (kW).

$T_a$  = Ambient temperature, °F (K).

$T_s$  = Smoke temperature, °F (K).

**Exception:** Reduced  $T_s$  as calculated based on the assurance of adequate dilution air.

❖ Fans used for smoke control systems must be able to tolerate the possible elevated temperatures to which they will be exposed. Again, like many other factors this depends upon the specifics of the design fire. Essentially, Equation 9-2 requires the calculation of the potential temperature rise. The exhaust fans must be specifically rated and certified by the manufacturer to be able to handle these rises in temperature. There is an exception that allows reduction of the temperature if it can be shown that adequate temperature reduction will occur. In many cases if the exhaust fans are near the ceiling, the smoke will be much cooler than the value resulting from Equation 9-2 since the smoke may cool considerably by the time it reaches the ceiling. Also, sprinkler activation will assist in cooling the smoke further.

**909.10.2 Ducts.** Duct materials and joints shall be capable of withstanding the probable temperatures and pressures to which they are exposed as determined in accordance with Section 909.10.1. Ducts shall be constructed and supported in accordance with the *International Mechanical Code*. Ducts shall be leak tested to 1.5 times the maximum design pressure in accordance with nationally accepted practices. Measured leakage shall not exceed 5 percent of design flow. Results of such testing shall be a part of the documentation procedure. Ducts shall be supported directly from fire-resistance-rated structural elements of the building by substantial, noncombustible supports.

**Exception:** Flexible connections, for the purpose of vibration isolation, complying with the *International Mechanical Code* and that are constructed of approved fire-resistance-rated materials.

❖ The next essential component of a smoke control system is the integrity of the ducts to transport supply and exhaust air. The integrity of ducts is also important for an HVAC system, but is more critical in this case since it is not simply a comfort issue but one of life safety. The key concern with ducts in smoke control systems is that they can withstand elevated temperatures and that there will be minimal leakage. The concern with leakage is the potential of leaking smoke into another smoke zone or not providing the proper amount of supply air to support the system.

More specifically, all ducts need to be leak tested to 1.5 times the maximum static design pressure. The leakage resulting should be no more than 5 percent of the design flow. For example, a duct that has a design flow of 300 cubic feet per minute (cfm) (0.141 m<sup>3</sup>/s) would be allowed 15 cfm (0.007 m<sup>3</sup>/s) of leakage when exposed to a pressure equal to 1.5 times the design pressure for that duct. The tests should be

in accordance with nationally accepted practices. This criterion will often limit ductwork for smoke control systems to lined systems, since the amount of leakage in such systems is much less.

As part of the concern for possible exposure to fire and fire products, the ducts are required to be supported by way of substantial noncombustible supports connected to the fire-resistance-rated structural elements of the building. As noted, the system needs to be able to run for 20 minutes starting from the detection of the fire. The supports are allowed to be other than noncombustible when they are flexible connections provided to mitigate the effects of vibration, perhaps as part of a building exposed to seismic loads. The flexible connections still need to be constructed of approved fire-resistance-rated materials.

NFPA 92B also references NFPA 90A for ducts conveying smoke and is part of the design requirements for exhaust systems.

As part of the concern for possible exposure to fire and fire products, the ducts are required to be supported by way of substantial noncombustible supports connected to the fire-resistance-rated structural elements of the building. As noted, the system needs to be able to run for 20 minutes starting from the detection of the fire. The exception to this section is really more of an acknowledgement that flexible connections for vibration isolation are acceptable when constructed of approved fire-resistance-rated materials. More specifically, it is often necessary to use such connections for connecting the duct to the fan. These connections cannot necessarily meet the requirements of the main section, but are a minimal part of the ductwork and as long as they perform adequately with regard to fire resistance they are permitted. Note that the term "approved" is used to determine the required fire resistance, therefore, flexibility is provided. The code does not specifically address this determination but perhaps a relationship to the duration or operation and these flexible connections could be made to determine the necessary performance.

**909.10.3 Equipment, inlets and outlets.** Equipment shall be located so as to not expose uninvolved portions of the building to an additional fire hazard. Outside air inlets shall be located so as to minimize the potential for introducing smoke or flame into the building. Exhaust outlets shall be so located as to minimize reintroduction of smoke into the building and to limit exposure of the building or adjacent buildings to an additional fire hazard.

❖ The intent of this section is to minimize the likelihood of smoke being reintroduced into the building due to poorly placed outdoor air inlets and exhaust air outlets; therefore, placing one right next to another on the exterior of the building would be inappropriate. Additionally, wind and other adverse conditions should be considered when choosing locations for these inlets and outlets. Particular attention should be paid to introducing exhausted smoke into another smoke zone. Also, smoke should be exhausted in a

direction that will not introduce it into surrounding buildings or facilities. Within the building itself, the supply air and exhaust outlets should also be strategically located. The exhaust inlets and supply air should be evenly distributed to reduce the likelihood of a high velocity of air that may disrupt the fire plume and also push smoke back into occupied areas. See the commentary for Section 909.8 for discussion on avoiding plugholing.

**909.10.4 Automatic dampers.** Automatic dampers, regardless of the purpose for which they are installed within the smoke control system, shall be *listed* and conform to the requirements of *approved* recognized standards.

❖ This section addresses the reliability of any dampers used within a smoke control system. This particular provision requires that the dampers be listed and conform to the appropriate recognized standards. More specifically, Section 717 of the IBC contains more detailed information on the specific requirements for smoke and fire dampers. Smoke and fire dampers should be listed in accordance with UL 555S and 555, respectively. Also, remember that each smoke control design is unique and the sequence and methods used to activate the dampers may vary from design to design. This information needs to be addressed in the construction documents.

Another factor to take into account, with regard to timing of the system, is the fact that some dampers react more quickly than others, simply due to the particular smoke damper characteristics. Additionally, during the commissioning of the system, the damper is going to be exposed to many repetitions. These repetitions need to be accounted for in the overall reliability of the system.

**909.10.5 Fans.** In addition to other requirements, belt-driven fans shall have 1.5 times the number of belts required for the design duty with the minimum number of belts being two. Fans shall be selected for stable performance based on normal temperature and, where applicable, elevated temperature. Calculations and manufacturer's fan curves shall be part of the documentation procedures. Fans shall be supported and restrained by noncombustible devices in accordance with the structural design requirements of Chapter 16 of the *International Building Code*.

Motors driving fans shall not be operated beyond their nameplate horsepower (kilowatts) as determined from measurement of actual current draw and shall have a minimum service factor of 1.15.

❖ Part of the overall reliability requires that fans used to provide supply air and exhaust capacity will be functioning when necessary; therefore, a safety factor of 1.5 is placed upon the required belts for fans. All fans used as part of a smoke control system must provide 1.5 times the number of required belts with a minimum of two belts for all fans.

This section also points out that the fan chosen should fit the specific application. It should be able to

withstand the temperature rise as calculated in Section 909.10.1 and generally be able to handle typical exposure conditions, such as location and wind. For instance, propeller fans are highly sensitive to the effects of wind. When located on the windward side of a building, wall-mounted, nonhooded propeller fans are not able to compensate for wind effects. Additionally, even hooded propeller fans located on the leeward side of the building may not adequately compensate for the decrease in pressure caused by wind effects. In general, when designing a system, it should be remembered that field conditions might vary from the calculations; therefore, flexibility should be built into the design that would account for things, such as variations in wind conditions.

Finally, this section stresses that fan motors not be operated beyond their rated horsepower.

**909.11 Standby power.** Smoke control systems shall be provided with standby power in accordance with Section 604.

❖ This section references Section 604 for the specifics as to what is required for standby power. As with any life safety system, a level of redundancy with regard to power supply is required to enable the functioning of the system during a fire. The primary source is the building's normal power system. The secondary power system is by means of standby power. One of the key elements is that standby power systems are intended to operate within 60 seconds of loss of primary power. It should be noted that the primary difference between standby power and emergency power is that emergency power must operate within 10 seconds of loss of primary power versus 60 seconds.

**909.11.1 Equipment room.** The standby power source and its transfer switches shall be in a room separate from the normal power transformers and switch gears and ventilated directly to and from the exterior. The room shall be enclosed with not less than 1-hour fire barriers constructed in accordance with Section 707 of the *International Building Code* or horizontal assemblies constructed in accordance with Section 711 of the *International Building Code*, or both.

❖ This section requires isolation from normal building power systems via a 1-hour fire barrier, 1-hour horizontal assembly, or both, depending upon the location within the building. This increases the reliability and reduces the likelihood that a single event could remove both power supplies. The intent of the ventilation is focused on the proper function of the standby power source in terms of engine-driven generators having appropriate cooling air and combustion air. The requirement that it be from the outside is related to the protection of such ventilation from the effects of the fire.

**909.11.2 Power sources and power surges.** Elements of the smoke control system relying on volatile memories or the like shall be supplied with uninterruptible power sources of sufficient duration to span 15-minute primary power interruption. Elements of the smoke control system susceptible to power

surges shall be suitably protected by conditioners, suppressors or other *approved* means.

❖ Smoke control systems have many components, sometimes highly sensitive electronics, that are adversely affected by any interruption in or sudden surges of power. Therefore, Section 909.11.1 requires that any components of a smoke control system, such as volatile memories, be supplied with an uninterruptible power system for the first 15 minutes of loss of primary power. Volatile memory components will lose memory upon any loss of power no matter how short the time period. Once the 15 minutes elapses, these elements can be transitioned to the already operating standby power supply.

With regard to components sensitive to power surges, they need to be provided with surge protection in the form of conditioners, suppressors or other approved means.

**909.12 Detection and control systems.** Fire detection systems providing control input or output signals to mechanical smoke control systems or elements thereof shall comply with the requirements of Section 907. Such systems shall be equipped with a control unit complying with UL 864 and *listed* as smoke control equipment.

❖ This section is focused on proper monitoring of the fire detection systems that activate the smoke control system through compliance with Section 907 and UL 864. This requires a specific listing of the fire alarm control unit as smoke control equipment. UL 864 has a subcategory (UUKL) specific to fire alarm control panels for smoke control system applications.

**909.12.1 Verification.** Control systems for mechanical smoke control systems shall include provisions for verification. Verification shall include positive confirmation of actuation, testing, manual override and the presence of power downstream of all disconnects. A preprogrammed weekly test sequence shall report abnormal conditions audibly, visually and by printed report. The preprogrammed weekly test shall operate all devices, equipment, and components used for smoke control.

**Exception:** Where verification of individual components tested through the preprogrammed weekly testing sequence will interfere with, and produce unwanted effects to, normal building operation, such individual components are permitted to be bypassed from the preprogrammed weekly testing, where *approved* by the *fire code official* and in accordance with both of the following:

1. Where the operation of components is bypassed from the preprogrammed weekly test, presence of power downstream of all disconnects shall be verified weekly by a listed control unit.
2. Testing of all components bypassed from the preprogrammed weekly test shall be in accordance with Section 909.20.6.

❖ This section addresses the function of the mechanical elements of the smoke control system once the

system is activated. In particular, there is a focus on verification of activities. Verification would include the following two aspects:

1. The system is able to verify actuations, testing, manual overrides and the presence of power downstream. This would require information reported back to the smoke control panel, which can be accomplished via the weekly test sequence or through full electronic monitoring of the system.
2. Conduct a preprogrammed weekly test that simulates an actual (smoke) event to test the components of the system. These components would include elements such as smoke dampers, fans and doors. Abnormal conditions need to be reported in three ways:
  - a. Audibly;
  - b. Visually; and
  - c. Printed report.

It should be noted that electrical monitoring of the control components is not required (supervision). Such supervision verifies integrity of the conductors from a fire alarm control unit to the control system input. The weekly test is considered sufficient verification of system performance and is often termed end-to-end verification. In other words, the control system input provides the expected results. Verification can be accomplished through any sensor that is calibrated to distinguish between the difference between proper operation and a fault condition. For fans, proper operation means that the fan is moving air within the intent of its design. Fault conditions include power failure, broken fan belts, adverse wind effects, a locked rotor condition and/or filters or large ducts that are blocked causing significantly reduced airflow. In addition to differential pressure transmitters and sail switches, this can be accomplished by the present state of the art current sensors. More discussion on verification for elements such as ducts and fire doors is discussed in Chapter 9 of *A Guide to Smoke Control in the 2006 IBC*.

Also, the fact that a smoke control system is non-dedicated (integrated with an HVAC system) does not mean that it is automatically being tested on a daily basis. It is cautioned that simply depending on occupant discomfort, for example, is sometimes an insufficient indicator of a fully functioning smoke control system. There may be various modes in which the HVAC system could operate that may not exercise the smoke control features and the sequence in which the system should operate. An example is an air-conditioning system operating only in full recirculating mode versus exhaust mode. This failure will likely not affect occupants and will not exercise the exhaust function. Plus, doors, which may be part of the smoke barrier, may not need to be closed in normal building operations but would need to be closed

during smoke control system operation. This is why this section does not necessarily differentiate between dedicated and non-dedicated smoke control systems and requires the system components to be tested.

It is important to note that this weekly test sequence is not an actual smoke event and is only intended to activate the system to ensure that the components are working correctly.

The exception addresses the impracticality of requiring a weekly test for many buildings. For many systems, the weekly test requires the introduction of untreated air into the smoke zone. This can be impractical in areas with cold or hot climates, and for buildings that require close control of temperature and humidity, such as art museums and similar facilities. The introduction of the untreated air can also result in wasting energy to reheat, recool, humidify, or dehumidify the smoke control zone.

The intent of the exception is to provide means to verify that the required systems will be available when needed. The code requires control units to comply with UL 864, thus all components of the control system will be supervised. The exception includes requirements for verification of the power downstream of all disconnects such as power breakers, power disconnects, automatic transfer switches, motor starters, and motor controls. This will provide reasonable assurance that power will be available for all smoke control components, such as fans, dampers, doors, and windows. The exception also adds the semiannual requirement for a complete system test by reference to Section 909.20.6. This allows the building owner to schedule complete system testing on days that will reduce the impact to the building and energy needs. The combination of additional supervision and additional testing provides a reasonable alternative to weekly testing.

**909.12.2 Wiring.** In addition to meeting requirements of NFPA 70, all wiring, regardless of voltage, shall be fully enclosed within continuous raceways.

❖ Wiring is required to be placed within continuous raceways which provides an additional level of reliability for the system. The definition of the term “raceway” in NFPA 70 lists several acceptable types of complying raceway that can be used, however manufactured cable assemblies such as metal-clad cable (Type MC) or armored cable (Type AC) are not included.

**909.12.3 Activation.** Smoke control systems shall be activated in accordance with this section.

❖ The activation of a smoke control system is dependent on when such a system is required. Mechanical smoke control systems, which could include pressurization, airflow or exhaust methods, require an automatic activation mechanism. When using a passive system, which depends upon compartmentation, spot-type detectors are acceptable for the release of door closers and similar openings. Whereas with

more complex mechanical systems such activation needs to go beyond single station detectors and be part of an automatic coordinated system.

**909.12.3.1 Pressurization, airflow or exhaust method.**

Mechanical smoke control systems using the pressurization, airflow or exhaust method shall have completely automatic control.

❖ Automatic activation of such systems is especially critical as tenability is much more difficult to achieve if a delay occurred waiting for manual activation of the system. See Sections 909.6 for the pressurization method, 909.7 for the airflow design method and 909.8 for the exhaust method.

**909.12.3.2 Passive method.** Passive smoke control systems actuated by *approved* spot-type detectors *listed* for releasing service shall be permitted.

❖ This section recognizes that a passive system does not address smoke containment through mechanical means; therefore, it does not need to be “automatically activated” except in cases where smoke barriers have openings. These openings would be required to have smoke detectors to close openings where required by the design. Although spot type detectors are technically automatic they are not part of a more coordinated system of activation as needed for mechanical smoke control systems. Such detectors are simply standalone devices that fail in the fail safe position. In other words if the power were lost a door on a magnetic hold would simply close.

**909.12.4 Automatic control.** Where completely automatic control is required or used, the automatic-control sequences shall be initiated from an appropriately zoned *automatic sprinkler system* complying with Section 903.3.1.1, manual controls that are readily accessible to the fire department and any smoke detectors required by the engineering analysis.

❖ When automatic activation is required, it must be accomplished by a properly zoned automatic sprinkler system and, if the engineering analysis requires them, smoke detectors. Manual control for the fire department needs to be provided. An important point with this particular requirement is that smoke control systems are engineered systems and a prescribed smoke detection system may not fit the needs of the specific design. Other types of detectors, such as beam detectors (within an atrium), may be used and could be more useful and be more practical from a maintenance standpoint. Also, it may not be practical or appropriate for the building’s fire alarm system to activate such systems as it may alter the effectiveness of the system by pulling smoke through the building versus removing or containing the smoke. For example, a building with an atrium may have several floors below the space. If a fire occurs in one of the floors not associated with the atrium the atrium smoke control system could possibly pull smoke throughout the building if the detection is zoned incorrectly.

**909.13 Control air tubing.** Control air tubing shall be of sufficient size to meet the required response times. Tubing shall be flushed clean and dry prior to final connections and shall be adequately supported and protected from damage. Tubing passing through concrete or masonry shall be sleeved and protected from abrasion and electrolytic action.

❖ Control tubing is a method that uses pneumatics to operate components such as the opening and closing of dampers. Due to the sophistication of electronic systems today, control tubing is becoming less common.

These particular requirements provide the criteria for properly designing and installing control tubing. Essentially, it is up to the design professional to determine the size requirements and to properly design appropriate supports. This information needs to be detailed within the construction documents. Additionally, due to the effect of moisture and other contaminants on control tubing, it must be flushed clean then dried before installation.

**909.13.1 Materials.** Control air tubing shall be hard drawn copper, Type L, ACR in accordance with ASTM B 42, ASTM B 43, ASTM B 68, ASTM B 88, ASTM B 251 and ASTM B 280. Fittings shall be wrought copper or brass, solder type, in accordance with ASME B 16.18 or ASME B 16.22. Changes in direction shall be made with appropriate tool bends. Brass compression-type fittings shall be used at final connection to devices; other joints shall be brazed using a BCuP5 brazing alloy with solidus above 1,100°F (593°C) and liquidus below 1,500°F (816°C). Brazing flux shall be used on copper-to-brass joints only.

**Exception:** Nonmetallic tubing used within control panels and at the final connection to devices, provided all of the following conditions are met:

1. Tubing shall comply with the requirements of Section 602.2.1.3 of the *International Mechanical Code*.
2. Tubing and the connected device shall be completely enclosed within a galvanized or paint-grade steel enclosure having a minimum thickness of 0.0296 inch (0.7534 mm) (No. 22 gage). Entry to the enclosure shall be by copper tubing with a protective grommet of neoprene or Teflon or by suitable brass compression to male-barbed adapter.
3. Tubing shall be identified by appropriately documented coding.
4. Tubing shall be neatly tied and supported within the enclosure. Tubing bridging cabinets and doors or moveable devices shall be of sufficient length to avoid tension and excessive stress. Tubing shall be protected against abrasion. Tubing serving devices on doors shall be fastened along hinges.

❖ This section addresses the materials allowed for control air tubing along with approved methods of connection. All of this information needs to be documented, as it will be subject to review by the special inspector.

**909.13.2 Isolation from other functions.** Control tubing serving other than smoke control functions shall be isolated by automatic isolation valves or shall be an independent system.

- ❖ This section requires separation of control tubing used for other functions through the use of isolation valves or a completely separate system. This is due to the difference in requirements for control tubing used in a smoke control system versus other building systems. The isolation of the control air tubing for a smoke control system needs to be specifically noted on the construction documents.

**909.13.3 Testing.** Control air tubing shall be tested at three times the operating pressure for not less than 30 minutes without any noticeable loss in gauge pressure prior to final connection to devices.

- ❖ As part of the acceptance testing of the smoke control system, the control air tubing will be pressure tested three times the operating pressure for 30 minutes or more. The performance criteria as to whether the control tubing is considered a failure is when there is any noticeable loss in gauge pressure prior to final connection of devices during the 30-minute duration test.

**909.14 Marking and identification.** The detection and control systems shall be clearly marked at all junctions, accesses and terminations.

- ❖ This section requires that all portions of the fire detection system that activate the smoke control system be marked and identified appropriately. This includes all applicable fire alarm-initiating devices, the respective junction boxes, all data-gathering panels and fire alarm control panels. Additionally, all components of the smoke control system, which are not considered a fire detection system, are required to be properly identified and marked. This would include all applicable junction boxes, control tubing, temperature control modules, relays, damper sensors, automatic door sensors and air movement sensors.

**909.15 Control diagrams.** Identical control diagrams showing all devices in the system and identifying their location and function shall be maintained current and kept on file with the *fire code official*, the fire department and in the *fire command center* in a format and manner *approved* by the fire chief.

- ❖ The purpose of control diagrams is to provide consistent information on the system in several key locations, including the building department, the fire department and the fire command center. If a fire command center is not required or provided, the diagrams need to be located such that they can be readily accessed during an emergency. Some possible locations may be the security office, the building manager's office or, if possible, within the smoke control panel. This information is intended to assist in the use and operation of the smoke control system. The format of the control diagram is as approved by the fire

chief. This is necessary since the fire department is the agency that will be using such a system during a fire and when the system is tested in the future. The more clearly the information is communicated, the more effective the smoke control system will be.

It should be noted that the fire department may want all smoke control systems within a jurisdiction to follow a particular protocol for control diagrams. Generally, the control diagrams should indicate the required reaction of the system in all scenarios. The status or position of every fan and damper in every scenario must be clearly identified.

**909.16 Fire fighter's smoke control panel.** A fire fighter's smoke control panel for fire department emergency response purposes only shall be provided and shall include manual control or override of automatic control for mechanical smoke control systems. The panel shall be located in a *fire command center* complying with Section 508 in high-rise buildings or buildings with smoke-protected assembly seating. In all other buildings, the fire fighter's smoke control panel shall be installed in an *approved* location adjacent to the fire alarm control panel. The fire fighter's smoke control panel shall comply with Sections 909.16.1 through 909.16.3.

- ❖ One of the elements that makes a smoke control system effective is that its activity is successfully communicated to the fire department and the fire department is able to manually operate the system. The following sections provide requirements for a control panel specifically for smoke control systems. This panel is required to be located within a fire command center when it is located in a high-rise building or there is smoke-protected seating. Section 403.4.6 of the IBC would require a fire command center for high-rise buildings. Smoke-protected seating does not require a fire command center in Chapter 10 but this provision would ensure that one exists and contains the smoke control panel. Facilities with smoke-protected seating tend to be larger facilities that, at the very least, would already have a central security center if not a fire command center as required by the jurisdiction. All other locations would only need to provide the panel in an approved location as long as it is located with the fire alarm panel. The specific location will depend on the needs of the fire department in that jurisdiction. The reason not all fire-fighter smoke control panels need to be located in a fire command center is that many smoke control systems are located in a building containing an atrium that may only be three stories in height. A 200-square-foot (19 m<sup>2</sup>) fire command center would be excessive for such buildings. There are two components that include the requirements for the display and for the controls. This control panel will provide an ability to override any other controls whether manual or automatic within the building as they relate to the smoke control system.

Note that the publication *A Guide to Smoke Control in the 2006 IBC* goes into more detail about the fire fighter smoke control panel requirements.

**909.16.1 Smoke control systems.** Fans within the building shall be shown on the fire fighter’s control panel. A clear indication of the direction of airflow and the relationship of components shall be displayed. Status indicators shall be provided for all smoke control equipment, annunciated by fan and zone and by pilot-lamp-type indicators as follows:

1. Fans, dampers and other operating equipment in their normal status—WHITE.
2. Fans, dampers and other operating equipment in their off or closed status—RED.
3. Fans, dampers and other operating equipment in their on or open status—GREEN.
4. Fans, dampers and other operating equipment in a fault status—YELLOW/AMBER.

❖ This section denotes what should be displayed on the control panel. The display is required to include all fans, an indication of the direction of airflow and the relationship of the components. Also, status lights are required, and this section sets out specific standardized colors to indicate normal status, closed status, open status and fault status. A standardized approach increases the likelihood that the fire department will be able to quickly become familiar with a system. Since the fire department has the ability to override the automatic functions of the system, this information is critical.

**909.16.2 Smoke control panel.** The fire fighter’s control panel shall provide control capability over the complete smoke control system equipment within the building as follows:

1. ON-AUTO-OFF control over each individual piece of operating smoke control equipment that can also be controlled from other sources within the building. This includes *stairway* pressurization fans; smoke exhaust fans; supply, return and exhaust fans; elevator shaft fans; and other operating equipment used or intended for smoke control purposes.
2. OPEN-AUTO-CLOSE control over individual dampers relating to smoke control and that are also controlled from other sources within the building.
3. ON-OFF or OPEN-CLOSE control over smoke control and other critical equipment associated with a fire or smoke emergency and that can only be controlled from the fire fighter’s control panel.

**Exceptions:**

1. Complex systems, where *approved*, where the controls and indicators are combined to control and indicate all elements of a single smoke zone as a unit.
2. Complex systems, where *approved*, where the control is accomplished by computer interface using *approved*, plain English commands.

❖ This section sets the requirements as to which controls need to be provided for the fire department on the control panel.

There are two aspects to the controls. The controls will include on-auto-off and open-auto-close settings or will be strictly on-off or open-close. If the system or component can be set on automatic (auto), it can be controlled from other locations beyond the fire command center. This would include an automatic smoke detection system or by manual activation. If a control only contains on-off or open-close settings, the only way the system component can be controlled is in the fire command center.

It should be noted that components such as fans are usually associated with on-off-type controls, whereas components such as dampers are associated with open-close-type controls.

**909.16.3 Control action and priorities.** The fire fighter’s control panel actions shall be as follows:

1. ON-OFF and OPEN-CLOSE control actions shall have the highest priority of any control point within the building. Once issued from the fire fighter’s control panel, automatic or manual control from any other control point within the building shall not contradict the control action. Where automatic means are provided to interrupt normal, nonemergency equipment operation or produce a specific result to safeguard the building or equipment including, but not limited to, duct freezestats, duct smoke detectors, high-temperature cutouts, temperature-actuated linkage and similar devices, such means shall be capable of being overridden by the fire fighter’s control panel. The last control action as indicated by each fire fighter’s control panel switch position shall prevail. Control actions shall not require the smoke control system to assume more than one configuration at any one time.

**Exception:** Power disconnects required by NFPA 70.

2. Only the AUTO position of each three-position fire-fighter’s control panel switch shall allow automatic or manual control action from other control points within the building. The AUTO position shall be the NORMAL, nonemergency, building control position. Where a fire fighter’s control panel is in the AUTO position, the actual status of the device (on, off, open, closed) shall continue to be indicated by the status indicator described in Section 909.16.1. Where directed by an automatic signal to assume an emergency condition, the NORMAL position shall become the emergency condition for that device or group of devices within the zone. Control actions shall not require the smoke control system to assume more than one configuration at any one time.

❖ This section clarifies that when a component of the system is placed in an on-off or open-close configuration, no other control point in the building, whether automatic or manual, can override the action established in the fire command center. If a system component is configured in auto mode, it can be controlled from locations within the building beyond the fire command center. Some controls are specifically

designed to only allow an action from the fire command center.

**909.17 System response time.** Smoke-control system activation shall be initiated immediately after receipt of an appropriate automatic or manual activation command. Smoke control systems shall activate individual components (such as dampers and fans) in the sequence necessary to prevent physical damage to the fans, dampers, ducts and other equipment. For purposes of smoke control, the fire fighter's control panel response time shall be the same for automatic or manual smoke control action initiated from any other building control point. The total response time, including that necessary for detection, shutdown of operating equipment and smoke control system startup, shall allow for full operational mode to be achieved before the conditions in the space exceed the design smoke condition. The system response time for each component and their sequential relationships shall be detailed in the required rational analysis and verification of their installed condition reported in the required final report.

❖ This particular section provides the criteria as to when the smoke control system is required to begin operation. Whether or not the activation is manual or automatic, this criteria clarifies that the system be initiated immediately. Also, it requires that components activate in a sequence that will not potentially damage the fans, dampers, ducts and other equipment. Unrealistic timing of the system has the potential of creating an unsuccessful system. Delays in the system can be seen in slow dampers, fans that ramp up or down, systems that poll slowly and intentional built-in delays. These factors can add significantly to the reaction time of the system and may hamper achieving the design goals.

The key element is that the system be fully operational before the smoke conditions exceed the design parameters. The design should include these possible delays when analyzing the smoke layer interface location. The sequence of events need to be justified within the design analysis and described clearly in the construction documents.

**909.18 Acceptance testing.** Devices, equipment, components and sequences shall be individually tested. These tests, in addition to those required by other provisions of this code, shall consist of determination of function, sequence and, where applicable, capacity of their installed condition.

❖ In order to achieve a certain level of performance, the smoke control system needs to be thoroughly tested. Section 909.18 requires that all devices, equipment components and sequences be individually tested.

**909.18.1 Detection devices.** Smoke or fire detectors that are a part of a smoke control system shall be tested in accordance with Chapter 9 in their installed condition. Where applicable, this testing shall include verification of airflow in both minimum and maximum conditions.

❖ Detection devices are required to be tested in accordance with the fire protection requirements found in Chapter 9. Also, since such detectors may be subject to higher air velocities than typical detectors, their

operation needs to be verified in the minimum and maximum anticipated airflow conditions.

**909.18.2 Ducts.** Ducts that are part of a smoke control system shall be traversed using generally accepted practices to determine actual air quantities.

❖ This section requires ducts that are part of the smoke control system to be tested to show that the proper amount of air is flowing. It should be noted that Section 909.10.2 requires that the ducts be leak tested to 1.5 times the maximum design pressure. Such leakage is not allowed to exceed 5 percent of the design flow.

**909.18.3 Dampers.** Dampers shall be tested for function in their installed condition.

❖ This section notes that all dampers need to be inspected to meet the function for which they are installed. For instance, a damper that is to be open when the system is in smoke control mode should be verified to be open when testing the system. Also, a damper may have a specific timing associated with its operation that would need to be verified though testing.

**909.18.4 Inlets and outlets.** Inlets and outlets shall be read using generally accepted practices to determine air quantities.

❖ Similar to ducts, the appropriate amount of air that is entering or exiting the inlets and outlets, respectively, must be checked.

**909.18.5 Fans.** Fans shall be examined for correct rotation. Measurements of voltage, amperage, revolutions per minute and belt tension shall be made.

❖ This section requires the testing of fans for the following: correct rotation, voltage, amperage, revolutions per minute and belt tension. These features are key in having the system run as designed.

A common problem with fans is that they are often installed in the reverse direction. Also, to verify the reliability of the fans, elements such as the appropriate voltage and belt tension need to be tested.

**909.18.6 Smoke barriers.** Measurements using inclined manometers or other *approved* calibrated measuring devices shall be made of the pressure differences across *smoke barriers*. Such measurements shall be conducted for each possible smoke control condition.

❖ As discussed in Section 909.5.2, the testing of pressure differences across smoke barriers needs to be measured in the smoke control mode. As noted in Section 909.18.6, such testing is to be performed for every possible smoke control condition, and the measurements will be taken using an inclined manometer or other approved methods. Electronic devices are also available. Qualified individuals must calibrate these types of devices. Additionally, before using an alternative method of testing, the fire code official needs to approve such a method.

**909.18.7 Controls.** Each smoke zone equipped with an automatic-initiation device shall be put into operation by the actu-

ation of one such device. Each additional device within the zone shall be verified to cause the same sequence without requiring the operation of fan motors in order to prevent damage. Control sequences shall be verified throughout the system, including verification of override from the fire fighter's control panel and simulation of standby power conditions.

❖ This section requires the overall testing of the system. More specifically, each zone needs to individually initiate the smoke control system by the activation of an automatic initiation device. Once that has occurred, all other devices within each zone need to be verified that they will activate the system, but to avoid damage, the fans do not need to be activated.

In addition to determining that all the appropriate devices initiate the system, it must also be verified that all of the controls on the fire-fighter control panel initiate the appropriate aspects of the smoke control system, including the override capability.

Finally, the initiation and availability of the standby power system need to be verified.

**909.18.8 Testing for smoke control.** Smoke control systems shall be tested by a special inspector in accordance with Section 1705.18 of the *International Building Code*.

❖ Smoke control systems require special inspection since they are unique and complex life safety systems. Section 1705.18 of the IBC provides the same requirements for special inspection as presented in Sections 909.18.8.1 and 909.18.8.2.

**909.18.8.1 Scope of testing.** Testing shall be conducted in accordance with the following:

1. During erection of ductwork and prior to concealment for the purposes of leakage testing and recording of device location.
2. Prior to occupancy and after sufficient completion for the purposes of pressure-difference testing, flow measurements, and detection and control verification.

❖ Special inspections need to occur at two different stages during construction to facilitate the necessary inspections. The first round of special inspections occurs before concealment of the ductwork or fire protection elements. The special inspector needs to verify the leakage as noted in Section 909.10.2. Additionally, the location of all fire protection devices needs to be verified and documented at this time.

The second round of special inspections occurs just prior to occupancy. The inspections include the verification of pressure differences across smoke barriers as required in Sections 909.5.2 and 909.18.6, the verification of appropriate volumes of airflow as noted in the design and finally the verification of the appropriate operation of the detection and control mechanisms as required in Sections 909.18.1 and 909.18.7. These tests need to occur just prior to occupancy, since the test result will more clearly represent actual conditions. This also makes a robust design and quality assurance during construction critical as it is very costly and difficult in most cases to

make changes at this stage. Note that the test does not actually place smoke into the space and demonstrate the smoke layer interface location. Instead, the testing is focused on all the elements of the design such as airflow and duct closure as prescribed by the specific design.

**909.18.8.2 Qualifications.** *Approved* agencies for smoke control testing shall have expertise in fire protection engineering, mechanical engineering and certification as air balancers.

❖ As noted in Section 909.3, special inspections are required for smoke control systems. This means a certain level of qualification that would include the need for expertise in fire protection engineering, mechanical engineering and certification as air balancers.

**909.18.8.3 Reports.** A complete report of testing shall be prepared by the approved agency. The report shall include identification of all devices by manufacturer, nameplate data, design values, measured values and identification tag or mark. The report shall be reviewed by the responsible registered design professional and, when satisfied that the design intent has been achieved, the responsible registered design professional shall sign, seal and date the report.

❖ Once the testing by the special inspector is complete, documentation of the activity is required. This documentation is to be prepared in the form of a report that identifies all devices by manufacturer, nameplate data, design values, measured values and identification or mark.

**909.18.8.3.1 Report filing.** A copy of the final report shall be filed with the *fire code official* and an identical copy shall be maintained in an *approved* location at the building.

❖ The report needs to be reviewed, approved and then signed, sealed and dated. This report is to be provided to the building official and a copy is also to remain in the building in an approved location. When a fire command center is required this is the best location for such documents. Otherwise, a location such as the security office or building manager's office might be appropriate.

**909.18.9 Identification and documentation.** Charts, drawings and other documents identifying and locating each component of the smoke control system, and describing their proper function and maintenance requirements, shall be maintained on file at the building as an attachment to the report required by Section 909.18.8.3. Devices shall have an *approved* identifying tag or mark on them consistent with the other required documentation and shall be dated indicating the last time they were successfully tested and by whom.

❖ Additional documentation that needs to be maintained includes charts, drawings and other related documentation that assists in the identification of each aspect of the smoke control system. This documentation is where information, such as the last time a device or component was successfully tested and by whom, is recorded. This will serve as the main

documentation for the system. Again, the fire command center, if required, is the most appropriate location for such information (see commentary, Section 909.18.8.3.1).

**909.19 System acceptance.** Buildings, or portions thereof, required by this code to comply with this section shall not be issued a certificate of occupancy until such time that the *fire code official* determines that the provisions of this section have been fully complied with and that the fire department has received satisfactory instruction on the operation, both automatic and manual, of the system and a written maintenance program complying with the requirements of Section 909.20.1 has been submitted and *approved* by the *fire code official*.

**Exception:** In buildings of phased construction, a temporary certificate of occupancy, as *approved* by the *fire code official*, shall be allowed, provided that those portions of the building to be occupied meet the requirements of this section and that the remainder does not pose a significant hazard to the safety of the proposed occupants or adjacent buildings.

❖ This section stipulates that the certificate of occupancy cannot be issued unless the smoke control system has been accepted. It is essential that the system be inspected and approved since it is a life safety system. There is an exception for buildings that are constructed in phases where a temporary certificate of occupancy is allowed. For example, a building where the portion requiring smoke control is not yet occupied so egress concerns through that space are not relevant. This space needs to be separated by smoke barriers (different smoke zone). The code also requires a maintenance program for smoke control systems since the long-term success of such systems depends heavily on proper maintenance in addition to rigorous acceptance testing. The IBC simply provides a reference to that section of the code.

**909.20 Maintenance.** Smoke control systems shall be maintained to ensure to a reasonable degree that the system is capable of controlling smoke for the duration required. The system shall be maintained in accordance with the manufacturer's instructions and Sections 909.20.1 through 909.20.6.

❖ Routine maintenance and testing of smoke control systems is essential to ensure their performance, as designed, under fire conditions. Maintenance practices must be consistent with the manufacturer's recommendations and as indicated in Sections 909.20.1 through 909.20.5. Note that Section 909.12.1 requires weekly preprogrammed tests which report abnormal conditions.

**909.20.1 Schedule.** A routine maintenance and operational testing program shall be initiated immediately after the smoke control system has passed the acceptance tests. A written schedule for routine maintenance and operational testing shall be established.

❖ Operational testing and maintenance must be performed on the smoke control system periodically to

verify that it still operates as required by the approved design. A written schedule must be maintained.

**909.20.2 Records.** Records of smoke control system testing and maintenance shall be maintained. The record shall include the date of the maintenance, identification of the servicing personnel and notification of any unsatisfactory condition and the corrective action taken, including parts replaced.

❖ This section prescribes the desired content of the written record for the smoke control testing and maintenance program. Test results and maintenance activities should be clearly documented. The written record should be available for inspection and reviewed by the fire code official.

**909.20.3 Testing.** Operational testing of the smoke control system shall include all equipment such as initiating devices, fans, dampers, controls, doors and windows.

❖ Smoke control systems are made up of components and equipment that are an integral part of other building systems such as fire alarm systems, heating, ventilating and air-conditioning (HVAC) equipment and automatic sprinkler systems. For this reason, operational testing of all related system components must ensure that the system as a whole will perform as intended.

**909.20.4 Dedicated smoke control systems.** Dedicated smoke control systems shall be operated for each control sequence semiannually. The system shall be tested under standby power conditions.

❖ Because dedicated smoke control systems are designed for smoke control only, the operation of these systems does not adversely affect other building systems or operations. The control sequence for these systems must be tested semiannually to check for system component failures that may not get noticed because dedicated smoke control systems are independent of building HVAC systems.

**909.20.5 Nondedicated smoke control systems.** Non-dedicated smoke control systems shall be operated for each control sequence annually. The system shall be tested under standby power conditions.

❖ Contrary to dedicated smoke control systems identified in Section 909.20.4, smoke control systems that are not dedicated share system components with other building systems including the HVAC system. Consequently, testing of the control sequence of systems that are not dedicated can be done annually, rather than semiannually, because equipment failures related to other building systems would most likely be noticed and corrected when those other systems were tested or maintained.

Simply because a system is nondedicated does not guarantee that failures will be detected easier. This relates to the fact that when a system is in smoke control mode it may have very different demands than when simply operating as a traditional HVAC system (see commentary, Section 909.12).

**909.20.6 Components bypassing weekly test.** Where components of the smoke control system are bypassed by the pre-programmed weekly test required by Section 909.12.1, such components shall be tested semiannually. The system shall be tested under standby power conditions.

❖ This section is specifically linked to the exception in Section 909.12.1 that allows the elimination of the weekly test of the system. In order to allow the elimination of the weekly test, Section 909.12.1 provides additional monitoring features and requires more frequent testing of the overall system by a special inspector. This will primarily affect nondedicated systems which are currently only required to be tested annually. Dedicated systems are already required to be tested semiannually.

**[BF] 909.21 Elevator hoistway pressurization alternative.** Where elevator hoistway pressurization is provided in lieu of required enclosed elevator lobbies, the pressurization system shall comply with Sections 909.21.1 through 909.21.11.

❖ This section sets out the requirements for hoistway pressurization when used as a method to protect hoistway openings as required in Section 3006. The minimum and maximum pressures are similar to those for pressurized stairs in Section 909.20.5 of the IBC. The provisions are located in Section 909 to group all the smoke control techniques and requirements into the same section. This will promote more consistency in code application when addressing smoke control.

**[BF] 909.21.1 Pressurization requirements.** Elevator hoistways shall be pressurized to maintain a minimum positive pressure of 0.10 inch of water (25 Pa) and a maximum positive pressure of 0.25 inch of water (67 Pa) with respect to adjacent occupied space on all floors. This pressure shall be measured at the midpoint of each hoistway door, with all elevator cars at the floor of recall and all hoistway doors on the floor of recall open and all other hoistway doors closed. The pressure differential shall be measured between the hoistway and the adjacent elevator landing. The opening and closing of hoistway doors at each level must be demonstrated during this test. The supply air intake shall be from an outside, uncontaminated source located a minimum distance of 20 feet (6096 mm) from any air exhaust system or outlet.

**Exceptions:**

1. On floors containing only Group R occupancies, the pressure differential is permitted to be measured between the hoistway and a *dwelling unit* or *sleeping unit*.
2. Where an elevator opens into a lobby enclosed in accordance with Section 3007.6 or 3008.6 of the *International Building Code*, the pressure differential is permitted to be measured between the hoistway and the space immediately outside the door(s) from the floor to the enclosed lobby.

3. The pressure differential is permitted to be measured relative to the outdoor atmosphere on floors other than the following:

- 3.1. The fire floor.
- 3.2. The two floors immediately below the fire floor.
- 3.3. The floor immediately above the fire floor.

4. The minimum positive pressure of 0.10 inch of water (25 Pa) and a maximum positive pressure of 0.25 inch of water (67 Pa) with respect to occupied floors is not required at the floor of recall with the doors open.

❖ This section states the minimum and the maximum positive pressure that must be achieved by the smoke control mechanical pressurization system. The minimum positive pressure is 0.10 inch of water column (0.02 kPa), the same as required for stairway pressurization in Section 909.20.5 of the IBC. The maximum pressure is 0.25 inch of water column (0.06 kPa) which is a little less than the maximum allowed for stairway pressurization. The minimum pressure is to ensure that the stack effect is overcome and the maximum pressure is an upper limit to ensure that the doors will operate properly. This section requires a test when the system is complete. The pressures are measured at the midpoint of each hoistway door with all elevator cars at the recall floor and all the hoistway doors open on that level. This simulates the Phase I recall requirements in Section 3003.2 of the IBC. Hoistway doors are then tested on each level to ensure proper operation.

The supply air intake for the pressurization system must be located at least 20 feet (6096 mm) away from any source of contamination to ensure that the hoistway remains tenable through the fire event or well into it before the elevators can no longer be used. Also, if smoke is drawn into the supply air, the system will only spread smoke and not prevent fire spread.

There are four exceptions to the requirements of this section. The first two provide exceptions as to where the pressure differential can be measured. Exception 3 allows the pressure differences only to be measured at the fire floor and several designated floors. Finally, Exception 4 allows the pressure differential measurement to be omitted for the floor of recall.

The first three exceptions originated from the City of Seattle, WA which has had a long history of requiring pressurized hoistways in high rise buildings to prevent smoke migration. In 2005, the City of Seattle Department of Planning & Development (DPD) convened a committee which included representatives from the industry, the Seattle Fire Department and DPD, to decide whether to recommend changes to

the high-rise smoke migration control requirements in place at that time. The committee also consulted with Dr. John Klote, who suggested the approach that Seattle eventually adopted with some small modifications. These requirements are an adaptation of the Seattle approach.

During the 2009/2010 code change cycle, a proposal was made to delete the hoistway pressurization requirements in the IBC without substitution (FS51-09/10), based on a study conducted by Drs. Miller and Beasley. This study showed that requiring the pressure differential of 0.10 inches of water column to be maintained at the recall floor with the elevator doors in the open position resulted in over-pressurization of all the other floors—meaning the current standards in the code cannot be met. Based on further modeling by Dr. Miller, the proponent for FS51-09/10 submitted a public comment introducing Seattle's requirements into the IBC. The reason statement for the public comment stated Dr. Miller "concluded that the 'Seattle approach' does indeed meet all the prescriptive requirements of the IBC 2009." The proposal and its public comment were ultimately withdrawn by the proponent in anticipation of further review of the overall elevator lobby provisions.

The intent of the code is to keep smoke out of the hoistway, so the pressure should be measured between the elevator hoistway and the elevator landing/lobby. However, Exception 1 allows the pressure to be measured between the hoistway and sleeping or dwelling units in residential buildings, since they are highly compartmented. In addition, the fire source is most likely to be in the dwelling or sleeping unit, and providing positive pressure in the corridor/hallway outside the units (via leakage through the elevator hoistway doors) will help reduce the smoke migrating from the affected unit. Exception 2, which is specific to elevator lobbies associated with fire service access elevators (FSAE) and occupant evacuation elevators, allows the pressure to be measured between the hoistway and the space on the outside of the smoke barrier that forms the lobby. It should be noted that hoistway pressurization is not a design alternative to enclosed lobbies for FSAEs and Occupant evacuation elevators. Enclosed elevator lobbies are always required for these types of elevators. This exception would only apply if such a system was provided.

Exception 3 allows the 0.10 inch water column pressure differential between the hoistway and the floor be met only on the four most critical floors—the floor of fire origin, the two floors immediately below, and one floor immediately above. For all other stories, the pressure differential is allowed to be measured between the hoistway and the outside of the building. The purpose of this requirement is to maintain a slightly positive pressure in the building relative to atmospheric pressure, so as to lower the neutral pressure plane in the building, which then reduces the driving force of stack effect. This exception is

intended to be permitted to be used in conjunction with Exceptions 1 and 2. The engineers who design this system begin by modeling one floor as the "notionalized" fire floor, and designing the system (fans, dampers, etc.) accordingly. Each floor is subsequently modeled as the notionalized fire floor, and the system is checked to make sure the maximum and minimum pressure differentials are met. (Note that actual models may not have to be run for each floor, if it is clear the worst case has been covered.) Ultimately, the system will need to be designed so it will correctly configure itself for a fire originating on any floor in the building.

Exception 4 omits the need to measure the pressure differential at the floor of elevator recall where the door is typically open. Section 909.21.1 requires the pressure difference, prescribed for the pressurization alternative, to be measured at the midpoint of each hoistway door, with all elevator cars at the floor of recall and all hoistway doors on the floor of recall open and all other hoistway doors closed.

Elevator hoistway pressurization is intended to minimize smoke movement into an elevator shaft when a lobby is not provided. Meeting the required pressure difference on the recall floor with the hoistway doors open is not necessary, because the recall floor is protected by smoke detectors that will not allow the hoistway doors to open if smoke is present.

The pressurization method is based on using pressure differences produced by fans to minimize the spread of smoke across a barrier. A barrier will not exist on the recall floor when the hoistway doors are open and smoke detectors used for elevator recall prevent the doors from opening when smoke is present.

**[BF] 909.21.1.1 Use of ventilation systems.** Ventilation systems, other than hoistway supply air systems, are permitted to be used to exhaust air from adjacent spaces on the fire floor, two floors immediately below and one floor immediately above the fire floor to the building's exterior where necessary to maintain positive pressure relationships as required in Section 909.21.1 during operation of the elevator shaft pressurization system.

❖ This section allows the use of the general building HVAC system to exhaust air to create/maintain the required pressure differential. It is to be noted that the requirements of the rest of Section 909.21, in particular, Section 909.21.10 regarding protection of equipment, would still apply to these components.

**[BF] 909.21.2 Rational analysis.** A rational analysis complying with Section 909.4 shall be submitted with the *construction documents*.

❖ Section 909.4 recognizes that there are many factors involved in a smoke control system, including stack effect due to height, temperature effect of fire, wind effect, interaction of the HVAC system, the weather and the egress time, all of which must be evaluated. The report must be submitted with the permit docu-

ments. Most importantly, the duration of operation of the smoke control system is a function of 1.5 times the egress time or 20 minutes, whichever is less. More discussion on the duration of operation is found in the commentary for Section 909.4.6.

**[BF] 909.21.3 Ducts for system.** Any duct system that is part of the pressurization system shall be protected with the same *fire-resistance rating* as required for the elevator shaft enclosure.

- ❖ All ductwork necessary for hoistway pressurization must be protected from the effects of fire by enclosure in fire-resistance-rated construction equivalent to that required for the elevator hoistway shaft enclosure.

**[BF] 909.21.4 Fan system.** The fan system provided for the pressurization system shall be as required by Sections 909.21.4.1 through 909.21.4.4.

- ❖ This section details the requirements for the mechanical system used for pressurization of the hoistway enclosure.

**[BF] 909.21.4.1 Fire resistance.** Where located within the building, the fan system that provides the pressurization shall be protected with the same *fire-resistance rating* required for the elevator shaft enclosure.

- ❖ The only way to ensure that the mechanical pressurization system can operate during a fire is to locate it in a safe place. If located within the building, it must be in an enclosed room protected with the same fire-resistance-rated construction required for the hoistway enclosure.

**[BF] 909.21.4.2 Smoke detection.** The fan system shall be equipped with a smoke detector that will automatically shut down the fan system when smoke is detected within the system.

- ❖ The airflow must be free of smoke or it will only increase the likelihood of smoke spreading throughout the building. The smoke detector required by this section should be located on the intake side of the blower fan.

**[BF] 909.21.4.3 Separate systems.** A separate fan system shall be used for each elevator hoistway.

- ❖ This section requires that each hoistway enclosure have its own mechanical system. This provides a more redundant system and helps to increase the likelihood that fans will be operational during a fire.

**[BF] 909.21.4.4 Fan capacity.** The supply fan shall be either adjustable with a capacity of not less than 1,000 cfm (0.4719 m<sup>3</sup>/s) per door, or that specified by a *registered design professional* to meet the requirements of a designed pressurization system.

- ❖ The fan capacity should be as specified by the registered design professional to meet the operational ranges of pressure at each door or be adjustable with

a capacity of at least 1,000 cfm (0.4719 m<sup>3</sup>/s) per hoistway door. In either case, it is subject to field testing and adjustments to meet the pressure ranges.

**[BF] 909.21.5 Standby power.** The pressurization system shall be provided with standby power in accordance with Section 604.

- ❖ The elevator hoistway pressurization system is an emergency system and must have provisions for standby power like other emergency systems. Section 604 states the requirements that standby power systems must meet. It is consistent with other smoke control systems required by Section 909 in that such systems have standby power as they are life-safety systems.

**[BF] 909.21.6 Activation of pressurization system.** The elevator pressurization system shall be activated upon activation of either the building fire alarm system or the elevator lobby smoke detectors. Where both a building fire alarm system and elevator lobby smoke detectors are present, each shall be independently capable of activating the pressurization system.

- ❖ This section requires that the pressurization system will be activated when the general building fire alarm system or an elevator lobby smoke detector is activated. All buildings using this pressurization option will more than likely be required to have both. High-rise buildings require elevator lobby smoke detectors, but other buildings may not. Section 909.12 requires smoke detectors to activate the pressurization system if the design requires it to operate to remove the smoke.

**[BF] 909.21.7 Testing.** Testing for performance shall be required in accordance with Section 909.18.8. System acceptance shall be in accordance with Section 909.19.

- ❖ Testing will be required to evaluate the performance of the completed system (see commentary, Sections 909.18 and 909.19).

**[BF] 909.21.8 Marking and identification.** Detection and control systems shall be marked in accordance with Section 909.14.

- ❖ See the commentary to Section 909.14.

**[BF] 909.21.9 Control diagrams.** Control diagrams shall be provided in accordance with Section 909.15.

- ❖ See the commentary to Section 909.15.

**[BF] 909.21.10 Control panel.** A control panel complying with Section 909.16 shall be provided.

- ❖ See the commentary to Section 909.16.

**[BF] 909.21.11 System response time.** Hoistway pressurization systems shall comply with the requirements for smoke control system response time in Section 909.17.

- ❖ See the commentary to Section 909.17.

## SECTION 910 SMOKE AND HEAT REMOVAL

**910.1 General.** Where required by this code, smoke and heat vents or mechanical smoke removal systems shall conform to the requirements of this section.

- ❖ This section essentially requires either smoke and heat vents or a mechanical smoke removal system where required by Section 910.2. It should be noted that where high piled combustible storage is involved, Chapter 32 of the IFC also applies.

The purpose of smoke and heat vents or smoke removal systems has historically been related to the needs of fire fighters. More specifically, smoke and heat vents or smoke removal systems, when activated, have the potential effect of lifting the height of the smoke layer and providing more tenable conditions to undertake fire-fighting activities. Other potential benefits include a reduction in property damage and the creation of more tenable conditions for occupants.

These provisions are based upon research on the interaction of sprinklers, roof vents and draft curtains funded by the National Fire Protection Research Foundation (NFPRF) and conducted at Underwriters Laboratories (UL) in 1997/1998. This research is summarized in a document referred to as National Institute of Science and Technology Interagency Report (NISTIR) 6196-1 dated September, 1998. The current provisions were also based on the following:

- Provisions for the use of roof vents in sprinklered buildings included in the 2010 and 2013 edition of NFPA 13, including the substantiation statement for the NFPA 13 roof vent provisions.
- The capability of standard spray sprinklers to both control and extinguish a fire within 30 minutes of sprinkler operation without supplemental fire department activity has been documented.
- Recommendations contained in National Institute for Occupational Safety and Health (NIOSH) 2005-132, *Preventing Injuries and Deaths of Fire Fighters Due to Truss Systems*, and NIOSH 2010-153, *Preventing Deaths and Injuries of Fire Fighters using Risk Management Principles at Structure Fires*.
- Recommendations contained in the Initial Report of the Federal Emergency Management Agency (FEMA)/National Fallen Firefighter Foundation (NFFF®) Firefighter Life Safety Summit held on April 14, 2004 in Tampa, Florida.

The primary purpose of smoke and heat removal from the perspective of the building code requirement is to assist fire-fighting operations after control of the fire has been achieved by the automatic sprinkler system. Automatic smoke and heat vents and automatic sprinkler systems were developed independently of one another and their interaction has been a concern for many years. Even today, there is no accepted method of analyzing their interaction and, therefore,

the installation standards for each (NFPA 204 and NFPA 13, respectively) give cautions to the designers of buildings having both systems. Note that NFPA 204 is not referenced in Section 910.

A manually activated mechanical smoke removal system can perform the same function as roof vents. Mechanical smoke removal systems, as required in Section 910, provide fire-rated, grade-level enclosures for the control of the mechanical smoke removal system. This provides greater control of the system for the fire incident commander and reduces the need to place fire fighters on roofs or in other hazardous situations to operate smoke and heat venting systems. This methodology is consistent with the latest recommendations from NIOSH and NFFF for fire fighter safety, risk management and recommended fire-fighting tactics.

**910.2 Where required.** Smoke and heat vents or a mechanical smoke removal system shall be installed as required by Sections 910.2.1 and 910.2.2.

### Exceptions:

1. Frozen food warehouses used solely for storage of Class I and II commodities where protected by an *approved automatic sprinkler system*.
  2. Smoke and heat removal shall not be required in areas of buildings equipped with early suppression fast-response (ESFR) sprinklers.
  3. Smoke and heat removal shall not be required in areas of buildings equipped with control mode special application sprinklers with a response time index of  $50 (m \cdot S)^{1/2}$  or less that are listed to control a fire in stored commodities with 12 or fewer sprinklers.
- ❖ Sections 910.2.1 and 910.2.2 provide the locations where such smoke removal or smoke and heat vents would be required. There are three overall exceptions to the application of Section 910.

Exception 1 recognizes the “building-within-a-building” nature of typical frozen food warehouses. As such, smoke from a fire within a freezer would be contained within the freezer, thus negating the usefulness of smoke and heat vents at the roof level.

Exception 2 recognizes the negative effect that smoke and heat vents can have on the operation of early suppression fast response (ESFR) sprinklers. Those negative effects include diverting heat away from the sprinklers, which could delay their activation or result in the activation of more sprinklers in areas away from the source of the fire, which may overwhelm the system.

Exception 3 recognizes a new category of automatic sprinkler that shares the key characteristics of ESFR sprinklers, i.e., thermal elements that have a response time index (RTI) of 50 or less and are listed to protect a design area that involves 12 or fewer sprinklers. These control mode special application (CMSA) sprinklers, while not called ESFR, still require similar precautions to ESFR sprinklers with

respect to not introducing unknowns, such as smoke and heat removal, that were not present in the full-scale fire tests that determined their listing parameters. Such unknowns can lead to sprinkler “skipping” and exceeding the 12 sprinkler design area, which was the exact concern that led to the ESFR-related provisions that are currently in this chapter and Chapter 32. Note that CMSA sprinklers must have both an RTI of 50 or less and be listed to control/suppress a fire with 12 or fewer sprinklers to qualify for this exception. Any sprinkler listed as “quick response” will satisfy the “50 RTI or less” criterion, based on the definition of “quick response” in NFPA 13 Section 3.6.4.7. The number of operating sprinklers will be indicated in the listing criteria for each sprinkler.

**910.2.1 Group F-1 or S-1.** Smoke and heat vents installed in accordance with Section 910.3 or a mechanical smoke removal system installed in accordance with Section 910.4 shall be installed in buildings and portions thereof used as a Group F-1 or S-1 occupancy having more than 50,000 square feet (4645 m<sup>2</sup>) of undivided area. In occupied portions of a building equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, where the upper surface of the story is not a roof assembly, a mechanical smoke removal system in accordance with Section 910.4 shall be installed.

**Exception:** Group S-1 aircraft repair hangars.

❖ Large-area buildings with moderate to heavy fire loads present special challenges to the fire department in disposing of the smoke generated in a fire. In order to provide the fire department with the ability to rapidly and efficiently dispose of smoke in large-area Groups F-1 and S-1 buildings exceeding 50,000 square feet (4645 m<sup>2</sup>) in undivided area without the exposure of personnel to the dangers associated with cutting ventilation holes in the roof, smoke and heat vents or a smoke removal system must be provided.

The code is not clear on what is meant by the term “undivided area.” However the intent is to provide the ability to manage the smoke in large spaces. Draft curtains or potentially any physical separation (regardless of rating) would provide such division. Draft curtains are typically constructed of sheet metal, lath and plaster, gypsum board or other materials that resist the passage of smoke. Typically draft curtains are at least 6 feet deep (1829 mm) from the ceiling. To keep with the concern for managing smoke, the joints and connections should be smoke tight.

Based on the intent of “undivided area,” a fire barrier, smoke barrier, fire partition or smoke partition would be more than what is required and would therefore be an acceptable method of dividing the area.

This requirement is independent of the requirements related to high-piled storage in Section 910.2.2. High-piled combustible storage is not occupancy-specific.

This section also addresses multistory buildings where the Group F-1 or S-1 occupancy is not the uppermost story and therefore would not have a roof in which to place smoke and heat vents. This section would require that a smoke removal system be installed. This issue was not clearly addressed in previous editions of the IBC.

**910.2.2 High-piled combustible storage.** Smoke and heat removal required by Table 3206.2 for buildings and portions thereof containing high-piled combustible storage shall be installed in accordance with Section 910.3 in unsprinklered buildings. In buildings and portions thereof containing high-piled combustible storage equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, a smoke and heat removal system shall be installed in accordance with Section 910.3 or 910.4. In occupied portions of a building equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 where the upper surface of the story is not a roof assembly, a mechanical smoke removal system in accordance with Section 910.4 shall be installed.

❖ This section requires smoke and heat removal as it is required in Chapter 32 for high piled combustible storage. Specifically, Table 3206.2 sets out when smoke and heat removal is required. If Table 3206.2 does not require such protection, compliance with Section 910 is not necessary. The requirement in Table 3206.2 is based primarily on the size of the high-piled combustible storage area and whether or not the area is equipped with an automatic sprinkler system.

There are several requirements provided within this section. The first addresses nonsprinklered high-piled storage areas. Such areas are required to use smoke and heat vents as mechanical smoke removal systems and are designed for use in sprinklered buildings. The rationale for this provision is that a mechanical smoke removal system capable of handling temperatures between 1,000° F and 2,000° F cannot be practically provided at a reasonable cost.

Where high-piled storage areas are equipped with an automatic sprinkler system, smoke and heat vents or a smoke removal system are required to comply with this section. However, if the high-piled storage area is located in a multistory building where the storage area is not located on the upper most story, this section requires that a smoke removal system be used. This was not clearly addressed in past editions of the code.

**910.3 Smoke and heat vents.** The design and installation of smoke and heat vents shall be in accordance with Sections 910.3.1 through 910.3.3.

❖ This section simply sets out the subsections that must be addressed to comply with the requirements for the installation of smoke and heat vents.

**910.3.1 Listing and labeling.** Smoke and heat vents shall be *listed* and labeled to indicate compliance with UL 793 or FM 4430.

❖ This section specifically requires that all smoke and heat vents be both listed and labeled in accordance with UL 793 or FM 4430. This provides consistency and a level of quality when smoke and heat vents are required. The standard addresses smoke and heat vents that automatically operate during fires via non-electrical means. Automatic vents listed and labeled to this standard can be operated both automatically and manually. There are two main mechanisms for activation that include a heat-responsive device or the action of a plastic cover shrinking and falling out of place, due to fire exposure.

**910.3.2 Smoke and heat vent locations.** Smoke and heat vents shall be located 20 feet (6096 mm) or more from adjacent *lot lines* and *fire walls* and 10 feet (3048 mm) or more from *fire barriers*. Vents shall be uniformly located within the roof in the areas of the building where the vents are required to be installed by Section 910.2, with consideration given to roof pitch, sprinkler location and structural members.

❖ This section has two functions, the first being to focus on hazards to adjacent buildings and the second being proper function of smoke and heat vents through proper placement.

In terms of adjacent properties, this section requires a minimum distance to lot lines and fire walls and then a minimum distance to fire barriers. The first set of distances focuses on separate buildings and exposures, whereas the distance to fire barriers is less restrictive since it focuses on different uses and

occupancies within the same building (see Commentary Figure 910.3.2).

To enhance vent performance within the area containing the smoke and heat vents, such vents need to be uniformly spaced. Consideration of issues such as sprinkler location and roof pitch are also essential to proper vent location.

**910.3.3 Smoke and heat vents area.** The required aggregate area of smoke and heat vents shall be calculated as follows:

For buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1:

$$A_{VR} = V/9000 \quad \text{(Equation 9-4)}$$

where:

$A_{VR}$  = The required aggregate vent area (ft<sup>2</sup>).

$V$  = Volume (ft<sup>3</sup>) of the area that requires smoke removal.

For unsprinklered buildings:

$$A_{VR} = AFA/50 \quad \text{(Equation 9-5)}$$

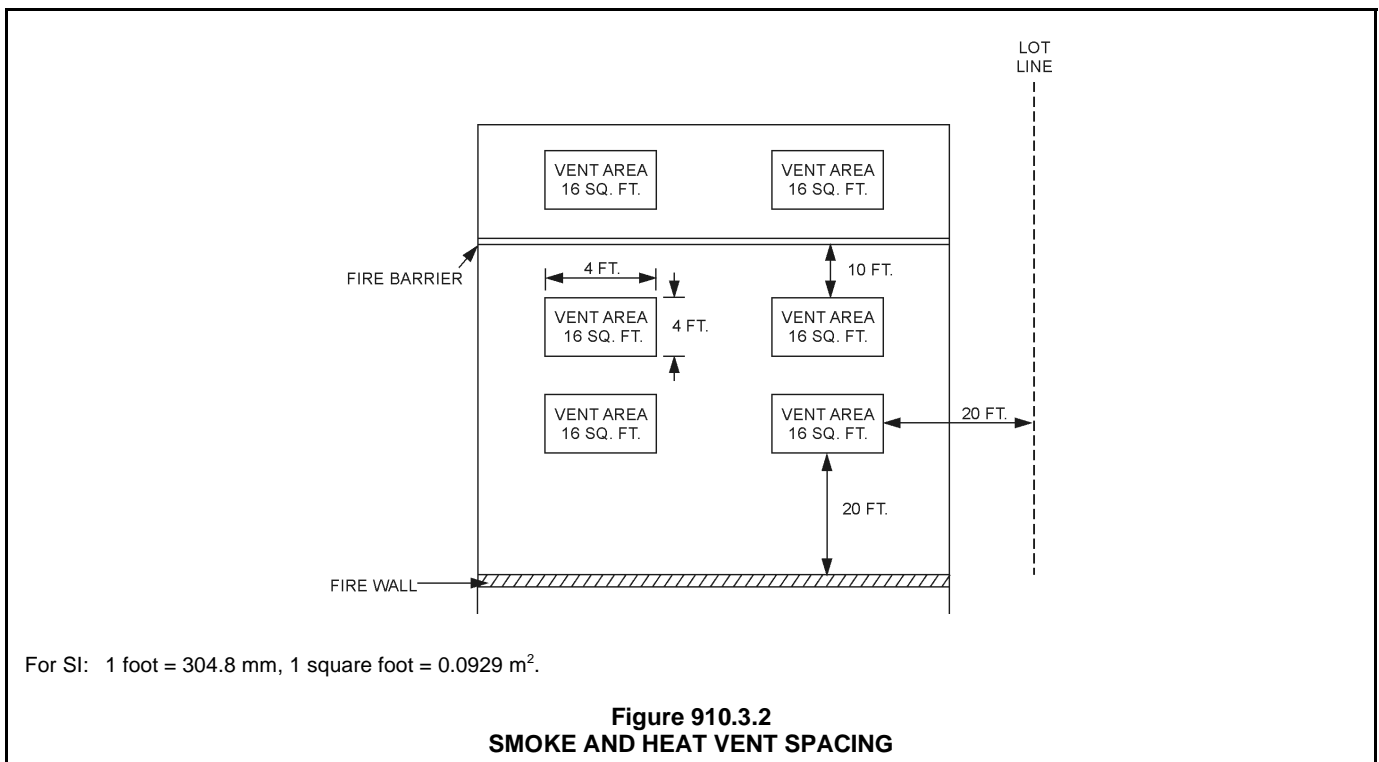
where:

$A_{VR}$  = The required aggregate vent area (ft<sup>2</sup>).

$A_{FA}$  = The area of the floor in the area that requires smoke removal.

❖ This section provides the design criteria to determine the area of smoke and heat vents required. The requirements are based on whether the area requiring smoke and heat vents is equipped with an automatic sprinkler system.

The design of roof vents in buildings protected by an automatic sprinkler system requires that the area



of roof vents provide equivalent venting to that required for the mechanical smoke removal system (2 air changes per hour) based on an assumption that each square foot of vent area will provide 300 cubic feet per minute (cfm) of ventilation. The reason for this requirement is that the roof vents should at least provide venting equivalent to the minimum venting provided by the mechanical smoke removal system. A factor of 300 cfm of venting per square foot of vent area was included in the 2012 edition of the code, although the use of this conversion factor is questionable at best. The actual ventilation provided by each square foot of vent area will depend on the temperature differential between ambient conditions and the smoke layer under the roof deck or the pressure achieved if positive pressure ventilation is utilized. If the prescribed value is not practical for a given building design, designers have the option of demonstrating other values which provide the same performance under Section 104.9 of the code, which allows alternative methods and designs.

The design of roof vents in buildings not protected by a sprinkler system requires that the ratio of the area of the vents to the floor area be a minimum of 1:50. The rationale is that the case where roof vents will be provided without sprinkler protection will be rare: buildings which contain high-piled storage with an area between 2,500 and 12,000 square feet. Given that this situation will be rare, a complex analysis to determine the required area of roof vents was felt to be unnecessary. The ratio of vent area to floor area of 1:50 is conservative based on the requirements that were included in the 2012 code and the IBC.

**910.4 Mechanical smoke removal systems.** Mechanical smoke removal systems shall be designed and installed in accordance with Sections 910.4.1 through 910.4.7.

❖ Mechanical smoke removal systems are considered to be equivalent to smoke and heat vents in terms of code compliance. In multistory buildings, those areas requiring smoke and heat removal will require the use of a mechanical smoke removal system due to location on other than the uppermost story. This section provides the various design requirements for such systems.

**910.4.1 Automatic sprinklers required.** The building shall be equipped throughout with an approved *automatic sprinkler system* in accordance with Section 903.3.1.1.

❖ The rationale for this provision is that a mechanical smoke removal system capable of handling temperatures between 1,000° F and 2,000° F cannot be practically provided at a reasonable cost. Therefore, in order to allow the use of a mechanical smoke removal system, the building is required to be equipped throughout with an automatic sprinkler system.

**910.4.2 Exhaust fan construction.** Exhaust fans that are part of a mechanical smoke removal system shall be rated for

operation at 221°F (105°C). Exhaust fan motors shall be located outside of the exhaust fan air stream.

❖ This section requires exhaust fan motors to be located out of the exhaust stream to protect the mechanical equipment from excessive heat. Provisions for the mechanical smoke removal system permit the system to be designed to handle air at ambient temperature, provided that the fan motors are located outside the air stream. The basis for this provision is the thermocouple temperature data for the large-scale fire tests conducted at UL in 1997/1998, specifically Tests P-1 and P-4. (In Tests P-1 and P-4, no vents opened so the ceiling temperatures recorded would be unaffected by the activation of vents. See pages 40 and 52 of the NISTIR 6196-1 report dated September, 1998 for the thermocouple temperature data recorded as a function of time.)

The exposing temperatures and time periods were reviewed and not considered to pose a threat to the building structure, fans or power wiring.

The sprinkler activation times and ceiling temperature data for the five large-scale fire tests summarized in NISTIR 6196-1 indicate that the exposure of mechanical exhaust fans and ducts located at the ceiling to high temperatures will be relatively short. Since it is anticipated that the exhaust system will only be activated after the arrival of fire fighters at the scene (estimated to be 7 minutes or longer after ignition), ceiling temperatures should be reduced sufficiently to allow fans rated for only ambient temperatures to be used for the exhaust system.

**910.4.3 System design criteria.** The mechanical smoke removal system shall be sized to exhaust the building at a minimum rate of two air changes per hour based upon the volume of the building or portion thereof without contents. The capacity of each exhaust fan shall not exceed 30,000 cubic feet per minute (14.2 m<sup>3</sup>/sec).

❖ Sections 910.4.3 and 910.4.3.1 specify the design requirement for the minimum number of air changes, maximum fan capacity and requirements for the provision of make-up air.

These provisions require that the mechanical smoke removal system be sized to provide a minimum exhaust rate of two air changes per hour based on the enclosed volume of the building space to be exhausted, without any deductions for the space occupied by storage or equipment. An exhaust rate of two air changes per hour is based on an analysis assuming a conservative approach using a Factory Mutual Research Corporation (FMRC) Standard Plastic Commodity (polystyrene cups in compartmented cartons). This commodity is recognized to represent a severe fire hazard of high density plastics.

In a calculation based on this commodity, a maximum of 68,960 cfm of smoke was generated by the design fire. Based on an empty building volume of 2.659 million cubic feet, the exhaust rate required to achieve two air changes per hour is 88,633 cfm.

Because no single fan can exceed 30,000 cfm, this building required five fans, each exhausting 25,570 cfm for a total of 127,850 cfm. This exceeds the minimum two air changes per hour by more than 40 percent. Even at the minimum required rate of two air changes per hour, the calculation results show that the mechanical smoke removal system will be capable of removing the smoke from the building faster than it will be generated, ultimately removing smoke from the building.

**910.4.3.1 Makeup air.** Makeup air openings shall be provided within 6 feet (1829 mm) of the floor level. Operation of makeup air openings shall be manual or automatic. The minimum gross area of makeup air inlets shall be 8 square feet per 1,000 cubic feet per minute (0.74 m<sup>2</sup> per 0.4719 m<sup>3</sup>/s) of smoke exhaust.

❖ In order for a mechanical smoke removal system to work properly, makeup air at the proper location and volume of air need to be provided. Generally, makeup air inlets need to be located much lower than where the smoke is exhausted to get the proper movement of air. In this case, the required location is within 6 feet of the floor.

The derivation of the gross vent area is based on NFPA 92-2012. Specifically, Annex Section A-4.4.4.1.4 states that the maximum air velocity through the make-up air inlet is 1 m/sec or 200 ft/min. This is the same limitation found in Section 909.7.1, which is for the airflow method of smoke control. The area requirement is then derived as follows:

- Effective Vent Area = (1000 ft<sup>3</sup>/min)/(200 ft/min) = 5 ft<sup>2</sup> per 1000 cfm
- Assume an orifice coefficient of 0.6
- Gross Vent Area = 5 ft<sup>2</sup>/(0.6) = 8.33 ft<sup>2</sup> per 1000 cfm, which is rounded down due to the conservative nature of the requirement

The reason for this limitation is to prevent significant deflection of the plume, which will cause more air entrainment into the plume and more smoke production. This is the same limitation found in Section 909.7.1, which is for the airflow method of smoke control. This criterion is conservative as the requirement above assumes an active fire and the design philosophy for this requirement is to provide post-fire smoke exhaust.

**910.4.4 Activation.** The mechanical smoke removal system shall be activated by manual controls only.

❖ This section requires that mechanical systems are to be activated manually so that the fire department is in control of the system. In some situations, automatic operation could cause a fire to grow or spread, opening an excessive number of sprinklers. Automatic operation of the mechanical smoke removal system could also be detrimental to the operation of the sprinkler system in a manner similar to draft curtains. The effect of the automatic mechanical smoke

removal system on sprinkler operation would depend on when the system was activated. The sooner the system is automatically activated, the greater the detrimental effect. The fire department will retain the option to shut down the exhaust system, as well.

**910.4.5 Manual control location.** Manual controls shall be located so as to be accessible to the fire service from an exterior door of the building and protected against interior fire exposure by not less than 1-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.

❖ This section establishes the required placement, access and protection of the manual controls to ensure the fire fighters will have quick and protected access to them.

**910.4.6 Control wiring.** Wiring for operation and control of mechanical smoke removal systems shall be connected ahead of the main disconnect in accordance with Section 701.12E of NFPA 70 and be protected against interior fire exposure to temperatures in excess of 1,000°F (538°C) for a period of not less than 15 minutes.

❖ Unless the mechanical smoke removal system also functions as a component of a smoke control system, standby power is not specifically required (see commentary, Sections 604 and 909.11). In order to provide an enhanced level of operational reliability, this section requires that the power supply to smoke exhaust fans must be provided from a circuit connected on the supply side (i.e., ahead of) the building's main electrical service disconnecting means. Note that this is one of the sources of standby power recognized by NFPA 70, Section 701.12(E). Such a circuit connected "ahead of the main" must still have its own approved overcurrent protection.

The provisions for the design of a mechanical smoke removal system indicate that wiring providing power to exhaust fans located in the interior of the building is to be protected by materials which will provide a 15-minute finish-rating protection. The ceiling temperature data collected in the five large-scale fire tests summarized in NISTIR 6196-1 (cited above) show that temperatures at the ceiling will be far less than the exposure temperatures defined by the ASTM E119 time-temperature curve and that the ceiling temperatures will rapidly decrease once sprinklers activate. The ceiling temperature data included in NISTIR 6196-1 indicates that providing 15-minute finish-rating protection for the interior electrical power supply is more than adequate to prevent damage to the power supply wiring for the exhaust system.

**910.4.7 Controls.** Where building air-handling and mechanical smoke removal systems are combined or where independent building air-handling systems are provided, fans shall automatically shut down in accordance with the *International Mechanical Code*. The manual controls provided for the smoke removal system shall have the capability to override

the automatic shutdown of fans that are part of the smoke removal system.

- ❖ This section requires that if a mechanical smoke removal system is integrated with a standard HVAC system, then the system must shut down upon detection of smoke as required by the IMC. This relates to the requirement in Section 910.4.4 that mechanical smoke removal systems shall be manually operated only.

The concern is that HVAC systems should not work against the intended operation of the smoke exhaust system. In some cases, the system may be a combination system where shutdown is not necessary or appropriate. It really depends on how the smoke exhaust system has been designed.

**910.5 Maintenance.** Smoke and heat vents and mechanical smoke removal systems shall be maintained in an operative condition in accordance with Section 910.5.1 or 910.5.2, respectively.

- ❖ Routine maintenance and testing of smoke removal systems is essential to ensure their performance, as designed, under fire conditions. Maintenance practices for these systems must be consistent with their design and any manufacturer's recommendations and as indicated in Section 910.5.1 or 910.5.2.

**910.5.1 Smoke and heat vents.** Smoke and heat vents shall be maintained in an operative condition in accordance with NFPA 204 and Section 910.5.1.1

- ❖ This section requires smoke and heat vents to be maintained in operating condition and incorporates NFPA 204 as the referenced standard for the maintenance of smoke and heat vents (see Section 901.6.1). Routine inspection, testing and maintenance of these devices is essential since they are typically only found in the largest commercial structures, and the amount of fire loading is usually very high (i.e., high-piled combustible storage). Ensuring that these devices are inspected, tested and maintained in proper working order by the building's owner also has positive effects on fire-fighter safety. These benefits include:

- Easy identification of the location of the fire within the structure.
- Release of excess heat within the structure.
- Decreasing fire severity.
- Increased visibility for fire fighters within the structure.
- Reduction of toxic products of combustion within the structure.

Additionally, the maintenance of these devices will have a mitigating effect on damage to the structure and/or its contents should a fire occur. These benefits include decreased likelihood of structural failure from heat retained within the structure and reduced damage to the structure and stored materials from smoke.

**910.5.1.1 Fusible links.** Fusible links for smoke and heat vents shall be replaced whenever fused, damaged or painted.

- ❖ The sensing elements of fusible link devices installed as part of smoke and heat vents must be routinely visually inspected and replaced as needed to increase the likelihood that the vents will operate in a timely fashion when needed.

**910.5.2 Mechanical smoke removal systems.** Mechanical smoke removal systems shall be maintained in accordance with the equipment manufacturer's maintenance instructions and Sections 910.5.2.1 through 910.5.2.4.

- ❖ The previously included reference to NFPA 204 for mechanical smoke removal systems was removed and replaced with the prescriptive testing and maintenance requirements in Sections 910.5.2.1 through 910.5.2.4. This was done because it was determined that the maintenance requirements in NFPA 204 were not specific enough to ensure the necessary maintenance of the mechanical smoke removal systems.

**910.5.2.1 Frequency.** Systems shall be operationally tested not less than once per year. Testing shall include the operation of all system components, including control elements.

- ❖ Annual operational exercising of the entire mechanical smoke removal system must be performed to verify that it still operates as required by the approved design.

**910.5.2.2 Testing.** Operational testing of the mechanical smoke removal system shall include all equipment such as fans, controls and make-up air openings.

- ❖ Because mechanical smoke removal systems are designed for smoke removal only, the operation of these systems does not adversely affect other building systems or operations. The control sequence for these systems must be included in the annual operational test to check for system component failures that may not get noticed because mechanical smoke removal systems are independent of building HVAC systems and operate only in emergency situations.

**910.5.2.3 Schedule.** A routine maintenance and operational testing program shall be initiated and a written schedule for routine maintenance and operational testing shall be established.

- ❖ Routine operational testing and maintenance must be performed on the mechanical smoke removal system periodically to verify that it still operates as required by the approved design. A written schedule must be established and maintained.

**910.5.2.4 Written record.** A written record of mechanical smoke exhaust system testing and maintenance shall be maintained on the premises. The written record shall include the date of the maintenance, identification of the servicing personnel and notification of any unsatisfactory condition and the corrective action taken, including parts replaced.

- ❖ This section prescribes the desired content of the written record for the mechanical smoke removal sys-

tem testing and maintenance program. Test results and maintenance activities should be clearly documented. The written record should be available for inspection and reviewed by the fire code official.

## SECTION 911 EXPLOSION CONTROL

**911.1 General.** Explosion control shall be provided in the following locations:

1. Where a structure, room or space is occupied for purposes involving explosion hazards as identified in Table 911.1.
2. Where quantities of hazardous materials specified in Table 911.1 exceed the maximum allowable quantities in Table 5003.1.1(1).

Such areas shall be provided with explosion (*deflagration*) venting, explosion (*deflagration*) prevention systems or *barricades* in accordance with this section and NFPA 69, or NFPA 495 as applicable. *Deflagration* venting shall not be utilized as a means to protect buildings from *detonation* hazards.

❖ It is usually impractical to design a building to withstand the pressure created by an explosion. Therefore, this section requires an explosion relief system for structures, rooms or spaces with occupancies involving explosion hazards. Explosions may result from the overpressurization of a containing structure, by physical/chemical means or by a chemical reaction. During an explosion, a sudden release of a high-pressure gas occurs and the energy is dissipated in the form of a shock wave.

Structures, rooms or spaces with occupancies involving explosion hazards must be equipped with some method of explosion control as required by the material-specific requirements in the code. Table 911.1 also specifies when explosion control is required based on certain materials or occupancies where the quantities of hazardous materials involved exceed the maximum allowable quantities in Table 5003.1.1(1). Section 911 recognizes explosion (*deflagration*) venting and explosion (*deflagration*) prevention systems as acceptable methods of explosion control where appropriate. The use of barricades or other explosion protective devices, such as magazines, may be permitted as the means of explosion control where indicated in the code as an acceptable alternative and when approved by the fire code official.

**TABLE 911.1.** See page 9-136.

❖ This table designates when some methods of explosion control are required for specific material or special use conditions. This table applies when the quantities of hazardous materials involved exceed the maximum allowable quantities in Table 5003.1.1(1). Section 911.2 contains design criteria for explosion (*deflagration*) venting. Explosion prevention (*suppression*) systems, where used, must com-

ply with NFPA 69. Barricade construction must be designed and installed to comply with NFPA 495. Chapters 50 through 67 of the code contain additional guidance on the applicability and design criteria for explosion control methods that depend on the specific type of hazardous material involved.

**911.2 Required deflagration venting.** Areas that are required to be provided with *deflagration* venting shall comply with the following:

1. Walls, ceilings and roofs exposing surrounding areas shall be designed to resist a minimum internal pressure of 100 pounds per square foot (psf) (4788 Pa). The minimum internal design pressure shall be not less than five times the maximum internal relief pressure specified in Item 5 of this section.
2. *Deflagration* venting shall be provided only in exterior walls and roofs.

**Exception:** Where sufficient *exterior wall* and roof venting cannot be provided because of inadequate exterior wall or roof area, *deflagration* venting shall be allowed by specially designed shafts vented to the exterior of the building.

3. *Deflagration* venting shall be designed to prevent unacceptable structural damage. Where relieving a *deflagration*, vent closures shall not produce projectiles of sufficient velocity and mass to cause life threatening injuries to the occupants or other persons on the property or adjacent *public ways*.
4. The aggregate clear area of vents and venting devices shall be governed by the pressure resistance of the construction assemblies specified in Item 1 of this section and the maximum internal pressure allowed by Item 5 of this section.
5. Vents shall be designed to withstand loads in accordance with the *International Building Code*. Vents shall consist of any one or any combination of the following to relieve at a maximum internal pressure of 20 pounds per square foot (958 Pa), but not less than the loads required by the *International Building Code*:
  - 5.1. *Exterior walls* designed to release outward.
  - 5.2. Hatch covers.
  - 5.3. Outward swinging doors.
  - 5.4. Roofs designed to uplift.
  - 5.5. Venting devices *listed* for the purpose.

6. Vents designed to release from the *exterior walls* or roofs of the building when venting a *deflagration* shall discharge directly to the exterior of the building where an unoccupied space not less than 50 feet (15 240 mm) in width is provided between the exterior walls of the building and the lot line.

**Exception:** Vents complying with Item 7 of this section.

7. Vents designed to remain attached to the building when venting a *deflagration* shall be so located that the discharge opening shall be not less than 10 feet (3048 mm)

## FIRE PROTECTION SYSTEMS

vertically from window openings and *exits* in the building and 20 feet (6096 mm) horizontally from *exits* in the building, from window openings and *exits* in adjacent buildings on the same lot and from the lot line.

8. Discharge from vents shall not be into the interior of the building.

❖ This section prescribes the basic design criteria necessary for deflagration venting.

Deflagration venting limits the deflagration pressure in a certain area so that, in case of an explosion, the damage to that enclosed area is minimized or eliminated. Because there are so many variables involved for adequate deflagration venting, the parameters for each design should fit the individual situation. NFPA 68 contains additional guidance on

the design and use of deflagration venting systems.

The area of the vent must be adequate to relieve the pressure before it reaches a level in excess of what can be withstood by the weakest building member. The vent area, therefore, is dependent on the actual construction of the enclosed area and the anticipated pressure. The vent panel should be of light-weight construction so that it can easily release at low pressures. Because the lightweight panels have little structural strength, railings may be required along the floor edge to prevent people or objects from falling against the panel.

Item 5 indicates that the vents are to be designed to relieve at a maximum internal pressure of 20 pounds per square foot (psf) (958 Pa) but not less

**TABLE 911.1  
EXPLOSION CONTROL REQUIREMENTS<sup>f</sup>**

MATERIAL	CLASS	EXPLOSION CONTROL METHODS	
		Barricade construction	Explosion (deflagration) venting or explosion (deflagration) prevention systems
<b>Hazard Category</b>			
Combustible dusts <sup>a</sup>	—	Not required	Required
Cryogenic fluids	Flammable	Not required	Required
Explosives	Division 1.1	Required	Not required
	Division 1.2	Required	Not required
	Division 1.3	Not required	Required
	Division 1.4	Not required	Required
	Division 1.5	Required	Not required
	Division 1.6	Required	Not required
Flammable gas	Gaseous	Not required	Required
	Liquefied	Not required	Required
Flammable liquids	IA <sup>b</sup>	Not required	Required
	IB <sup>c</sup>	Not required	Required
Organic peroxides	Unclassified detonable	Required	Not permitted
	I	Required	Not permitted
Oxidizer liquids and solids	4	Required	Not permitted
Pyrophoric	Gases	Not required	Required
Unstable (reactive)	4	Required	Not permitted
	3 detonable	Required	Not permitted
	3 nondetonable	Not required	Required
Water-reactive liquids and solids	3	Not required	Required
	2 <sup>e</sup>	Not required	Required
<b>Special Uses</b>			
Acetylene generator rooms	—	Not required	Required
Grain processing	—	Not required	Required
Liquefied petroleum gas distribution facilities	—	Not required	Required
Where explosion hazards exist <sup>d</sup>	Detonation	Required	Not permitted
	Deflagration	Not required	Required

a. Combustible dusts that are generated during manufacturing or processing. See definition of “Combustible dust” in Chapter 2.

b. Storage or use.

c. In open use or dispensing.

d. Rooms containing dispensing and use of hazardous materials where an explosive environment can occur because of the characteristics or nature of the hazardous materials or as a result of the dispensing or use process.

e. A method of explosion control shall be provided where Class 2 water-reactive materials can form potentially explosive mixtures.

f. Explosion venting is not required for Group H-5 Fabrication Areas complying with Chapter 27 and the *International Building Code*.

than the load design requirements in Chapter 16 of the IBC. In areas commonly subject to high winds, the release pressure has to be increased accordingly to prevent the vents from being actuated by wind forces. Even though the release pressure should be as low as practical, it must always be higher than the external wind pressure.

Venting devices must be located to discharge directly to the open air or to an unoccupied space at least 50 feet (15 240 mm) in width on the same lot. To minimize damage and maintain the integrity of the existing system, window openings and egress facilities are not to be within 10 feet (3048 mm) vertically or 20 feet (6096 mm) horizontally of the vent. The spatial distance will permit the pressure to decrease and not to cause additional damage.

**911.3 Explosion prevention systems.** Explosion prevention systems shall be of an *approved* type and installed in accordance with the provisions of this code and NFPA 69.

❖ Depending on the conditions of the anticipated explosion hazard, the use of an explosion prevention system may be an effective means of explosion control. An explosion prevention system is most effective in confined spaces or enclosures in which combustible gases, mists or dusts are subject to deflagration in a gas-phase oxidant. Explosion prevention systems are intended to prevent an explosion hazard by combating the process of combustion at its incipient stage.

NFPA 69 contains further information on the installation, operation and design considerations for explosion prevention systems. Explosion prevention systems are commonly used to protect laboratory equipment, such as reactor vessels, mills and dust collectors.

**911.4 Barricades.** *Barricades* shall be designed and installed in accordance with NFPA 495.

❖ As indicated in Table 911.1, depending on the type of materials involved, barricade construction may be an acceptable method of explosion control. Barricade construction is an effective method of screening a building containing explosives from other buildings, magazines or public rights-of-way. The barricade could be either natural or artificial, where applicable, as specified in NFPA 495.

## SECTION 912 FIRE DEPARTMENT CONNECTIONS

**912.1 Installation.** Fire department connections shall be installed in accordance with the NFPA standard applicable to the system design and shall comply with Sections 912.2 through 912.7.

❖ An FDC is required as part of a water-based suppression system as the auxiliary water supply. These connections give the fire department the capability of supplying the necessary water to the automatic sprinkler or standpipe system at a sufficient pressure with-

out pressurizing the underground supply. The FDC also serves as an alternative source of water should a valve in the primary water supply be closed. A fire department connection does not, however, constitute an automatic water source. See Commentary Figure 903.3.1.1 for a typical FDC arrangement on a wet pipe sprinkler system.

The requirements for the FDC depend on the type of sprinkler system installed and whether a standpipe system is installed. NFPA 13 and 13R, for example, include design considerations for FDCs that are an auxiliary water supply source for automatic sprinkler systems; NFPA 14 is the design standard to use for FDCs serving standpipe systems. Threads for FDCs to sprinkler systems, standpipes, yard hydrants or any other fire hose connection must be approved (NFPA 1963 may be utilized as part of the approval or as otherwise approved) and be compatible with the connections used by the local fire department (see commentary, Sections 903.3.6 and 905.1).

**912.2 Location.** With respect to hydrants, driveways, buildings and landscaping, fire department connections shall be so located that fire apparatus and hose connected to supply the system will not obstruct access to the buildings for other fire apparatus. The location of fire department connections shall be *approved* by the fire chief.

❖ This section specifies that the FDC must be located so that vehicles and hose lines will not interfere with access to the building for the use of other fire department apparatus. The location of potential connected hose lines to the FDC and hydrants must be pre-planned with the fire department. Many fire departments have a policy restricting the distance that a FDC may be from a fire hydrant. Some also have policies that indicate the maximum distance from the nearest point of fire department vehicle access (often, the curb). Since fireground operations are based on local operational procedures, it is only reasonable that the fire chief of the jurisdiction have approval authority over the location of and access to the FDC.

Landscaping can also be a hindrance to fire department operations. Even where the FDC is visible, the extensive use of landscaping may make access difficult. Landscaping also changes over time. What may not have been an obstruction when it was planted can sometimes grow into an obstruction over time.

**912.2.1 Visible location.** Fire department connections shall be located on the street side of buildings, fully visible and recognizable from the street or nearest point of fire department vehicle access or as otherwise *approved* by the fire chief.

❖ FDCs must be readily visible and easily accessed. A local policy constituting what is readily visible and accessible needs to be established. While the intent is clearly understandable, its application can vary widely. A precise policy is the best way to avoid ambiguous directives that result in inconsistent and

arbitrary enforcement. Usually, the policy will address issues such as location on the outside of the building and proximity to fire hydrants.

Landscaping is often used to hide the FDCs from the public. This can greatly hamper the efforts of the fire department in staging operations and supplying water to the fire protection systems. Landscaping must be designed so that it does not obstruct the visibility of the FDC. Since fireground operations are based on local operational procedures, it is only reasonable that the fire chief of the jurisdiction have final approval authority over the visibility of and access to the FDC.

**912.2.2 Existing buildings.** On existing buildings, wherever the fire department connection is not visible to approaching fire apparatus, the fire department connection shall be indicated by an *approved* sign mounted on the street front or on the side of the building. Such sign shall have the letters “FDC” not less than 6 inches (152 mm) high and words in letters not less than 2 inches (51 mm) high or an arrow to indicate the location. Such signs shall be subject to the approval of the *fire code official*.

- ❖ The section acknowledges that FDCs on existing buildings may not always be readily visible from the street or nearest point of fire department vehicle access. In those instances, the location of the connection must be clearly marked with signage. The FDC may be located on the side of the building or in an alley, not visible to arriving fire-fighting forces. A sign is necessary so that those driving the arriving apparatus know where to maneuver the vehicle to get close to the FDC.

**912.3 Fire hose threads.** Fire hose threads used in connection with standpipe systems shall be *approved* and shall be compatible with fire department hose threads.

- ❖ There are several sections in the code which contain requirements for fire department connections. This section simply correlates with those requirements by further clarifying that fire hose threads for standpipe systems must be approved.

**912.4 Access.** Immediate access to fire department connections shall be maintained at all times and without obstruction by fences, bushes, trees, walls or any other fixed or moveable object. Access to fire department connections shall be *approved* by the fire chief.

**Exception:** Fences, where provided with an access gate equipped with a sign complying with the legend requirements of Section 912.5 and a means of emergency operation. The gate and the means of emergency operation shall be *approved* by the fire chief and maintained operational at all times.

- ❖ The FDC must be readily accessible to fire fighters and allow fire-fighting personnel an adequate area to maneuver a hose for the connection. Landscaping design must not block a clear view of the FDC from arriving fire department vehicles. Depending on the type of landscaping materials, an active maintenance program may be necessary to maintain ready access

over time. This section also recognizes that the obstructing objects regulated here can be either fixed or movable (such as outdoor furnishings, shopping cart queue areas, etc.). Note that no specific dimension is given as was the case in previous editions of the code. This performance language avoids previous misinterpretations that the code intended to allow obstructions to FDC access as long as they were kept 3 feet (914 mm) away. Since fireground operations are based on local operational procedures, it is only reasonable that the fire chief of the jurisdiction have final approval authority over the access to the FDC.

The exception recognizes the practical fact that sometimes, security or other considerations make installation of a fence around a building necessary as long as the fence meets the stated criteria. The sign requirement intends to provide a visual location cue to approaching fire apparatus where the height of the fence may obscure the visibility of the FDC.

**912.4.1 Locking fire department connection caps.** The *fire code official* is authorized to require locking caps on fire department connections for water-based *fire protection systems* where the responding fire department carries appropriate key wrenches for removal.

- ❖ This section allows for the FDC caps to be equipped with locks as long as the fire departments that respond to that building or facility have the appropriate key wrenches. This avoids vandalism and affords a more functional FDC when needed. Locking caps, even more so than regular FDC caps, need proper maintenance so that they can be removed when required. Any time that an additional mechanical function is added to something that is exposed to the elements, it must be done with the understanding that the corrosive nature of the elements can place the FDC out of commission if the cap cannot be removed (see Commentary Figure 912.4.1).



**Figure 912.4.1**  
**LOCKING FDC CAPS**  
(Photo courtesy of Knox Company)

**912.4.2 Clear space around connections.** A working space of not less than 36 inches (914 mm) in width, 36 inches (914 mm) in depth and 78 inches (1981 mm) in height shall be provided and maintained in front of and to the sides of wall-mounted fire department connections and around the circumference of free-standing fire department connections, except as otherwise required or *approved* by the fire chief.

❖ Care must be taken so that fences, utility poles, barricades and other obstructions do not prevent access to and use of FDCs. A clear space of 3 feet (914 mm) must be maintained in front of and to either side of wall-mounted FDCs and around free-standing FDCs to allow easy hose connections to the fitting and efficient use of spanner wrenches and other tools needed by the apparatus engineer.

Though not specifically mentioned in this section, it is also important that FDCs be installed with the hose connections well above adjoining grade to accommodate the free turning of a spanner wrench when connecting hoses to the FDC.

**912.4.3 Physical protection.** Where fire department connections are subject to impact by a motor vehicle, vehicle impact protection shall be provided in accordance with Section 312.

❖ Section 312 requires vehicle impact protection by placing steel posts filled with concrete around the FDC. Section 312 gives the specifications for the posts.

**912.5 Signs.** A metal sign with raised letters not less than 1 inch (25 mm) in size shall be mounted on all fire department connections serving automatic sprinklers, standpipes or fire pump connections. Such signs shall read: AUTOMATIC SPRINKLERS or STANDPIPES or TEST CONNECTION or a combination thereof as applicable. Where the fire department connection does not serve the entire building, a sign shall be provided indicating the portions of the building served.

❖ The purpose of the sign is to provide the responding firefighters with the correct information on which portions of a building are served by the fire department connection. They identify the type of system or zone served by a given FDC. Many buildings include multiple sets of fire department connections which are not interconnected, such as separate connections for the building sprinkler system and the dry standpipe system in open parking structures. Some buildings may have only a partial sprinkler system, such as rehabilitated buildings where a sprinkler system is only installed on certain floors or a building that only has basement sprinklers in accordance with Section 903.2.11.

Signs may also distinguish FDCs from fire pump test headers. Usually, FDCs may be distinguished from fire pump test headers by the types of couplings provided. FDCs are customarily equipped with female couplings, while fire pump test headers usually have separately valved male couplings. Furthermore, fire pump test headers are equipped with one 2<sup>1</sup>/<sub>2</sub>-inch

(64 mm) outlet for each 250 gallon per minute (gpm) (16 L/s) of rated capacity.

Raised letters are required so that any repainting or fading of the colors on the sign will not affect its ability to be read. Each letter must be at least 1 inch (25 mm) in height so that the wording is clear. Often the wording may be abbreviated such that "AUTOMATIC SPRINKLERS" reads as "AUTO. SPKR." Existing signs may use language slightly different than that noted in the code. As long as the information is adequately communicated there should be no reason to require new signage to replace existing ones (see Commentary Figure 912.5).



**Figure 912.5**  
**FIRE DEPARTMENT CONNECTION WITH SIGN**

**912.6 Backflow protection.** The potable water supply to automatic sprinkler and standpipe systems shall be protected against backflow as required by the *International Plumbing Code*.

❖ Section 608.16.4 of the IPC requires all connections to automatic sprinkler systems and standpipe systems to be equipped with a means to protect the potable water supply. The means of backflow protection can be either a double check-valve assembly or a reduced pressure-principle backflow preventer. This, in general, assumes a FDC is required. For example, a limited-area sprinkler system off the domestic supply does not necessarily require a FDC and would not require backflow protection.

**912.7 Inspection, testing and maintenance.** Fire department connections shall be periodically inspected, tested and maintained in accordance with NFPA 25. Records of inspection, testing and maintenance shall be maintained.

❖ Because FDCs are components of a water-based extinguishing system, NFPA 25 is applicable. Inspections must determine that connections are unob-

structed, well-protected and in good working order. Plugs or covers must be installed to protect threads and pipe openings, and must be easily removed to permit connection of a fire hose.

Caps or plugs must be kept in place whenever the connection is not in use to discourage the insertion of objects into the connection openings. The interior of piping behind connection clappers must be checked for foreign material and obstructions.

Threads must be compatible with local fire service hose couplings and free of burrs, depressions and other flaws. Couplings must spin freely. Clappers, if installed in the pipe openings, must open easily and automatically return to the closed position.

Exposed piping, fittings, valves and couplings must be free of water where subject to freezing. Defects must be corrected without delay. These and other maintenance features are addressed in NFPA 25. This section also requires that written inspection and maintenance records be kept. Such records should indicate the date and time and the name of the person conducting the inspection or maintenance. These records must be maintained by the owner and should be made available to the fire code official for review when requested. This requirement relieves the fire code official of the administrative burden of maintaining test records.

### SECTION 913 FIRE PUMPS

**913.1 General.** Where provided, fire pumps shall be installed in accordance with this section and NFPA 20.

❖ This section contains specific installation requirements for fire pumps supplying water to fire protection systems. Inspection, testing and maintenance requirements comply with NFPA 20 unless noted otherwise. Applicable maintenance standards are also identified.

Fire pumps are installed in sprinkler and standpipe systems to pressurize the water supply for the minimum required sprinkler and standpipe operation. They are considered a design feature or component of the system. Fire pumps can improve only the pressure of the incoming water supply, not the volume of water available.

When the volume from a water supply is not adequate to supply sprinkler or standpipe demand, water tanks for private fire protection, improvements in the size and capacity of fire mains or water distribution systems or all of these for the installation of a fire pump are needed.

When fire pumps are required to meet the pressure requirements of sprinkler and standpipe systems, they must be installed and tested in accordance with NFPA 20.

**913.2 Protection against interruption of service.** The fire pump, driver and controller shall be protected in accordance with NFPA 20 against possible interruption of service through damage caused by explosion, fire, flood, earthquake, rodents, insects, windstorm, freezing, vandalism and other adverse conditions.

❖ This section lists hazards that must be taken into account when determining the extent of protection required for the fire pump and its auxiliary equipment. A pump room in a building that is protected against the listed hazards in compliance with the IBC would be considered in compliance. Because fire pumps are also typically located in separate detached structures, geographical and security issues must also be considered.

**913.2.1 Protection of fire pump rooms.** Rooms where fire pumps are located shall be separated from all other areas of the building in accordance with Section 913.2.1 of the *International Building Code*.

❖ The purpose of this section is to require indoor fire pump room separation by fire barriers and horizontal assemblies in accordance with the requirements in the IBC. See the commentary to Section 913.2.1 of the IBC for a complete discussion of the requirements.

**913.2.2 Circuits supplying fire pumps.** Cables used for survivability of circuits supplying fire pumps shall be *listed* in accordance with UL 2196. Electrical circuit protective systems shall be installed in accordance with their listing requirements.

❖ This section is provided to better protect cables used for survivability of circuits associated with fire pumps by referencing the appropriate standard. UL 2196 is the ANSI approved standard for tests of fire resistive cables. NFPA 20 includes selective survivability requirements to assure integrity of certain critical circuits. NFPA 70 does not specify the applicable standard within its mandatory provisions, but recognizes electrical circuit protective systems as an alternate to listed cables. An electrical circuit protective system is a field assembly of components that must be installed according to the listing requirements and manufacturer's instructions in order to maintain the listing for the system. There are more than two dozen electrical circuit protective systems listed in the *UL Fire Resistance Directory*.

**913.3 Temperature of pump room.** Suitable means shall be provided for maintaining the temperature of a pump room or pump house, where required, above 40°F (5°C).

❖ As previously noted for sprinkler systems, standpipe systems and other water-based fire protection systems, pump rooms or pump houses must be maintained at a temperature of 40°F (4°C) or above to prevent the system from freezing.

**913.3.1 Engine manufacturer's recommendation.** Temperature of the pump room, pump house or area where engines are installed shall never be less than the minimum recommended by the engine manufacturer. The engine manufacturer's recommendations for oil heaters shall be followed.

❖ The engine manufacturer's recommendation must be compiled with where the temperature is higher than the minimum established in Section 913.3. Maintaining the desired engine temperature enhances the startability of the engine. Maintaining water heaters and oil heaters as required for diesel engines, for example, will improve the starting capabilities of the fire pump and reduce engine wear and the drain on batteries.

**913.4 Valve supervision.** Where provided, the fire pump suction, discharge and bypass valves, and isolation valves on the backflow prevention device or assembly shall be supervised open by one of the following methods:

1. Central-station, proprietary or remote-station signaling service.
2. Local signaling service that will cause the sounding of an audible signal at a constantly attended location.
3. Locking valves open.
4. Sealing of valves and *approved* weekly recorded inspection where valves are located within fenced enclosures under the control of the *owner*.

❖ As was the case with sprinkler systems, water control valves that are a part of the fire pump installation must be supervised in the open position so that the system is operational when needed and also to reduce the chance of a system failure (see commentary, Section 903.4). In most cases the required water-based extinguishing system, of which the fire pump is an integral component, will be electrically supervised. Locking or sealing valves open as the only means of supervision may not be permitted, depending on the type of valve. Section 903.4, for example, specifically exempts jockey pump control valves from being electrically supervised if they are sealed or locked in the open position.

**913.4.1 Test outlet valve supervision.** Fire pump test outlet valves shall be supervised in the closed position.

❖ Fire pump test outlet valves are for performance testing of the fire pump and do not control the available water supply to either a sprinkler system or a standpipe system. These valves are normally in a closed position and are supervised accordingly.

**913.5 Testing and maintenance.** Fire pumps shall be inspected, tested and maintained in accordance with the requirements of this section and NFPA 25. Records of inspection, testing and maintenance shall be maintained.

❖ Fire pumps require periodic maintenance so that they will perform as required. Monthly maintenance includes running the pump at churn to exercise the pump and driver. Pump packings and relief valve settings must be adjusted as needed.

Annually, the pump must be retested to verify its proper performance. Pressure, flow, revolutions per minute, voltage and, for electric motor-driven pumps, voltage and amperage readings must be recorded, plotted and compared with original design criteria. Upon completion of testing and maintenance, the pump must be left in the automatic-start condition, ready for service. Because a fire pump is a component of a water-based extinguishing system, NFPA 25 is applicable. If the fire pump is powered by a liquid fuel, such as diesel, it is important that the fuel supply be replenished as soon as possible after the test.

**913.5.1 Acceptance test.** Acceptance testing shall be done in accordance with the requirements of NFPA 20.

❖ Chapter 14 of NFPA 20 details the procedure for conducting a fire pump acceptance test. This test is run to determine that the installation matches the sprinkler or standpipe system design criteria, the approved shop drawings and the pump manufacturer's performance specifications. The test is to be conducted in the presence of the building official in accordance with Section 901.5 by the installing contractor and representatives of the pump manufacturer and the controller manufacturer. Where the pump engine and/or transfer switch are separately supplied components, their manufacturer representative must also be present

**913.5.2 Generator sets.** Engine generator sets supplying emergency or standby power to fire pump assemblies shall be periodically tested in accordance with NFPA 110. Records of testing shall be maintained.

❖ This section does not require emergency or standby power for all fire pump installations, but rather requires the testing of on-site generator sets that are used for emergency or standby power to fire pump assemblies. The need for emergency or standby power is typically based on occupancy conditions as indicated in the IBC. Section 403.4.8 of the IBC, for example, requires standby power for all electrically powered fire pumps in high-rise buildings. A generator set is recognized as a permissible standby power source. NFPA 110 prescribes the operational testing requirements, including load tests, as well as the periodic inspection and maintenance for generator sets.

**913.5.3 Transfer switches.** Automatic transfer switches shall be periodically tested in accordance with NFPA 110. Records of testing shall be maintained.

❖ Automatic transfer switches are self-acting equipment that is used to transfer power from a normal source of electrical supply to an alternative supply, such as an engine generator set. NFPA 110 requires a test on each automatic transfer switch that simulates failure of the normal power source. Upon failure, the automatic transfer switch must then automatically transfer the load to the emergency power supply. Manual transfer switches are not permitted as the only means to transfer power between the normal

supply and the alternative supply to the fire pump controller.

**913.5.4 Pump room environmental conditions.** Tests of pump room environmental conditions, including heating, ventilation and illumination, shall be made to ensure proper manual or automatic operation of the associated equipment.

❖ Maintaining suitable environmental conditions is essential to the proper starting capability, performance and safe operation of fire pumps and associated emergency power supplies, where required. Adequate ventilation, for example, is needed to maintain the ambient temperature in the pump room within the range recommended by the manufacturer for the emergency power supply equipment.

### SECTION 914

#### FIRE PROTECTION BASED ON SPECIAL DETAILED REQUIREMENTS OF USE AND OCCUPANCY

**914.1 General.** This section shall specify where *fire protection systems* are required based on the detailed requirements of use and occupancy of the *International Building Code*.

❖ This section is intended to be a duplication of the fire protection system requirements included in Chapter 4 of the IBC located here in a single section of the code for ease of access by the user. It is organized based on the type of facility rather than the type of fire protection system required. Frequently, reference is made to other sections of the code where the requirements are to be found. Occasionally, administrative requirements are noted that do not appear in other sections. In all cases, the referenced section must be reviewed carefully since this section is intended to be subordinate to the main requirements found elsewhere in the code.

**914.2 Covered and open mall buildings.** Covered and open mall buildings shall comply with Sections 914.2.1 through 914.2.4.

❖ Various fire protection-related code sections from Section 402 of the IBC are included in the code so that the fire code official has convenient access to the necessary tools to address conditions and monitor new construction requirements related to fire protection systems in covered and open mall buildings. Not all covered and open mall provisions are included here. Specific information regarding kiosk placement, types of signage and other concerns are located in the IBC and can be consulted when the fire code official reviews the covered or open mall building. Although those provisions are not included here, they address issues that can have an adverse effect on the safety of occupants in the covered or open mall building.

**914.2.1 Automatic sprinkler system.** Covered and open mall buildings and buildings connected shall be equipped

throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, which shall comply with the all of the following:

1. The automatic sprinkler system shall be complete and operative throughout occupied space in the mall building prior to occupancy of any of the tenant spaces. Unoccupied tenant spaces shall be similarly protected unless provided with approved alternative protection.
2. Sprinkler protection for the mall of a covered mall building shall be independent from that provided for tenant spaces or anchor buildings.
3. Sprinkler protection for the tenant spaces of an open mall building shall be independent from that provided for anchor buildings.
4. Sprinkler protection shall be provided beneath exterior circulation balconies located adjacent to an open mall.
5. Where tenant spaces are supplied by the same system, they shall be independently controlled.

**Exception:** An *automatic sprinkler system* shall not be required in spaces or areas of open parking garages separated from the covered or open mall in accordance with Section 402.4.2.3 of the *International Building Code* and constructed in accordance with Section 406.5 of the *International Building Code*.

❖ The requirement for an automatic sprinkler system is found in Section 402.5 of the IBC. This reference provides the fire code official with the information and tools in order to work jointly with the building official in applying the sprinkler requirement for a covered and open mall building.

The covered or open mall building and connected buildings, such as anchor buildings, must be protected with an automatic sprinkler system to protect life and property effectively. As has been discussed throughout the section, numerous allowances (such as reduced tenant separations and elimination of area limitations) are based on the effectiveness of the automatic sprinkler system.

The sprinkler system is to be designed, installed, tested and maintained in accordance with Chapter 9 and NFPA 13. Additionally, the system must be installed such that any portion serving tenant spaces in a covered mall building may be shut down independently without affecting the operation of the systems protecting the mall area. This special feature is in recognition of the frequent need to shut down the system so that changes can be made to it as a result of tenant improvements and modifications.

In an open mall building, the sprinkler systems for the tenant spaces are to be separate from those provided for the anchor buildings. It is necessary that sprinkler protection for open mall buildings be extended to the underneath side of pedestrian walkways and exterior balconies used for circulation and egress purposes. Although the open mall itself

requires no sprinkler protection, it is important that those areas below overhead walkways be provided with sprinklers.

Section 909.12.4 requires operation of the sprinkler system to activate automatically the mechanical smoke control system (where an automatic control system is utilized). It is imperative that the zoning of the sprinkler system match the zoning of the smoke control system. This is necessary so that the area where water flow has occurred will also be the area from which smoke is removed.

The exception clarifies that sprinkler protection need not be extended to complying open parking garages that are adequately separated from the covered mall building, open mall building or anchor store. The allowance is consistent with the automatic sprinkler provisions of Section 903.2 where no sprinkler protection is required in open parking garages based on a Group S-2 occupancy classification.

**914.2.2 Standpipe system.** The covered and open mall building shall be equipped throughout with a standpipe system as required by Section 905.3.3.

❖ The standpipe requirements for covered and open mall buildings exist in the code, as well as in Section 402.7.1 of the IBC, which refers to Section 905 for the requirements. For additional information regarding the requirements, see the commentary for Section 905.3.3.

**914.2.3 Emergency voice/alarm communication system.** Where the total floor area exceeds 50,000 square feet (4645 m<sup>2</sup>) within either a covered mall building or within the perimeter line of an open mall building, an emergency voice/alarm communication system shall be provided. Emergency voice/alarm communication systems serving a mall, required or otherwise, shall be accessible to the fire department. The system shall be provided in accordance with Section 907.5.2.2.

❖ This section is identical to Section 402.7.4 of the IBC. In covered and open mall buildings, there is a need to be able to control the large number of people that may be present. This can best be done when specific instructions are conveyed. Covered and open malls that are less than 50,000 square feet (4645 m<sup>2</sup>) in area are not required to be provided with an emergency voice alarm system. If a public address system is provided in a smaller mall, it can serve the same purpose. See the commentary to Section 907.5.2.2 for additional information.

**914.2.4 Fire department access to equipment.** Rooms or areas containing controls for air-conditioning systems, automatic fire-extinguishing systems, *automatic sprinkler systems* or other detection, suppression or control elements shall be identified for use by the fire department.

❖ Section 402.7.5 of the IBC also states this requirement. The intent is that the fire department be able to access those systems that are critical to fire protection as well as those parts of the mechanical system that can aid in control of the ventilation system to use

as conditions warrant. The text is included here so that the fire code official has a means for applying the requirement and approving the means by which identification of the rooms or areas will be provided.

**914.3 High-rise buildings.** High-rise buildings shall comply with Sections 914.3.1 through 914.3.7.

❖ High-rise buildings have unique challenges that set them apart from other buildings. Section 403 of the IBC establishes multiple fire protection requirements for such buildings.

**914.3.1 Automatic sprinkler system.** Buildings and structures shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 and a secondary water supply where required by Section 914.3.3.

**Exception:** An *automatic sprinkler system* shall not be required in spaces or areas of:

1. Open parking garages in accordance with Section 406.5 of the *International Building Code*.
2. Telecommunications equipment buildings used exclusively for telecommunications equipment, associated electrical power distribution equipment, batteries and standby engines, provided that those spaces or areas are equipped throughout with an automatic fire detection system in accordance with Section 907.2 and are separated from the remainder of the building by not less than 1-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or not less than 2-hour *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.

❖ In order to provide protection for occupants and fire fighters, high-rise buildings are required to be equipped with an automatic sprinkler system. There are two exceptions that allow sprinkler protection to be omitted. Exception 1 is for an open parking garage that is a part of the high-rise building. This exception recognizes the relatively low life safety threat posed by fires in open parking garages. Additional information on open parking garages can be obtained in the commentary for Section 406 of the IBC.

Exception 2 acknowledges the water sensitivity of telecommunications systems. See commentary to the same exception in Section 903.2.

**914.3.1.1 Number of sprinkler risers and system design.** Each sprinkler system zone in buildings that are more than 420 feet (128 m) in height shall be supplied by no fewer than two risers. Each riser shall supply sprinklers on alternate floors. If more than two risers are provided for a zone, sprinklers on adjacent floors shall not be supplied from the same riser.

❖ The intent of this section is to increase the reliability of automatic sprinkler systems in very tall buildings, i.e., those that exceed 420 feet in height, by requiring a minimum of two risers for each sprinkler system zone. The difficulty of fighting fires in very tall buildings ranges from difficult to virtually impossible with

the sprinkler system impaired. Accordingly, the reliable functioning of sprinkler systems is critical. Various events could cause a sprinkler riser to be impaired, thereby leaving the structure vulnerable to fire. The NIST World Trade Center (WTC) Report documented that the proximate cause of the buildings collapse was a building contents fire that raged out of control, in part at least, because the building's automatic sprinkler systems were nonfunctional due to the initial aircraft attack. Events far less dramatic could knock out or make a sprinkler riser inoperative, thereby leaving the structure highly vulnerable to fire.

Recommendation 12 of the NIST WTC report calls for the redundancy of active fire suppression systems to be increased to accommodate the greater risks associated with increased building height and population. This section seeks to do that by requiring two risers designed such that, if one riser is taken out of service, the other will be able to supply sprinklers on the floors above and below. This will impede any fire spread and allow the fire department time to respond and extinguish the fire. At the Meridian Plaza fire in Philadelphia, the further spread of an out of control fire occurring on floors not protected by sprinklers was prevented by the operation of ten sprinklers when the fire reached a floor which had been retrofitted with sprinklers.

**914.3.1.1.1 Riser location.** Sprinkler risers shall be placed in interior exit stairways and ramps that are remotely located in accordance with Section 1015.2.

❖ This section requires the sprinkler risers to be located in protected interior exit stairways and ramps and specifies a separation distance to reduce the possibility that one incident could incapacitate both risers which is consistent with the approach used in the code for interior exit stairway separation. See commentary to Section 1007.

**914.3.1.2 Water supply to required fire pumps.** In buildings that are more than 420 feet (128 m) in *building height*, required fire pumps shall be supplied by connections to no fewer than two water mains located in different streets. Separate supply piping shall be provided between each connection to the water main and the pumps. Each connection and the supply piping between the connection and the pumps shall be sized to supply the flow and pressure required for the pumps to operate.

**Exception:** Two connections to the same main shall be permitted provided the main is valved such that an interruption can be isolated so that the water supply will continue without interruption through no fewer than one of the connections.

❖ Fire pumps are installed in sprinkler and standpipe systems to pressurize the water supply for the minimum required sprinkler and standpipe operation. Fire pumps are only "required" to meet the system needs. Therefore, whether a particular high-rise building includes fire pumps will depend on interaction of the height of the building, the local water system and the

designs of the sprinkler and standpipe systems in the building (see Section 913 for more information on fire pumps).

The difficulty of fighting fires in very tall buildings ranges from hard to virtually impossible. Accordingly, the reliable functioning of required sprinkler and standpipe systems is critically important.

Recommendation 12 of the NIST WTC report called for the redundancy of active fire suppression systems to be increased to accommodate the greater risks associated with increasing building height and population. Where the systems require a fire pump and the building is more than 420 feet (128 m) in height, this section requires the fire pumps to be supplied by two water mains located in separate streets. The purpose of this is to increase the reliability of fire suppression systems in very tall buildings by requiring independent street-level water feeds such that the system will function as intended if one of those feeds is damaged or otherwise interrupted. Having two connections will greatly reduce the possibility of the loss of water due to a main break, given the valving which is a feature of a public water system. Each connection must be adequate to provide the flow and pressure needed for the fire pumps to operate. The exception is a performance-based provision that is not tied to any specific configuration.

**914.3.2 Secondary water supply.** An automatic secondary on-site water supply having a capacity not less than the hydraulically calculated sprinkler demand, including the hose stream requirement, shall be provided for high-rise buildings assigned to Seismic Design Category C, D, E or F as determined by the *International Building Code*. An additional fire pump shall not be required for the secondary water supply unless needed to provide the minimum design intake pressure at the suction side of the fire pump supplying the *automatic sprinkler system*. The secondary water supply shall have a duration of not less than 30 minutes as determined by the occupancy hazard classification in accordance with NFPA 13.

**Exception:** Existing buildings.

❖ The intent of this section is that a secondary water supply be provided on the high-rise building site in order to provide a high level of functional reliability for the fire protection systems if a seismic event disables the primary water supply for high-rise buildings assigned these Seismic Design categories. The categories are described in Section 1613 of the IBC.

The text's specific wording that the secondary supply be "on-site" rather than "to the site" would preclude the use, for example, of a secondary connection to the municipal supply to achieve compliance with this requirement.

The required amount of water is equal to the hydraulically calculated sprinkler demand plus hose stream demand for a minimum 30 minute period dependent on the appropriate occupancy hazard classification in NFPA 13.

Note that the beginning of Section 914.3.2 requires that the secondary water supply be automatic; in other words, switchover to the secondary water source cannot occur manually. This is consistent with the definitions of "Automatic sprinkler system" and "Classes of standpipe systems;" in that both systems are required to be connected to a reliable water supply.

Generally, this section does not automatically require a second fire pump, but, if necessary, an additional pump may be required. A second pump would be necessary if the secondary water supply does not provide the necessary water pressure for intake into the primary fire pump.

**914.3.3 Fire alarm system.** A fire alarm system shall be provided in accordance with Section 907.2.13.

❖ See the commentary to Section 907.2.13.

**914.3.4 Automatic smoke detection.** Smoke detection shall be provided in accordance with Section 907.2.13.1.

❖ Section 907.2.13 indicates specific locations where smoke detection is required for a high-rise building. These requirements are due to the fact that the building is a high rise and not necessarily dependent upon the occupancy within. There may be additional requirements in other sections of the code that require specific detection due to the occupancy.

**914.3.5 Emergency voice/alarm communication system.** An emergency voice/alarm communication system shall be provided in accordance with Section 907.5.2.2.

❖ Due to the size of high-rise buildings, an emergency voice/alarm communication is required so that specific commands can be given as necessary. See the commentary to Sections 907.2.13 and 907.5.2.2 for additional information.

**914.3.6 Emergency responder radio coverage.** Emergency responder radio coverage shall be provided in accordance with Section 510.

❖ The provisions of Section 510 are concerned with the reliability of portable radios used by emergency responders inside of buildings. This is in keeping with the philosophy inherent in the I-Codes that, when a facility grows too large or complex for effective fire response, fire protection features must be provided within the building. See the commentary to Section 510 for complete information on this topic.

**914.3.7 Fire command.** A *fire command center* complying with Section 508 shall be provided in a location *approved* by the fire department.

❖ Section 508 of the code contains the same information as Section 911 of the IBC on this subject. The fire command center must always be accessible to the fire service. See the commentary to Section 508 for additional information.

**914.4 Atriums.** Atriums shall comply with Sections 914.4.1 and 914.4.2.

❖ Atriums are addressed in Section 404 of the IBC, which identifies several fire protection systems that must be included in atriums. It is important to remember that these are requirements that are unique to the specific condition noted and the fire protection systems are a result of those conditions. These requirements are only partially related to the occupancies that may be present.

**914.4.1 Automatic sprinkler system.** An *approved automatic sprinkler system* shall be installed throughout the entire building.

**Exceptions:**

1. That area of a building adjacent to or above the atrium need not be sprinklered, provided that portion of the building is separated from the atrium portion by not less than a 2-hour *fire barrier* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.
2. Where the ceiling of the atrium is more than 55 feet (16 764 mm) above the floor, sprinkler protection at the ceiling of the atrium is not required.

❖ Due to the possibility that smoke and fire could spread through an unprotected vertical opening, an automatic sprinkler system is required when an atrium is present in a building and must be installed throughout the building as a preventive measure. If, however, the atrium is treated more like a shaft and provided with a 2-hour enclosure, only the atrium itself must be sprinklered.

The assumption in Exception 1 is that the passive protection systems that isolate the atrium would be sufficient to compensate for the limited sprinkler coverage and be an acceptable alternative to sprinklers throughout the building.

Exception 2 allows for the omission of sprinklers in tall spaces for two reasons. First, due to the entrainment of cooler ambient air in the flame plume, the likelihood that sprinklers will activate diminishes greatly with increased atrium ceiling height. Secondly, the effectiveness of the sprinkler water discharging from such heights is also substantially diminished.

**914.4.2 Fire alarm system.** A fire alarm system shall be provided where required by Section 907.2.14.

❖ See the commentary for Section 907.2.14.

**914.5 Underground buildings.** Underground buildings shall comply with Sections 914.5.1 through 914.5.5.

❖ Section 405 of the IBC contains requirements for underground buildings. The fire protection features

necessary for this type of building are also found elsewhere in this chapter but are reiterated in the following sections. Underground buildings present unique hazards in that the path of egress is upward, in the same direction as vertical fire movement. Fires in such buildings are also more challenging for fire fighters since there is no opportunity for an exterior fire attack. See the commentary for Section 405 of the IBC for additional information.

**914.5.1 Automatic sprinkler system.** The highest *level of exit discharge* serving the underground portions of the building and all levels below shall be equipped with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1. Water-flow switches and control valves shall be supervised in accordance with Section 903.4.

❖ Underground buildings have occupiable levels that are more than 30 feet (9144 mm) below the lowest level of exit discharge. This requirement from the IBC indicates that sprinklers are required for the portions of the building that are below ground and the story at the highest level of exit discharge. The provision does not require sprinklers for any stories that may be above the highest level of exit discharge. If sprinklers were required for those areas, it would be due to provisions in other sections of the code. In some respects, this is an expansion of the general provisions for windowless stories in Section 903.2.11.1.

**914.5.2 Smoke control system.** A smoke control system is required to control the migration of products of combustion in accordance with Section 909 and provisions of this section. Smoke control shall restrict movement of smoke to the general area of fire origin and maintain *means of egress* in a usable condition.

❖ One common application for an underground building is to use excavated caverns for storage. In such a condition, there is no roof from which the fire service can attempt to vent the “building.” Because occupants must egress in the same direction that smoke will vent itself, and because there are few, if any, openings by which to vent smoke to the exterior, the need for smoke control is greater than for traditional buildings. This section adds a degree of clarity to the design requirements of Section 909 in that the intent is to contain smoke to the general area of origin. Any method identified in Section 909 can be used, given that the intent is to allow for egress and limit smoke spread to areas of the building that are not involved in the fire event. See Section 909 for additional commentary on smoke control.

**914.5.3 Compartment smoke control system.** Where compartmentation is required by Section 405.4 of the *International Building Code*, each compartment shall have an independent smoke control system. The system shall be automatically activated and capable of manual operation in accordance with Section 907.2.18.

❖ When buildings contain levels that are more than 60 feet below the lowest level of exit discharge, Section

405.4.1 of the IBC requires that there be at least two fire-resistance-rated compartments per floor and of approximately the same size. Because compartmentation exists, there is a need for additional safety with the smoke control system. Consequently, each compartment must have a smoke control system that is independent of that in the adjoining compartment. The word “independent” means that there can be no sharing of ductwork, mechanical equipment or power distribution. Connection to the standby system can be shared since that is consistent with the general intent of the smoke control system provisions in Section 909 and the IMC. See the commentary to Section 405.4 of the IBC.

**914.5.4 Fire alarm system.** A fire alarm system shall be provided where required by Sections 907.2.18 and 907.2.19.

❖ The threshold for requiring the fire alarm system is the same as that for compartmentation—an occupied floor level more than 60 feet (18 288 mm) below the level of exit discharge. The fire alarm requirements include the requirements for an emergency voice/ alarm communication system. See the commentary to Sections 907.2.18 and 907.2.19 for additional information.

**914.5.5 Standpipe system.** The underground building shall be provided throughout with a standpipe system in accordance with Section 905.

❖ Section 905.3.1 requires a standpipe system when the building’s lowest level is more than 30 feet (9144 mm) below the lowest level of fire department access. By definition, an underground building is one in which the lowest level is more than 30 feet (9144 mm) below the lowest level of exit discharge. One condition uses fire department vehicle access as the benchmark while the other uses the level of exit discharge. Care must be taken so that both conditions are addressed when determining standpipe system requirements for buildings that have levels below ground.

**914.6 Stages.** Stages shall comply with Sections 914.6.1 and 914.6.2.

❖ Section 410 of the IBC contains definitions and requirements for both stages and platforms. A stage, however, is a special condition according to the IBC. It does not mean, for example, that an elevated platform in the front of the banquet hall is intended to be regulated the same as a stage. The term “stage,” as used here, is traditionally considered a “legitimate stage”—one with scenery drops and a gridiron above. See the commentary to Section 410 of the IBC for further information.

**914.6.1 Automatic sprinkler system.** Stages shall be equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1. Sprinklers shall be installed under the roof and gridiron and under all catwalks and galleries over the stage. Sprinklers shall be installed in dressing rooms, per-

former lounges, shops and storerooms accessory to such stages.

**Exceptions:**

1. Sprinklers are not required under stage areas less than 4 feet (1219 mm) in clear height utilized exclusively for storage of tables and chairs, provided the concealed space is separated from the adjacent spaces by Type X gypsum board not less than  $\frac{5}{8}$  inch (15.9 mm) in thickness.
  2. Sprinklers are not required for stages 1,000 square feet (93 m<sup>2</sup>) or less in area and 50 feet (15 240 mm) or less in height where curtains, scenery or other combustible hangings are not retractable vertically. Combustible hangings shall be limited to a single main curtain, borders, legs and a single backdrop.
  3. Sprinklers are not required within portable orchestra enclosures on stages.
- ❖ Stages contain significant quantities of combustible materials stored in, around and above the stage that are located in close proximity to large quantities of lighting equipment (i.e., scenery and lighting above the stage). There also is scenery on the sides and rear of the stage; shops located along the back and sides of the stage and storage, props, trap doors and lifts under the stage floor. This combination of fuel load and ignition sources increases the potential for a fire. As such, stages and accessory areas, such as dressing rooms, workshops and storerooms, are required to be protected with an automatic sprinkler system (see commentary, IBC Section 410.7).

Both of the exceptions are intended to be applied where the building would not otherwise be required to be provided with sprinklers. If the building must be sprinklered throughout then the two exceptions are moot. Sprinkler installations must be in accordance with NFPA 13 and placed as required by that standard.

Exception 1 allows simple storage in the space below the stage, a space traditionally used for table and chair storage. The space must be compartmentalized so that a minimal thermal barrier is provided between the stored material and the areas outside the space. If the height of the space exceeds 4 feet (1219 mm) or the materials stored are other than those associated with table and chair storage, then sprinklers must be provided.

Exception 2 recognizes that small stage settings do not pose the same risk as larger stages. In schools where the stage may only be an elevated portion at the end of the cafeteria, for example, the exception gives a basis for determining whether sprinkler protection is required or not. If scenery is simply manually set in place or moved horizontally, the large fuel loads associated with stages is not present.

**914.6.2 Standpipe system.** Standpipe systems shall be provided in accordance with Section 905.

- ❖ Due to the historic fires on stages of theaters, the code requires that a standpipe system be provided

for all stages greater than 1,000 square feet (93 m<sup>2</sup>) in area. The design requirements are dependent on the extent of sprinkler protection. See the commentary to Section 905.3.4 for additional information about the standpipe requirements.

**914.7 Special amusement buildings.** Special amusement buildings shall comply with Sections 914.7.1 and 914.7.2.

- ❖ A special amusement building is one in which the egress is not readily apparent, is intentionally confounded or is not readily available. Due to those characteristics, special fire protection features are required. See the commentary to Section 411 of the IBC for additional information about these types of facilities.

**914.7.1 Automatic sprinkler system.** Special amusement buildings shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1. Where the special amusement building is temporary, the sprinkler water supply shall be of an *approved* temporary means.

**Exception:** Automatic sprinklers are not required where the total floor area of a temporary special amusement building is less than 1,000 square feet (93 m<sup>2</sup>) and the *exit access* travel distance from any point to an *exit* is less than 50 feet (15 240 mm).

- ❖ Special amusement buildings do not normally have a readily identifiable means of egress. Consequently additional time for safe egress may be necessary. A sprinkler system will minimize the potential hazard to occupants by controlling fire development (see commentary, IBC Section 411).

**914.7.2 Automatic smoke detection.** Special amusement buildings shall be equipped with an automatic smoke detection system in accordance with Section 907.2.12.

- ❖ Section 907.2.12 indicates that a smoke detection system is required for special amusement buildings. See the commentary to Section 907.2.12 for additional information.

**914.8 Aircraft-related occupancies.** Aircraft-related occupancies shall comply with Sections 914.8.1 through 914.8.6.

- ❖ Aircraft related occupancies include air traffic control towers, residential and commercial hangars and heliports and helistops. Hangars can be those for storage and “parking” of the aircraft or for repair and painting. All of these are addressed in Section 412 of the IBC.

While the following provisions do not identify fire protection requirements for heliports and helistops, Section 412.8 of the IBC requires that these facilities be designed in accordance with NFPA 418. That standard contains various provisions for fire protection including a foam fire-extinguishing system for rooftop landing pads and portable fire extinguishers. Section 2007 of the code contains fire protection requirements for helistops and heliports. Section 905.3.6 requires a standpipe system for helistops and heliports. Additional requirements for portable fire extinguishers in aviation facilities can be found in Section 2005 of the code.

**914.8.1 Automatic smoke detection systems.** Airport traffic control towers shall be provided with an automatic smoke detection system installed in accordance with Section 907.2.22.

❖ Airport traffic control towers are required to have an automatic fire detection system. Because the tower is designed so that people are elevated in the air, the vertical supports generally are narrow and contain little room for separated stairways. An early notification of a fire hazard is important in alerting the occupants so that fire safety operations can be begun as quickly as possible. An automatic detection system is therefore required. Section 907.2.22.1 applies specifically to towers where sprinklers are provided and there are at least two means of egress. Where there is only a single means of egress, Section 907.2.22.2 specifies the coverage of the fire detection systems. Section 907.2.22.2 also applies to towers which are not sprinkler protected although only towers of a height of less than 35 feet would be without sprinklers (see IBC Section 412.3.6). Where suppression is not required by the code, the detection system is vital for the safety of the occupants. No requirements are included in Chapter 11 of the code to address existing airport traffic control towers.

**914.8.2 Automatic sprinkler system for new airport traffic control towers.** Where an occupied floor is located more than 35 feet (10 668 mm) above the lowest level of fire department vehicle access, new airport traffic control towers shall be equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

❖ Sprinkler systems are required for all towers being constructed under Section 412.3.6 of the IBC once there is an occupied floor above 35 feet. This height was selected because shorter towers should be reachable by ladders typically found at rural fire stations and smaller airports. These are also the types of airports that would have the shorter control towers. Due to the absence of aerial ladders or means to reach higher elevations at these locations, additional levels of fire protection are required. As such, life safety is positively affected by limiting the chance of smoke/fire spread and flashover in the facility where delayed evacuation of the cab may be required. In addition, property protection to allow sooner reuse of the structure would be provided.

**914.8.3 Fire suppression for aircraft hangars.** Aircraft hangars shall be provided with a fire suppression system designed in accordance with NFPA 409, based upon the classification for the hangar given in Table 914.8.3.

**Exception:** Where a fixed base operator has separate repair facilities on site, Group II hangars operated by a fixed base operator used for storage of transient aircraft only shall have a fire suppression system, but the system shall be exempt from foam requirements.

❖ To minimize the fire hazards associated with aircraft hangars, most hangars are required to be protected with a fire suppression system. Where required, the

fire suppression system must be designed and installed in accordance with the referenced standard, NFPA 409 which requires fire suppression based on the type and construction and the activities in a given hangar.

In the standard, the suppression requirements are broken down based on three categories: Group I, Group II and Group III hangars. Table 914.8.2 designates which Group designation applies to various sizes of fire areas within a hangar and the type of construction. For example a hangar which is 28,000 square feet (2601 m<sup>2</sup>) in Type IIB construction would be a Group II hangar. Groups I and II hangars are required to have fire suppression as specified the NFPA 409. In general Group III hangars are exempt from providing fire suppression unless one (or more) of the hazardous operations listed in Section 914.8.3.1 occurs within the hangar. In these situations fire suppression based on the appropriate portion of the standard for either Group I or Group II is required.

The exception allows for Group II hangars that the foam requirements for fire suppression do not need to be provided if the hangar is essentially a parking garage for transient aircraft. The exception is only applicable where a larger airport facility has multiple hangars and separate hangars for repair operations.

**TABLE 914.8.3.** See page 9-149.

❖ This table is a correlation of the NFPA 409 construction and area limits with the IBC construction type requirements. It combines several tables in NFPA 409 into a single table that allows determination of the group type for aircraft hangars based on construction type and area before proceeding to the standard for the suppression requirements. Note a indicates that, regardless of size or construction type, any hangar with a door opening greater than 28 feet high (8534 mm) is required to have a fire suppression system as required for a Group I hangar. Note c provides a Group IV designation for any hangar located in a membrane structure.

**914.8.3.1 Hazardous operations.** Any Group III aircraft hangar in accordance with Table 914.8.3 that contains hazardous operations including, but not limited to, the following shall be provided with a Group I or II fire suppression system in accordance with NFPA 409 as applicable:

1. Doping.
2. Hot work including, but not limited to, welding, torch cutting and torch soldering.
3. Fuel transfer.
4. Fuel tank repair or maintenance not including defueled tanks in accordance with NFPA 409, inerted tanks or tanks that have never been fueled.
5. Spray finishing operations.
6. Total fuel capacity of all aircraft within the unsprinklered single *fire area* in excess of 1,600 gallons (6057 L).

7. Total fuel capacity of all aircraft within the maximum single *fire area* in excess of 7,500 gallons (28 390 L) for a hangar equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.

❖ Any of the operations listed in this section where they occur in a Group III hangar will require some level of fire suppression under NFPA 409. The hazardous operations on the list are straight forward. Additional information may be found as follows: Item 1 is discussed further in Section 914.8.4; Item 2 is regulated by Chapter 35; Items 3 and 4 are regulated by Chapter 57; Item 5 is regulated by Chapter 24.

**914.8.3.2 Separation of maximum single fire areas.** Maximum single *fire areas* established in accordance with hangar classification and construction type in Table 914.8.3 shall be separated by 2-hour *fire walls* constructed in accordance with Section 706 of the *International Building Code*. In determining the maximum single fire area as set forth in Table 914.8.3, ancillary uses that are separated from aircraft servicing areas by not less than a 1-hour *fire barrier* constructed in accordance with Section 707 of the *International Building Code* shall not be included in the area.

❖ Table 914.8.3 places a maximum size limit on hangars based on type of construction. For a hangar structure to exceed these sizes requires the construction of fire walls to establish fire areas than stay within the limits. This section is more stringent than the definition of “Fire areas” which allows fire barriers to establish a fire area. For hangars, the fire areas must be created by exterior walls of a building or a combination of exterior walls and fire walls. Note that there is some allowance for the use of fire barriers to create fire areas when separating ancillary uses such as business offices, maintenance shops and storage areas. The fire suppression requirements contained within NFPA 409 are primarily focused on the protection of aircraft within the servicing and storage area.

The fire protection requirements in the ancillary areas are not as extensive as those required for the aircraft servicing and storage areas and less restrictive separations are considered appropriate. This allowance is consistent with NFPA 409 requirements.

**914.8.4 Finishing.** The process of “doping,” involving the use of a volatile flammable solvent, or of painting shall be carried on in a separate detached building equipped with automatic fire-extinguishing equipment in accordance with Section 903.

❖ Doping is a type of lacquer used to protect, waterproof and make taut cloth surfaces of airplane wings. It is used on lighter-than-air, ultra-light and some light aircraft. It is essentially painting on fabric. Doping is not used on metallic surfaces; however, the use of flammable paints is also addressed in this section. When flammable finishes are applied, the process must occur in a separate building not attached to the hangar. Because the code text refers to Section 903 the intent is for an automatic sprinkler system to be installed, unless otherwise approved (see commentary, IBC Section 412.4.5).

**914.8.5 Residential aircraft hangar smoke alarms.** Smoke alarms shall be provided within residential aircraft hangars in accordance with Section 907.2.21.

❖ A residential aircraft hangar, as defined in Section 202 of the IBC, is “. . . an accessory building less than 2,000 square feet (186 m<sup>2</sup>) and 20 feet (6096 mm) in height, constructed on a one- or two-family residential property where aircraft are stored. . .” The requirements for the residential hangar are very similar to that for a residential garage. The hangar can be either detached or attached. If attached, it must be separated from the dwelling by construction with not less than a 1-hour fire-resistance rating. Section 907.2.21 requires a minimum of one smoke alarm in a residential aircraft hangar. See the commentary to Section 907.2.21 for additional information.

**TABLE 914.8.3  
HANGAR FIRE SUPPRESSION REQUIREMENTS<sup>a,b,c</sup>**

MAXIMUM SINGLE FIRE AREA (square feet)	INTERNATIONAL BUILDING CODE TYPE OF CONSTRUCTION								
	IA	IB	IIA	IIB	IIIA	IIIB	IV	VA	VB
> 40,001	Group I	Group I	Group I	Group I	Group I	Group I	Group I	Group I	Group I
40,000	Group II	Group II	Group II	Group II	Group II	Group II	Group II	Group II	Group II
30,000	Group III	Group II	Group II	Group II	Group II	Group II	Group II	Group II	Group II
20,000	Group III	Group III	Group II	Group II	Group II	Group II	Group II	Group II	Group II
15,000	Group III	Group III	Group III	Group II	Group III	Group II	Group III	Group II	Group II
12,000	Group III	Group III	Group III	Group III	Group III	Group III	Group III	Group II	Group II
8,000	Group III	Group III	Group III	Group III	Group III	Group III	Group III	Group III	Group II
5,000	Group III	Group III	Group III	Group III	Group III	Group III	Group III	Group III	Group III

For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 foot = 304.8 mm.

a. Aircraft hangars with a door height greater than 28 feet shall be provided with fire suppression for a Group I hangar regardless of maximum fire area.

b. Groups shall be as classified in accordance with NFPA 409.

c. Membrane structures complying with Section 3102 of the *International Building Code* shall be classified as a Group IV hangar.

**914.8.6 Aircraft paint hangar fire suppression.** Aircraft paint hangars shall be provided with fire suppression as required by NFPA 409.

❖ To minimize the fire hazards associated with aircraft paint hangars, all such buildings are required to be protected with a fire suppression system. This requirement is applicable regardless of the size of the hangar in terms of height or area or the types and quantities of aircraft that are being cleaned or painted. The fire suppression system must be designed and installed in accordance with NFPA 409.

This section assumes the primary function of the hangar is as a paint hangar. Minor painting may constitute finishing in accordance with Section 914.8.4. While not referenced in the code, NFPA 410 provides additional guidance on aircraft maintenance, including the painting of aircraft.

**914.9 Application of flammable finishes.** An *automatic sprinkler system* or fire-extinguishing system shall be provided in all spray, dip and immersing spaces and storage rooms, and shall be installed in accordance with Chapter 9.

❖ Chapter 24 provides detailed information about spaces and rooms involved in the application of flammable finishes. This section references Chapter 9 for the appropriate type of fire-extinguishing system.

**914.10 Drying rooms.** Drying rooms designed for high-hazard materials and processes, including special occupancies as provided for in Chapter 4 of the *International Building Code*, shall be protected by an *approved* automatic fire-extinguishing system complying with the provisions of Chapter 9.

❖ This section reiterates the requirements from Section 417.4 of the IBC. See the commentary to Section 417.4 of the IBC for additional information.

**914.11 Ambulatory care facilities.** Occupancies classified as ambulatory care facilities shall comply with Sections 914.11.1 through 914.11.3.

❖ This section simply introduces the fire protection requirements for ambulatory care facilities. See also the commentary to Section 422 of the IBC.

**914.11.1 Automatic sprinkler systems.** An *automatic sprinkler system* shall be provided for ambulatory care facilities in accordance with Section 903.2.2.

❖ See the commentary to Section 903.2.2.

**914.11.2 Manual fire alarm systems.** A manual fire alarm system shall be provided for ambulatory care facilities in accordance with Section 907.2.2.

❖ See the commentary to Section 907.2.2.

**914.11.3 Fire alarm systems.** An automatic smoke detection system shall be provided for ambulatory care facilities in accordance with Section 907.2.2.1.

❖ See the commentary to Section 907.2.2.1.

## SECTION 915 CARBON MONOXIDE DETECTION

**915.1 General.** Carbon monoxide detection shall be installed in new buildings in accordance with Sections 915.1.1 through 915.6. Carbon monoxide detection shall be installed in existing buildings in accordance with Section 1103.9.

❖ These provisions were added to this code and the IBC to be consistent with the requirements for carbon monoxide (CO) detectors in all new construction of one- and two-family dwellings that had been added to the IRC in the 2009 edition. Another reason for its approval was technical data in a 1998 article published by the *Journal of the American Medical Association* that stated that approximately 2,100 deaths occur annually as a result of CO poisoning. That annual number is based on the findings of a paper prepared by the U.S. Department of Health Centers for Disease Control (CDC). That paper documented epidemiological research by two CDC physicians who examined 56,133 death certificates over a 10-year period. Excluding suicides, homicides, structure fires and deaths resulting from CO poisoning in motor vehicles, the death rate steadily decreased for the sample period, from a value of 1513 people in 1979 to 878 in 1988. The highest death rates occurred in winter and among males, African Americans, the elderly and residents in northern states.

CO is a colorless, tasteless, odorless gas that interrupts the attachment of oxygen molecules to hemoglobin in blood cells and can cause headaches, confusion and dizziness. At higher concentrations, CO can cause loss of consciousness and eventual death. Exposures above 100 parts/million are dangerous to human health. It is not a toxic or highly toxic gas as defined in Chapter 2 but is classified as a flammable gas.

The provisions of Section 915 detail what occupancies require CO detection and where that detection is specifically to be located within the building. Also flexibility on the use of single- and multiple-station alarms versus CO detection systems is provided.

Retroactive requirements are found in Chapter 11. These requirements are essentially the same except that Group E classrooms are not addressed and the CO alarms can be battery powered.

**915.1.1 Where required.** Carbon monoxide detection shall be provided in Group I-1, I-2, I-4 and R occupancies and in classrooms in Group E occupancies in the locations specified in Section 915.2 where any of the conditions in Sections 915.1.2 through 915.1.6 exist.

❖ CO detection is provided to protect occupants of dwelling units and sleeping units within Group I-1, I-4, and R occupancies and classrooms in Group E occupancies. These are locations where occupants are

likely to be sleeping or that young children may be at risk. Sections 915.1.2 through 915.1.5 address the different scenarios that warrant CO detection and are more specific than past editions of the code and the IBC.

**915.1.2 Fuel-burning appliances and fuel-burning fireplaces.** Carbon monoxide detection shall be provided in *dwelling units, sleeping units* and classrooms that contain a fuel-burning appliance or a fuel-burning fireplace.

❖ This section clarifies that CO detection is required where the dwelling or sleeping unit or the classroom actually contains a fuel burning appliance or fuel burning fireplace. Section 915.1.3 discusses dwelling and sleeping units and classrooms that are served by fuel burning, forced-air furnaces.

**915.1.3 Forced-air furnaces.** Carbon monoxide detection shall be provided in *dwelling units, sleeping units* and classrooms served by a fuel-burning, forced-air furnace.

**Exception:** Carbon monoxide detection shall not be required in *dwelling units, sleeping units* and classrooms where carbon monoxide detection is provided in the first room or area served by each main duct leaving the furnace, and the carbon monoxide alarm signals are automatically transmitted to an approved location.

❖ This section addresses forced-air furnaces that physically move air. This source is more indirect than having the fuel-burning appliance or fuel-burning fireplace within the space itself but still creates a potential hazard.

The exception addresses the fact that if detection is provided more closely to the source, then further detection within dwelling units, sleeping units and Group E classrooms is not necessary provided that a CO alarm signal is transmitted to an approved location from which emergency actions can be initiated and occupants in the portions of the building more remote from the initial detection can be notified. The CO will continue to be generated until action is taken.

**915.1.4 Fuel-burning appliances outside of dwelling units, sleeping units and classrooms.** Carbon monoxide detection shall be provided in *dwelling units, sleeping units* and classrooms located in buildings that contain fuel-burning appliances or fuel-burning fireplaces.

**Exceptions:**

1. Carbon monoxide detection shall not be required in *dwelling units, sleeping units* and classrooms where there are no communicating openings between the fuel-burning appliance or fuel-burning fireplace and the *dwelling unit, sleeping unit* or classroom.
2. Carbon monoxide detection shall not be required in *dwelling units, sleeping units* and classrooms where carbon monoxide detection is provided in one of the following locations:
  - 2.1. In an approved location between the fuel-burning appliance or fuel-burning fireplace and the *dwelling unit, sleeping unit* or classroom.

- 2.2. On the ceiling of the room containing the fuel-burning appliance or fuel-burning fireplace.

❖ This section focuses on the presence of fuel burning equipment in buildings containing dwelling units, sleeping units and classrooms but with the fuel burning equipment located outside of those areas. CO detection is required in every dwelling unit, sleeping unit and classroom, even if that equipment does not serve those spaces. A good example of this is a multi-story hotel that has all electric HVAC in the sleeping units, but perhaps a fireplace in the lobby, forced air heating in the common area, and a boiler in an equipment room.

There are two exceptions provided that recognize, based upon several factors, that the CO is a very low risk to the spaces required to be protected by Section 915.

Exception 1 addresses buildings where there are no communicating openings between the location of the fuel burning appliance and dwelling units, sleeping units and classrooms. The intent is that if the appliance is not serving the space and has no communication with the space, CO should not enter those spaces. This covers situations where CO emanating from the fuel burning appliance has no direct path to a dwelling unit or sleeping unit, such as a water heater in an equipment room that only has access from the exterior of the building, and no openings through which the CO can get to dwelling units or sleeping units. An interior door, between the equipment room and a dwelling unit, even if it is self-closing, would not allow this exception to be used.

Exception 2 is similar to the exception to Section 915.1.3. This exception requires the installation of one or more CO alarms in approved locations between fuel burning appliances and the nearest dwelling unit, sleeping unit or classroom or on the ceiling of the room in which a fuel-burning appliance is located. CO alarms are only required where there are communicating openings including ducts, concealed spaces, interior hallways, stairs and spaces between the fuel-burning appliance or fuel burning fireplace and the dwelling unit or sleeping unit where air can flow from the appliance to the dwelling unit or sleeping unit.

**915.1.5 Private garages.** Carbon monoxide detection shall be provided in *dwelling units, sleeping units* and classrooms in buildings with attached private garages.

**Exceptions:**

1. Carbon monoxide detection shall not be required where there are no communicating openings between the private garage and the *dwelling unit, sleeping unit* or classroom.
2. Carbon monoxide detection shall not be required in *dwelling units, sleeping units* and classrooms located more than one story above or below a private garage.

3. Carbon monoxide detection shall not be required where the private garage connects to the building through an open-ended corridor.
4. Where carbon monoxide detection is provided in an approved location between openings to a private garage and *dwelling units*, *sleeping units* or classrooms, carbon monoxide detection shall not be required in the *dwelling units*, *sleeping units* or classrooms.

❖ This section addresses attached private garages. Private garages, a term defined in Chapter 2 of the code, are often sources of CO generation. When attached to a building containing dwelling units, sleeping units or classrooms in Group E, CO detection is required.

There are several exceptions to the requirement for CO detection. These are similar to those found in Sections 915.1.3 and 915.1.4.

Exception 1 is similar to Exception 1 in Section 915.1.4. If there are no communicating openings, then CO detection is not required. The likelihood of CO entering the dwelling units, sleeping units or classrooms is greatly reduced.

Exception 2 addresses buildings where the dwelling units, sleeping units and classrooms are two stories above or below the location of the fuel-burning appliance. The CO would need to travel through an entire story before reaching the areas of concern.

Exception 3 does not require CO alarms to be provided when the private garage is attached to the building by an open ended corridor (a term defined in Chapter 2 of the code and the IFC, and commonly called a breezeway). This allows the CO concentration to dissipate before becoming a hazard to building occupants.

Exception 4 is similar to the exception to Section 915.1.3 and recognizes that the detection can be located closer to the source of the hazard versus requiring detection in every dwelling unit, sleeping unit or classroom.

**915.1.6 Exempt garages.** For determining compliance with Section 915.1.5, an open parking garage complying with Section 406.5 of the *International Building Code* or an enclosed parking garage complying with Section 406.6 of the *International Building Code* shall not be considered a private garage.

❖ This section is only provided to distinguish open parking garages and enclosed parking garages from private garages. "Open parking garage" is a defined term in Section 202 of the code. "Private garage" is a defined term in Chapter 2 of the IBC.

**915.2 Locations.** Where required by Section 915.1.1, carbon monoxide detection shall be installed in the locations specified in Sections 915.2.1 through 915.2.3.

❖ Sections 915.2.1 through 915.2.3 provide more detail on where detection is specifically required to be installed. This is a clarification from previous editions. NFPA 720 does not provide detailed enough information as to where detection should be located so spe-

cific direction is provided in the code. In some cases, the locations differ from that provided in NFPA 720.

**915.2.1 Dwelling units.** Carbon monoxide detection shall be installed in *dwelling units* outside of each separate sleeping area in the immediate vicinity of the bedrooms. Where a fuel-burning appliance is located within a bedroom or its attached bathroom, carbon monoxide detection shall be installed within the bedroom.

❖ The language is similar to that required for smoke alarms but the detection is only required outside of each sleeping area. If the fuel-burning appliance is within the bedroom or the attached bathroom, detection is required within the bedroom itself. Commentary Figure 915.2.1 shows the layout of carbon monoxide alarms versus smoke alarms. Note that if they are combined (smoke and CO alarms) the smoke alarm placement would be more restrictive.

**915.2.2 Sleeping units.** Carbon monoxide detection shall be installed in *sleeping units*.

**Exception:** Carbon monoxide detection shall be allowed to be installed outside of each separate sleeping area in the immediate vicinity of the *sleeping unit* where the *sleeping unit* or its attached bathroom does not contain a fuel-burning appliance and is not served by a forced air furnace.

❖ The intent of this section is the same as Section 915.2.1, except that it is applicable to sleeping units. Sleeping units can be as simple as a hotel room or a suite-type layout. This allows the detection to be either in the sleeping area itself, as with a simple hotel room, or outside the sleeping area, as is the case for dwelling units.

**915.2.3 Group E occupancies.** Carbon monoxide detection shall be installed in classrooms in Group E occupancies. Carbon monoxide alarm signals shall be automatically transmitted to an on-site location that is staffed by school personnel.

**Exception:** Carbon monoxide alarm signals shall not be required to be automatically transmitted to an on-site location that is staffed by school personnel in Group E occupancies with an occupant load of 30 or less.

❖ This section clarifies that the detection is to be located within the classroom and that a signal from the CO detection be automatically transmitted to a location on-site where school personnel can react to the situation, such as the school office. The exception provides relief to small schools where it is very easy to communicate a hazardous situation throughout the building.

**915.3 Detection equipment.** Carbon monoxide detection required by Sections 915.1 through 915.2.3 shall be provided by carbon monoxide alarms complying with Section 915.4 or carbon monoxide detection systems complying with Section 915.5.

❖ This section provides the option of providing the CO detection through single- or multiple-station CO alarms or through a CO detection system. This is a similar concept to smoke alarms and smoke detec-

tion systems. Each type of CO detector is listed to a different UL standard depending on whether it is to be used as a stand-alone or interconnected detector (UL 2034) or a detector that is part of a CO detection system (UL 2075). Section 915.4 addresses CO alarms and Section 915.5 addresses CO detection systems.

**915.4 Carbon monoxide alarms.** Carbon monoxide alarms shall comply with Sections 915.4.1 through 915.4.3.

❖ If the option of using CO alarms is chosen, compliance is required with Sections 915.4.1 through 915.4.3. CO alarms can be stand-alone or interconnected (single- or multiple-station). Section 915 does not address whether such alarms are required to be interconnected.

CO alarms are designed to initiate an audible alarm when the level of CO is below that which can cause a loss of the ability to react to the dangers of CO exposure. UL specifies that CO alarms activate at a level where the CO concentration over a given period of time can achieve 10-percent carboxyhemoglobin (COHb) in the body. Ten-percent COHb will not cause physiological injury, but is a level at which increases in the CO concentration will begin to affect the human body.

**915.4.1 Power source.** Carbon monoxide alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source, and when primary power is interrupted, shall receive power from a bat-

tery. Wiring shall be permanent and without a disconnecting switch other than that required for overcurrent protection.

**Exception:** Where installed in buildings without commercial power, battery-powered carbon monoxide alarms shall be an acceptable alternative.

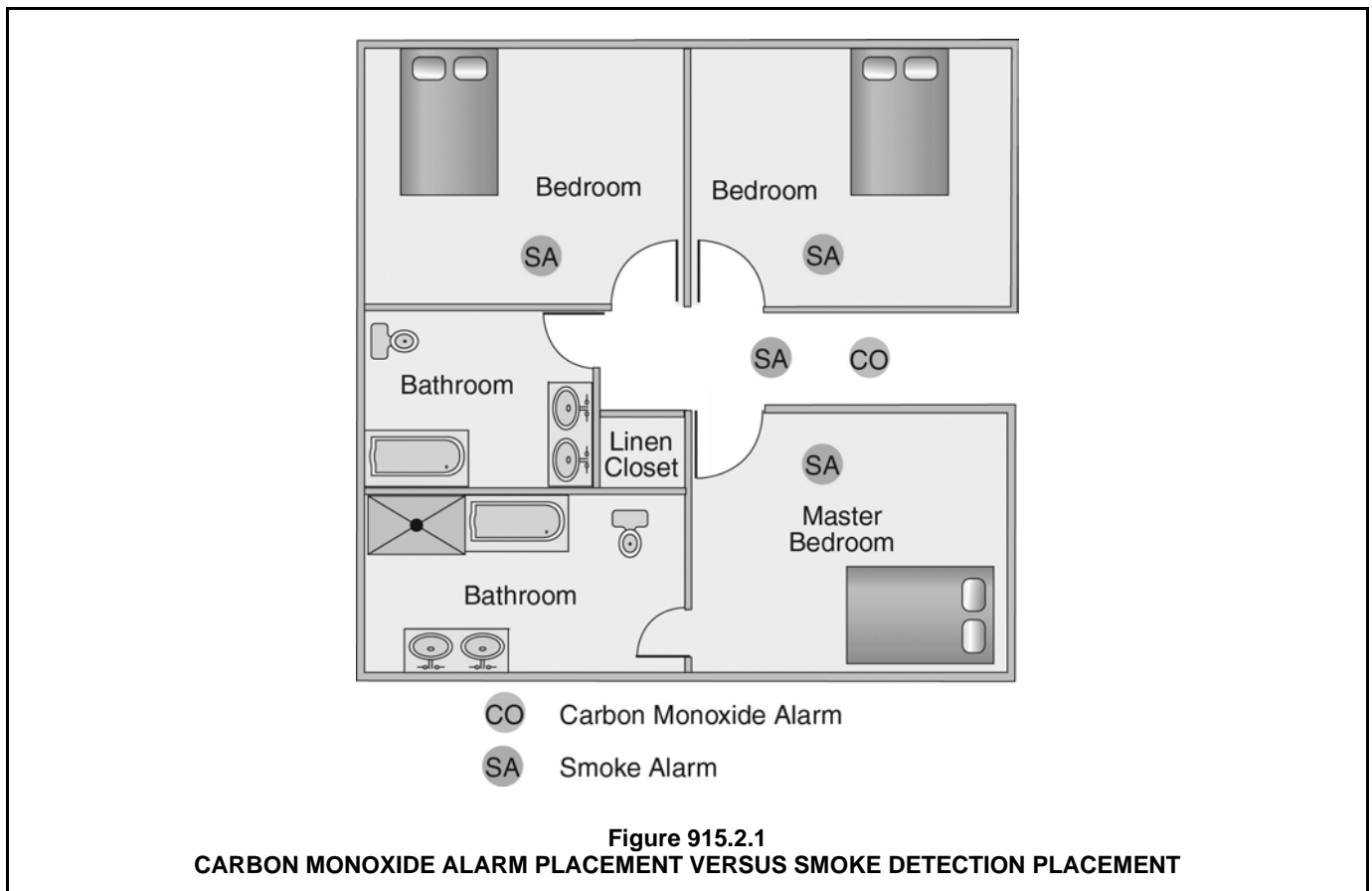
❖ This section is very similar to that required for smoke alarms (i.e., Section 907.2.11.6). The power supply must be provided by the building with battery backup. As with smoke alarms, if commercial power is not available, battery power is acceptable.

**915.4.2 Listings.** Carbon monoxide alarms shall be listed in accordance with UL 2034.

❖ Single- or multiple-station CO alarms are required to be listed in accordance with UL 2034. This standard is specific to CO alarms that provide both detection and notification.

**915.4.3 Combination alarms.** Combination carbon monoxide/smoke alarms shall be an acceptable alternative to carbon monoxide alarms. Combination carbon monoxide/smoke alarms shall be listed in accordance with UL 2034 and UL 217.

❖ Since smoke alarms are required in many occupancies, often a single combination alarm is desired. In fact, in some jurisdictions the CO alarms are required to be combined with smoke alarms. To meet this requirement, the combination CO and smoke alarm must be listed to both UL 2034 and UL 217. See



Commentary Figure 915.4.3 for an example of a combination CO and smoke alarm.



**Figure 915.4.3  
COMBINATION CARBON  
MONOXIDE AND SMOKE ALARM**

**915.5 Carbon monoxide detection systems.** Carbon monoxide detection systems shall be an acceptable alternative to carbon monoxide alarms and shall comply with Sections 915.5.1 through 915.5.3.

❖ If a CO detection system is preferred over CO alarms, compliance with Sections 915.5.1 through 915.5.3 is required.

**915.5.1 General.** Carbon monoxide detection systems shall comply with NFPA 720. Carbon monoxide detectors shall be listed in accordance with UL 2075.

❖ There are two standards applicable to CO detection systems. The systems are required to comply with NFPA 720 and the detectors themselves are required to comply with UL 2075.

**915.5.2 Locations.** Carbon monoxide detectors shall be installed in the locations specified in Section 915.2. These locations supersede the locations specified in NFPA 720.

❖ This section is provided to clarify that the locations required for CO detectors in Section 915.2 differ from NFPA 720 and that those locations will supersede the standard. This simply reaffirms the provisions of Section 1027.1 regarding conflicts between the code and a referenced standard.

**915.5.3 Combination detectors.** Combination carbon monoxide/smoke detectors installed in carbon monoxide detection systems shall be an acceptable alternative to carbon monoxide detectors, provided they are listed in accordance with UL 2075 and UL 268.

❖ Similar to CO alarms, there is often a desire or a requirement to combine smoke detection and CO

detection systems. If the detectors themselves are combined, they need to be listed in accordance with both UL 2075 and UL 268. NFPA 720 requires the CO alarm be capable of transmitting a distinct audible signal that is different than the smoke alarm signal.

**915.6 Maintenance.** Carbon monoxide alarms and carbon monoxide detection systems shall be maintained in accordance with NFPA 720. Carbon monoxide alarms and carbon monoxide detectors that become inoperable or begin producing end-of-life signals shall be replaced.

❖ This section is simply a reference to the maintenance requirements of NFPA 720. In addition, when detectors become inoperable or start producing end-of-life signals, they are required to be replaced.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

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*International Code Interpretations.* Washington, DC: International Code Council, 2009.

Grosshandler, William, *The Use of Portable Fire Extinguishers in Nightclubs.* Gaithersburg MD. National Institute of Science and Technology, July, 2008, pg. 5.

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*The SFPE Handbook of Fire Protection Engineering*, 4th edition. Quincy, MA: National Fire Protection Association, 2008.

# Chapter 10: Means of Egress

## General Comments

The general criteria set forth in Chapter 10 regulating the design of the means of egress are established as the primary method for protection of people in buildings. Chapter 10 provides the minimum requirements for means of egress in all buildings and structures. Both prescriptive and performance language is utilized in this chapter to provide for a basic approach in determining a safe exiting system for all occupancies. Chapter 10 addresses all portions of the egress system and includes design requirements as well as provisions regulating individual components. The requirements detail the size, arrangement, number and protection of means of egress components. Functional and operational characteristics also are specified, permitting safe use of components without special knowledge or effort.

This chapter provides a zonal approach to egress through regulation of an egress system's three parts: exit access, exit and exit discharge. Section 1001 includes administrative provisions. Section 1002 shows a list of defined terms that are primarily associated with Chapter 10. For commentary on these definitions, see Chapter 2.

Sections 1003 through 1015 include general provisions that apply to all three components. This includes general means of egress requirements; occupant loads; means of egress sizing; the number of exits and exit access doorways and their configuration; illumination for the means of egress; specific requirements for accessible means of egress; doors, gates and turnstiles; provisions for stairways and ramps along with their associated handrail and guard requirements; and exit signage (see commentary to Section 1003).

The exit access requirements are in Sections 1016 through 1021. This includes general exit access requirements, exit access travel distance; aisles (for other than assembly spaces); specific requirements for stairways and ramps that serve as part of the exit access; corridors; and egress balconies (see commentary, Section 1016).

The exit requirements are in Sections 1022 through 1027. Exit information includes provisions for exits; interior and exterior stairways and ramps that serve as an exit element; exit passageways; luminous egress path markings that are required on the exit stairways in high-rise buildings (see Section 403); and horizontal exits (see commentary, Section 1022).

The exit discharge requirements are in Section 1028. Section 1029 includes those means of egress

requirements that are unique to spaces used for assembly purposes.

Emergency escape and rescue opening requirements are in Section 1030.

Section 1002 through 1030 are duplicated text from Chapter 10 of the *International Building Code*® (IBC®) and are fully applicable to new buildings constructed after adoption of the code. The code has one additional section at the end of the chapter dealing with maintenance of the means of egress (see commentary, Section 1031). For means of egress requirements in existing buildings, refer to the *International Existing Building Code*® (IEBC®) or Chapter 11.

The evolution of means of egress requirements has been influenced by lessons learned from real fire incidents. While contemporary fires may reinforce some of these lessons, one must view each incident as an opportunity to assess critically the safety and reasonability of current regulations.

Cooperation among the developers of model codes and standards has resulted in agreement on many basic terms and concepts. The text of the code, including this chapter, is consistent with these national uniformity efforts.

National uniformity in an area such as means of egress has many benefits for the fire code official and other code users. At the top of the list are the lessons to be learned from experiences throughout the nation and the world, which can be reported in commonly used terminology and conditions that we can all relate to and clearly understand.

## Purpose

A primary purpose of codes in general, and building and fire codes in particular, is to safeguard life in the presence of a fire. Integral to this purpose is the path of egress travel for occupants to escape and avoid a fire. Means of egress can be considered the lifeline of a building. The principles on which means of egress are based and that form the fundamental criteria for requirements are to provide a system:

1. That will give occupants alternative paths of travel to a place of safety to avoid fire.
2. That will shelter occupants from fire and the products of combustion.
3. That will accommodate all occupants of a structure.

4. That is clear, unobstructed, well marked and illuminated and in which all components are under the control of the user without requiring any tools, keys or special knowledge or effort.

History is marked with the loss of life from fire. Early as well as contemporary multiple fire fatalities can be traced to a compromise of one or more of the above principles.

Life safety from fire is a matter of successfully evacuating or relocating the occupants of a building to a place

of safety. As a result, life safety is a function of time: time for detection, time for notification and time for safe egress. The fire growth rate over a period of time is also a critical factor in addressing life safety. Other sections of the code, such as protection of vertical openings (Chapter 7), interior finish (Chapter 8), fire suppression and detection systems (Chapter 9), also have an impact on life safety. Chapter 10 addresses the issues related to the means available to relocate or evacuate building occupants.

## SECTION 1001 ADMINISTRATION

**1001.1 General.** Buildings or portions thereof shall be provided with a means of egress system as required by this chapter. The provisions of this chapter shall control the design, construction and arrangement of means of egress components required to provide an approved means of egress from structures and portions thereof. Sections 1003 through 1029 shall apply to new construction. Section 1030 shall apply to existing buildings.

**Exception:** Detached one- and two-family dwellings and multiple single-family dwellings (townhouses) not more than three stories above grade plane in height with a separate means of egress and their accessory structures shall comply with the *International Residential Code*.

- ❖ The minimum requirements for means of egress are to be incorporated in all structures as specified in this chapter. Application would be effective on the date the code is adopted and placed into effect.

The means of egress in an existing building that experiences a change of occupancy, such as from Group S-2 (storage) to A-3 (assembly), would require reevaluation for code compliance based on the new occupancy, as stated in *International Existing Building Code*® (IEBC)®. Similarly, the means of egress in an existing occupancy of Group A-3 in which additional seating is to be provided, thereby increasing the occupant load, would require reevaluation for code compliance based on the increased occupant load.

Fundamental to the level of life safety in any building, whether it is new or many years old, is the provision for an adequate egress system. It is for that reason that Section 1104 is retroactively applicable to existing buildings that are not undergoing changes, as regulated by the IEBC. The means of egress in existing buildings must also be properly maintained in accordance with Section 1031 if the intended level of safety is to remain for the life of the building.

Reflecting the correlation and compatibility that is a hallmark of the *International Codes*® (I-Codes)®, the

exception makes it clear that the means of egress in buildings that are within the scope of the *International Residential Code*® (IRC)® are to comply with those requirements instead of Chapter 10.

**1001.2 Minimum requirements.** It shall be unlawful to alter a building or structure in a manner that will reduce the number of *exits* or the capacity of the *means of egress* to less than required by this code.

- ❖ A fundamental concept in life safety design is that the means of egress system is to be constantly available throughout the life of a building. Any change in the building or its contents, by physical reconstruction, alteration or a change of occupancy, is cause to review the resulting egress system. As a minimum, a building's means of egress is to be continued as initially approved. If a building or portion thereof has a change of occupancy, the complete egress system is to be evaluated and approved for compliance with the current code requirements for new occupancies (see IEBC).

The means of egress in an existing building that experiences a change of occupancy, such as from Group S-2 (storage) to A-3 (assembly), requires reevaluation for code compliance based on the new occupancy. Similarly, the means of egress in an existing occupancy of Group A-3 in which additional seating is to be provided, thereby increasing the occupant load, requires reevaluation for code compliance based on the increased load.

The temptation is to temporarily remove egress components or other fire protection or life safety features from service during an alteration or repair to or temporary occupancy of a building. During such times, a building is frequently more vulnerable to fire and the rapid spread of products of combustion. Either the occupants should not occupy those spaces where the means of egress has been compromised by the construction, or compensating fire safety features, providing equivalent safety for the occupants, should be considered. Occupants in adjacent areas may also require access to the egress facilities in the area under construction.

## SECTION 1002 DEFINITIONS

**1002.1 Definitions.** The following terms are defined in Chapter 2:

ACCESSIBLE MEANS OF EGRESS.  
AISLE.  
AISLE ACCESSWAY.  
ALTERNATING TREAD DEVICE.  
AREA OF REFUGE.  
BLEACHERS.  
BREAKOUT.  
COMMON PATH OF EGRESS TRAVEL.  
CORRIDOR.  
DOOR, BALANCED.  
EGRESS COURT.  
EMERGENCY ESCAPE AND RESCUE OPENING.  
EXIT.  
EXIT ACCESS.  
EXIT ACCESS DOORWAY.  
EXIT ACCESS RAMP.  
EXIT ACCESS STAIRWAY.  
EXIT DISCHARGE.  
EXIT DISCHARGE, LEVEL OF.  
EXIT, HORIZONTAL.  
EXIT PASSAGEWAY.  
EXTERIOR EXIT RAMP.  
EXTERIOR EXIT STAIRWAY.  
FIRE EXIT HARDWARE.  
FIXED SEATING.  
FLIGHT.  
FLOOR AREA, GROSS.  
FLOOR AREA, NET.  
FOLDING AND TELESCOPIC SEATING.  
GRANDSTAND.  
GUARD.  
HANDRAIL.  
INTERIOR EXIT RAMP.  
INTERIOR EXIT STAIRWAY.  
LOW ENERGY POWER-OPERATED DOOR.  
MEANS OF EGRESS.  
MERCHANDISE PAD.  
NOSING.  
OCCUPANT LOAD.  
OPEN-ENDED CORRIDOR.  
PANIC HARDWARE.

PHOTOLUMINESCENT.  
POWER-ASSISTED DOOR.  
POWER-OPERATED DOOR.  
PUBLIC WAY.  
RAMP.  
SCISSOR STAIRWAY.  
SELF-LUMINOUS.  
SMOKE-PROTECTED ASSEMBLY SEATING.  
STAIR.  
STAIRWAY.  
STAIRWAY, SPIRAL.  
WINDER.

❖ This section lists terms that are specifically associated with the subject matter of this chapter. It is important to emphasize that these terms are not exclusively related to this chapter, but may or may not also be applicable where the term is used elsewhere in the code.

Definitions of terms can help in the understanding and application of the code requirements. The purpose for including a list within this chapter is to provide more convenient access to terms that may have a specific or limited application within this chapter. For the complete definition and associated commentary, refer back to Chapter 2. Terms that are italicized provide a visual identification throughout the code that a definition exists for that term. The use and application of all defined terms are set forth in Section 201.

## SECTION 1003 GENERAL MEANS OF EGRESS

**1003.1 Applicability.** The general requirements specified in Sections 1003 through 1015 shall apply to all three elements of the *means of egress* system, in addition to those specific requirements for the *exit access*, the *exit* and the *exit discharge* detailed elsewhere in this chapter.

❖ The requirements in the chapter address the three parts of a means of egress system: the exit access, the exit and the exit discharge. This section specifies that the requirements of Sections 1003 through 1015 apply to the components of all three parts of the system. For example, the stair tread and riser dimensions in Section 1009 apply to interior exit access stairways, such as those leading from a mezzanine, and also apply to enclosed exit stairways per Section 1022, exterior exit stairways per Section 1026 and steps in the exit discharge per Section 1027.

The following sections are applicable for all parts of the means of egress:

- Section 1003 deals with the path for means of egress to remain free of obstructions and tripping hazards.

- Section 1004 provides criteria for determining occupant loads for a space. These numbers are used for determining means of egress, as a threshold for some suppression requirements and to determine the required plumbing fixture count.
- Section 1005 deals with the required size (i.e., width) of the path of travel for emergency evacuation. It is important not to create a “bottleneck” that could increase the amount of time necessary for occupants to exit the buildings.
- Section 1006 deals with the number of ways out of a space or off a floor, either by exit elements or exit access elements.
- Section 1007 provides placement and remoteness requirements for the exit and exit access elements prescribed in Section 1006.
- Section 1008 deals with illumination for the path of travel for the means of egress. Both general lighting and emergency backup lighting are addressed.
- Section 1009 – Chapter 11 indicates how to get people with mobility impairments into a building. Section 1009 explains the options to allow people with mobility impairments to self-evacuate or how to arrange for assisted rescue. The accessible means of egress is an important part of the fire and safety evacuation plans (see Section 1001.4).
- Section 1010 includes requirements for doors, gates and turnstiles that are part of the path of travel from any occupied spaces. For example, doors that lead to a walk-in closet must comply with this section, but doors for reach-in closets are exempted.
- Section 1011 provides information on all types of stairways: interior and exterior and from one riser to stairways with multiple flights and landings. Stepped aisles for areas within assembly seating are specifically addressed in Section 1029. For protection of the stairways between stories, see Sections 1019, 1023 and 1027.
- Section 1012 deals with ramps. Ramped aisles serving assembly seating areas are specifically addressed in Section 1029. The ramp provisions are coordinated with ICC A117.1 and the 2010 Standard for Accessible Design [formerly the Americans with Disabilities Act Accessibility Guidelines (ADAAG), now referred to as the 2010 ADA Standard]. For protection of the ramp between stories, see Sections 1019, 1023 and 1027.
- Section 1013 describes where exit signs are required and what criteria they need to meet to be readily visible.

- Section 1014 describes handrail requirements for stairways and ramps. Handrails are important for guidance and to arrest a possible fall.
- Section 1015 provides criteria for the vertical portions of barriers that serve to protect people from possible falls at dropoffs greater than 30 inches (762 mm).

**1003.2 Ceiling height.** The *means of egress* shall have a ceiling height of not less than 7 feet 6 inches (2286 mm).

**Exceptions:**

1. Sloped ceilings in accordance with Section 1208.2.
2. Ceilings of *dwelling units* and *sleeping units* within residential occupancies in accordance with Section 1208.2.
3. Allowable projections in accordance with Section 1003.3.
4. *Stair* headroom in accordance with Section 1011.3.
5. Door height in accordance with Section 1010.1.1.
6. *Ramp* headroom in accordance with Section 1012.5.2.
7. The clear height of floor levels in vehicular and pedestrian traffic areas of public and private parking garages in accordance with Section 406.4.1.
8. Areas above and below *mezzanine* floors in accordance with Section 505.2.

❖ Generally, the specified ceiling height is the minimum allowed in any part of the egress path. The exceptions are intended to address conditions where the code allows the ceiling height to be lower than specified in this section.

This section is consistent with the minimum ceiling height for other areas as specified in Section 1208. The exceptions are pointers to the lower headroom areas permitted in the code. For example, the headroom above and below a mezzanine is 7 feet (2134 mm) minimum.

**1003.3 Protruding objects.** Protruding objects on *circulation paths* shall comply with the requirements of Sections 1003.3.1 through 1003.3.4.

❖ This section begins the provisions that apply to protruding objects and helps to improve awareness of these safety and accessibility-related provisions. The intent of the phrase “on circulation paths” is intended to allow for judgment determining where people walk versus all floor surfaces. For example, a drinking fountain in an alcove is over a floor, but it is not over a circulation path; therefore, it typically it would not be considered a protruding object.

**1003.3.1 Headroom.** Protruding objects are permitted to extend below the minimum ceiling height required by Section 1003.2 where a minimum headroom of 80 inches (2032 mm) is provided over any walking surface, including walks, corri-

dors, aisles and passageways. Not more than 50 percent of the ceiling area of a means of egress shall be reduced in height by protruding objects.

**Exception:** Door closers and stops shall not reduce headroom to less than 78 inches (1981 mm).

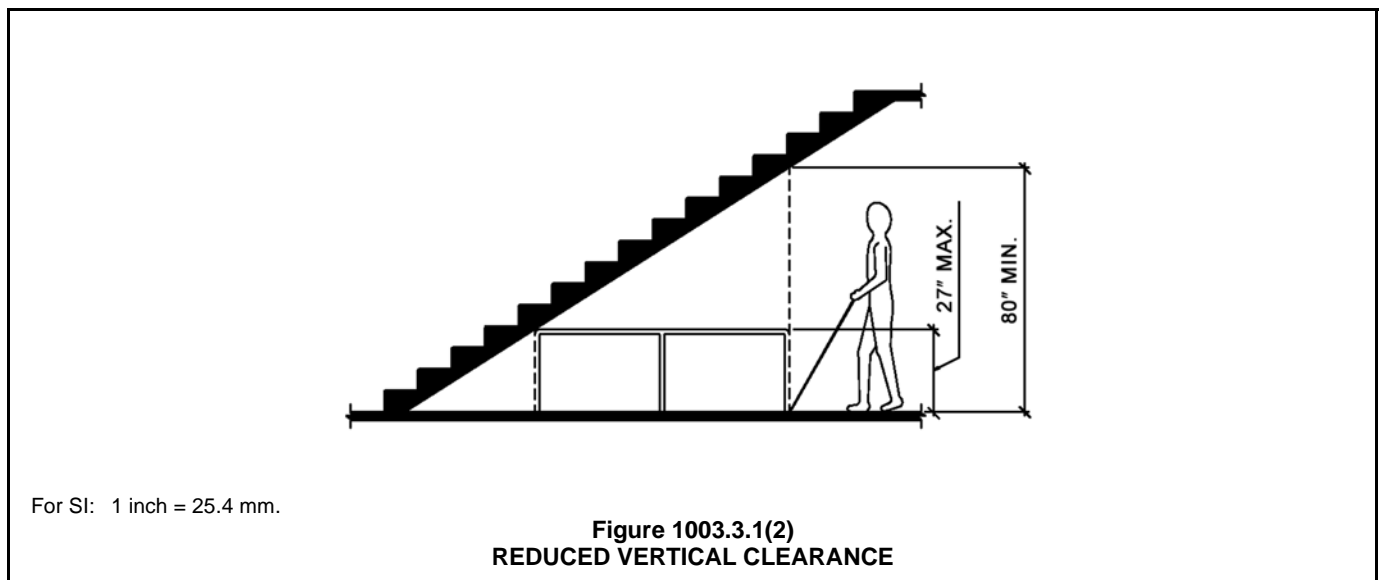
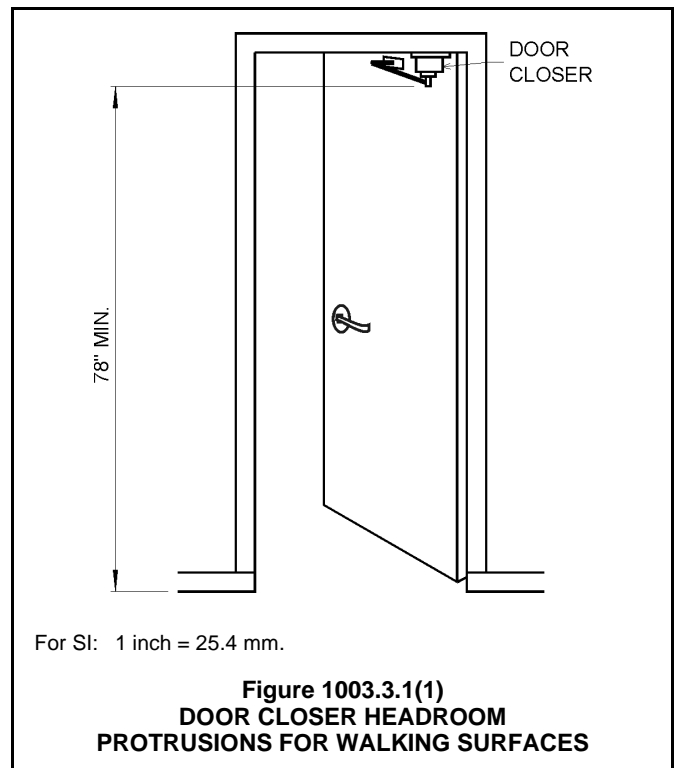
A barrier shall be provided where the vertical clearance is less than 80 inches (2032 mm) high. The leading edge of such a barrier shall be located 27 inches (686 mm) maximum above the floor.

❖ This provision is applicable to all routes that make up components of the means of egress. Specifically, the limitations in this section and those in Sections 1003.3.2 and 1003.3.3 provide a reasonable level of safety for people with vision impairments as well as during emergency events when vision may be obscured by smoke or low lighting.

Minimum dimensions for headroom clearance are specified in this section. The minimum headroom clearance over all walking surfaces or circulation paths is required to be maintained at 80 inches (2032 mm). This minimum headroom clearance is consistent with the requirements in Section 1011.3 for stairs and Section 1012.5.2 for ramps. Allowance must be made for door closers and stops, since their design and function necessitates placement within the door opening. The minimum headroom clearance for door closers and stops is allowed to be 78 inches (1981 mm) [see Commentary Figure 1003.3.1(1)]. The 2-inch (51 mm) projection into the doorway height is reasonable since these devices are normally mounted away from the center of the door opening, thus minimizing the potential for contact with a person moving through the opening. This is consistent with the exception to Section 1010.1.1.1.

The limitation on overhangs is of primary importance to individuals with visual impairments. When vertical clearance along a walking surface is less than 80 inches (2032 mm), such as underneath the stairway on the ground floor, some sort of barrier that is

detectable by a person using a cane must be provided. This can be a full-height wall, a rail at or below 27 inches (686 mm), a planter, fixed seating, etc. A low curb is not effective as a barrier. A person with visual impairments might mistake it for a stair tread, step up onto it and strike their head. A rail at handrail height would not be detectable by a person using a cane, and he or she could possibly walk into the rail before detecting it. Also, when making decisions on the choice of type of barrier, keep in mind that persons of shorter stature and children have a detectable range that may be below 27 inches (686 mm) [see Commentary Figure 1003.3.1(2)].



## MEANS OF EGRESS

**1003.3.2 Post-mounted objects.** A free-standing object mounted on a post or pylon shall not overhang that post or pylon more than 4 inches (102 mm) where the lowest point of the leading edge is more than 27 inches (686 mm) and less than 80 inches (2032 mm) above the walking surface. Where a sign or other obstruction is mounted between posts or pylons and the clear distance between the posts or pylons is greater than 12 inches (305 mm), the lowest edge of such sign or obstruction shall be 27 inches (686 mm) maximum or 80 inches (2032 mm) minimum above the finished floor or ground.

**Exception:** These requirements shall not apply to sloping portions of *handrails* between the top and bottom riser of *stairs* and above the *ramp* run.

- ❖ Post-mounted objects, such as signs or some types of drinking fountains or phone boxes, are not permitted to overhang more than 4 inches (102 mm) past the post where the bottom edge is located higher than 27 inches (686 mm) above the walking surface [see Commentary Figure 1003.3.2(1)]. Since the minimum required height of doorways, stairways and ramps in the means of egress is 80 inches (2032 mm), protruding objects located higher than 80 inches (2032 mm) above the walking surface are not regulated. Protrusions that are located lower than 27 inches (686 mm) above the walking surface are also permitted since they are more readily detected by a person using a long cane, provided that the minimum required width of the egress element is maintained. This is consistent with the post-mounted objects requirements in Section 307.3 of ICC A117.1, *Accessible and Usable Buildings and Facilities*. The intent is to reduce the potential for accidental impact for a person who is visually impaired.

When signs are provided on multiple posts, the posts must be located closer than 12 inches (305 mm) apart, or the bottom edge of the sign must be

lower than 27 inches (686 mm) so it is within detectable cane range or above 80 inches (2032 mm) so that it is above headroom clearances [see Commentary Figure 1003.3.2(2)].

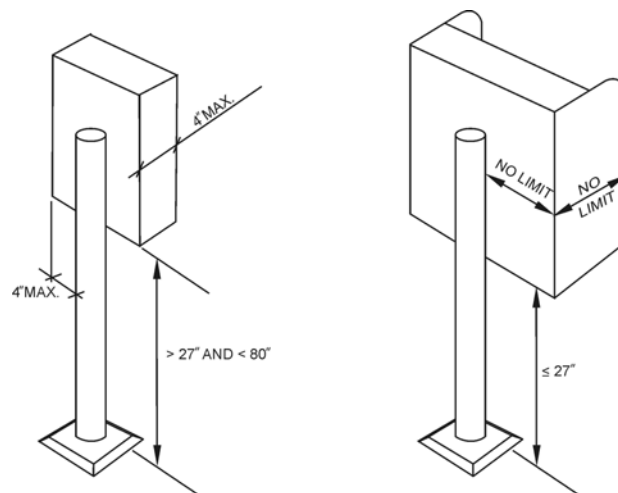
The exception is intended for handrails that are located along the run of a stairway flight or ramp run. The extensions at the top and bottom of stairways and ramps must meet the requirements for protruding objects where people walk perpendicular to the stair or ramp.

**1003.3.3 Horizontal projections.** Objects with leading edges more than 27 inches (685 mm) and not more than 80 inches (2030 mm) above the floor shall not project horizontally more than 4 inches (102 mm) into the *circulation path*.

**Exception:** *Handrails* are permitted to protrude 4½ inches (114 mm) from the wall.

- ❖ Protruding objects could slow the egress flow through a corridor or passageway and injure someone hurriedly passing by or someone with a visual impairment. Persons with a visual impairment who use a long cane for guidance must have sufficient warning of a protruding object. Where protrusions are located higher than 27 inches (686 mm) above the walking surface, the cane will most likely not encounter the protrusion before the person collides with the object.

Additionally, people with poor visual acuity or poor depth perception may have difficulty identifying protruding objects higher than 27 inches (686 mm). Therefore, objects such as lights, signs and door hardware, located between 27 inches (686 mm) and 80 inches (2032 mm) above the walking surface, are not permitted to extend more than 4 inches (102 mm) from each wall (see Commentary Figure 1003.3.3). The requirement for protrusions into the door clear width in Section 1010.1.1.1 is different because it deals with allowances for panic hardware on a door.



For SI: 1 inch = 25.4 mm.

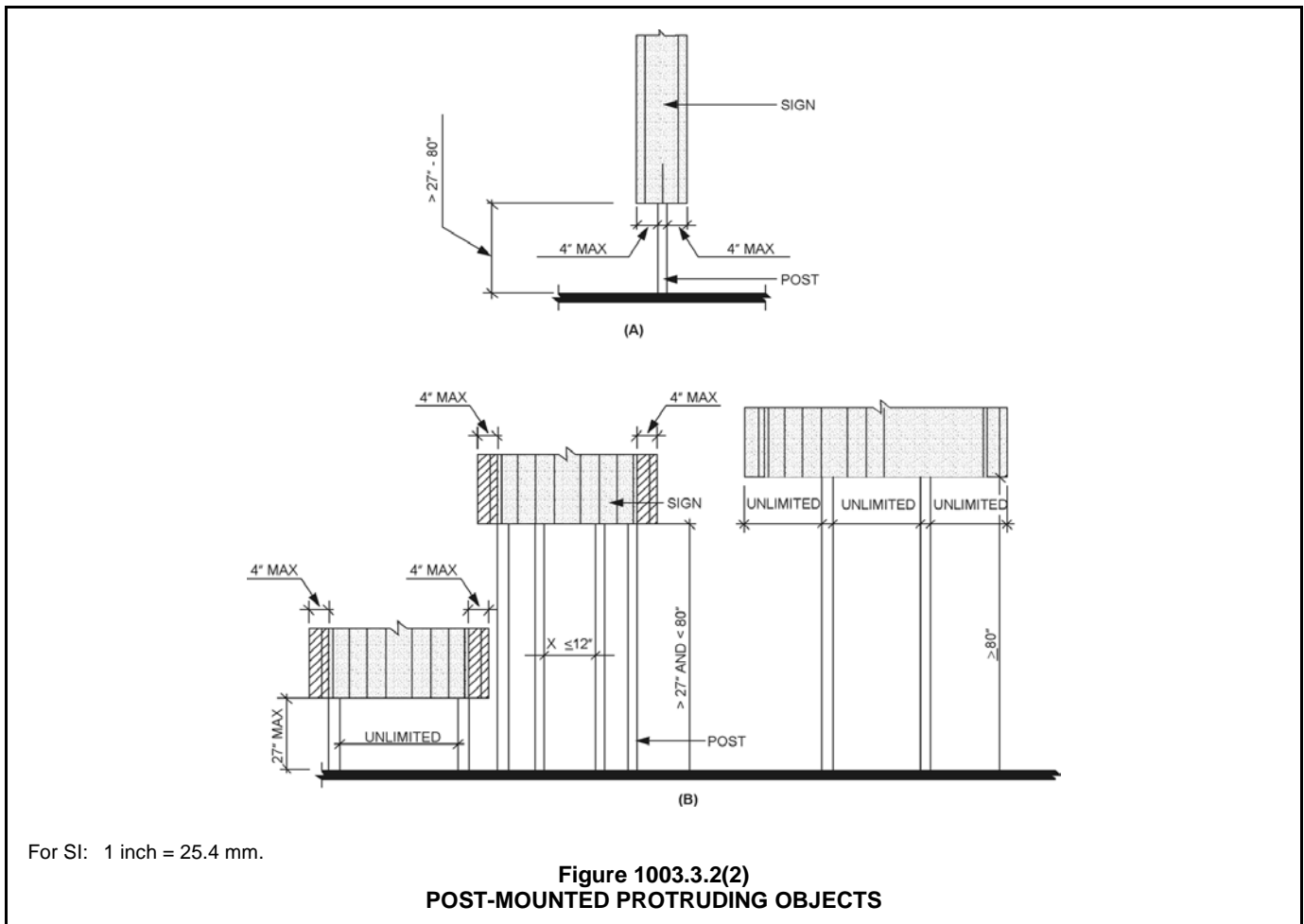
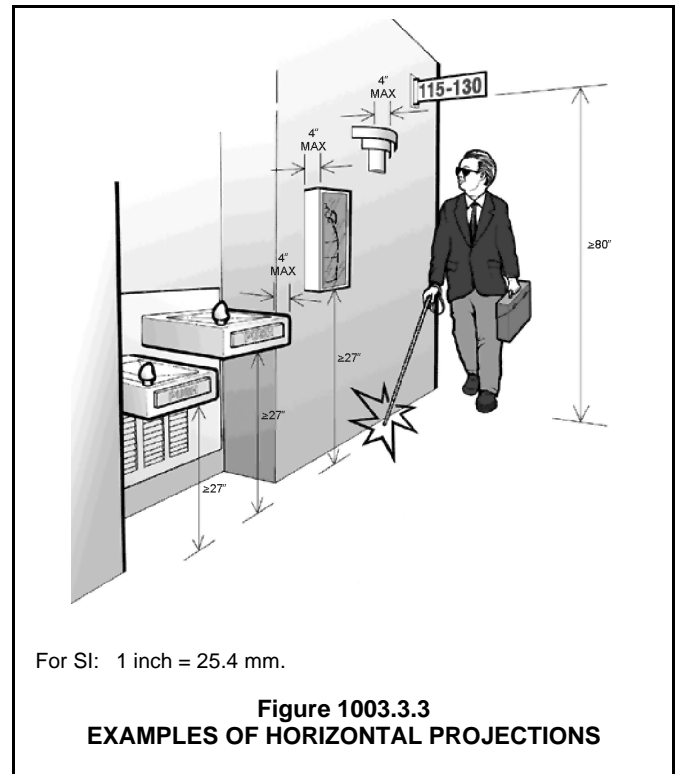
**Figure 1003.3.2(1)**  
**POST-MOUNTED OBJECTS**

It is not the intent of this section to prohibit columns, pilasters or wing walls to project into a corridor as long as adequate egress width is maintained. These types of structural elements are detectable by persons using a long cane.

The exception is an allowance for handrails when they are provided along a wall, such as in some hospitals or nursing homes. The 4½-inch (114 mm) measurement is intended to be consistent with projections by handrails into the required width of stairways and ramps in Section 1014.8. There are additional requirements when talking about the required width (see Section 1005.2).

**1003.3.4 Clear width.** Protruding objects shall not reduce the minimum clear width of *accessible routes*.

❖ The intent of this section is to limit the projections into an accessible route so that a minimum clear width of 36 inches (914 mm) is maintained along the route. ICC A117.1 is referenced by Chapter 11 for technical requirements for accessibility. ICC A117.1, Section 403.5, allows the accessible route to be reduced in width to 32 inches (813 mm) for segments not to exceed 24 inches (610 mm) in length and spaced a minimum of 48 inches (1219 mm) apart. This allows for movement through a doorway or through a gap in planters or counters.



## MEANS OF EGRESS

**1003.4 Floor surface.** Walking surfaces of the *means of egress* shall have a slip-resistant surface and be securely attached.

❖ As the pace of exit travel becomes hurried during emergency situations, the probability of slipping on smooth or slick floor surfaces increases. To minimize the hazard, all floor surfaces in the means of egress are required to be slip resistant. The use of hard floor materials with highly polished, glazed, glossy or finely finished surfaces should be avoided.

Field testing and uniform enforcement of the concept of slip resistance are not practical. One method used to establish slip resistance is that the static coefficient of friction between leather [Type 1 (Vegetable Tanned) of Federal Specification KK-L-165C] and the floor surface is greater than 0.5. Laboratory test procedures, such as ASTM D2047, can determine the static coefficient of resistance. Bulletin No. 4, "Surfaces," issued by the U.S. Architectural and Transportation Barriers Compliance Board (ATBCB or Access Board) contains further information regarding slip resistance.

**1003.5 Elevation change.** Where changes in elevation of less than 12 inches (305 mm) exist in the *means of egress*, sloped surfaces shall be used. Where the slope is greater than one unit vertical in 20 units horizontal (5-percent slope), *ramps* complying with Section 1012 shall be used. Where the difference in elevation is 6 inches (152 mm) or less, the *ramp* shall be equipped with either *handrails* or floor finish materials that contrast with adjacent floor finish materials.

### Exceptions:

1. A single step with a maximum riser height of 7 inches (178 mm) is permitted for buildings with occupancies in Groups F, H, R-2, R-3, S and U at exterior doors not required to be *accessible* by Chapter 11.
2. A *stair* with a single riser or with two risers and a tread is permitted at locations not required to be *accessible* by Chapter 11 where the risers and treads comply with Section 1011.5, the minimum depth of the tread is 13 inches (330 mm) and not less than one *handrail* complying with Section 1014 is provided within 30 inches (762 mm) of the centerline of the normal path of egress travel on the *stair*.
3. A step is permitted in *aisles* serving seating that has a difference in elevation less than 12 inches (305 mm) at locations not required to be *accessible* by Chapter 11, provided that the risers and treads comply with Section 1029.13 and the *aisle* is provided with a *handrail* complying with Section 1029.15.

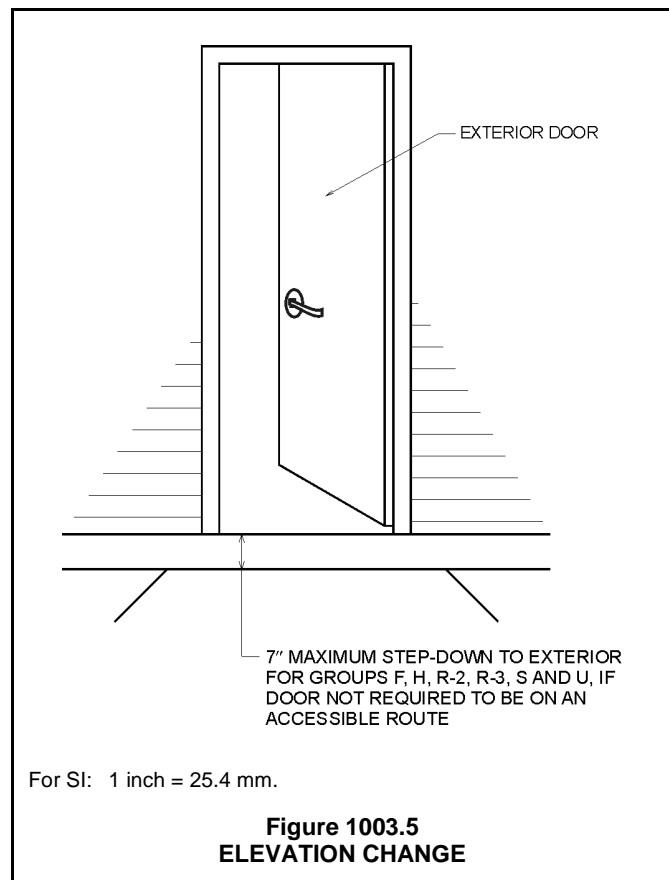
Throughout a story in a Group I-2 occupancy, any change in elevation in portions of the *means of egress* that serve non-ambulatory persons shall be by means of a *ramp* or sloped walkway.

❖ Minor changes in elevation, such as a single step that is located in any portion of the means of egress (i.e., exit access, exit or exit discharge), may not be readily

apparent during normal use or emergency egress and are considered to present a potential tripping hazard. Where the elevation change is less than 12 inches (305 mm), a ramp or sloped surface is specified to make the transition from higher to lower levels. This is intended to reduce accidental falls associated with the tripping hazard of an unseen step. Ramps must be constructed in accordance with Section 1012.1. Ramp provisions do not require handrails for ramps with a rise of 6 inches or less. However, the presence of the ramp must be readily apparent from the directions from which it is approached. Handrails are one method of identifying the change in elevation. In lieu of handrails, the surface of the ramp must be finished with materials that visually contrast with the surrounding floor surfaces. The walking surface of the ramp should contrast both visually and physically.

None of the exceptions are permitted along an accessible route required for either entry or egress from a space or building (see Section 1009 and Chapter 11).

Exception 1 allows up to a 7-inch (178 mm) step at exterior doors to avoid blocking the outward swing of the door by a buildup of snow or ice in locations that are not used by the public on a regular basis (see Commentary Figure 1003.5). This exception is coordinated with Exception 2 of Section 1010.1.5, and is only applicable in occupancies that have relatively low occupant densities, such as factory and industrial



structures. This exception is not applicable to exterior doors that are required to serve as an accessible entrance or that are part of a required accessible route. If this exception is utilized at a Group R-2 or R-3 occupancy, the designer may want to consider the issues of potential tripping hazards if this is a common entrance for a large number of occupants.

Exception 2 allows the transition from higher to lower elevations to be accomplished through the construction of stairs with one or two risers. The pitch of the stairway, however, must be shallower than that required for typical stairways (see Section 1011.5.2). Since the total elevation change is limited to 12 inches (305 mm), each riser must be approximately 6 inches (152 mm) in height. The elevation change must be readily apparent from the directions from which it is approached. At least one handrail is required. It must be constructed in accordance with Section 1014 and located so as to provide a graspable surface from the normal walking path.

Exception 3 is basically a cross reference to the assembly provisions for stepped aisles in Section 1029.

None of the exceptions are permitted in a Group I-2 occupancy (e.g., nursing home, hospital) in areas where nonambulatory persons may need access. The mobility impairments of these individuals require additional consideration.

**1003.6 Means of egress continuity.** The path of egress travel along a *means of egress* shall not be interrupted by a building element other than a *means of egress* component as specified in this chapter. Obstructions shall not be placed in the minimum width or required capacity of a *means of egress* component except projections permitted by this chapter. The minimum width or required capacity of a *means of egress* system shall not be diminished along the path of egress travel.

❖ This section requires that the entire means of egress path be clear of obstructions that could reduce the egress path to below the minimum width at any point. The egress path is also not allowed to be reduced in width such that the design occupant load (required capacity) would not be served. Note, however, that the egress path could be reduced in width in situations where it is wider than required by the code based on the occupant load. For example, if the required width of a corridor was 52 inches (1321 mm) based on the number of occupants using the corridor and the corridor provided was 96 inches (2438 mm) in width, the corridor would be allowed to be reduced to the minimum required width of 52 inches (1321 mm) since that width would still serve the number of occupants required by the code. In the context of this section, a “means of egress component” would most likely be a door or doorway.

**1003.7 Elevators, escalators and moving walks.** Elevators, escalators and moving walks shall not be used as a compo-

nent of a required *means of egress* from any other part of the building.

**Exception:** Elevators used as an accessible *means of egress* in accordance with Section 1009.4.

❖ Generally, the code does not allow elevators, escalators and moving sidewalks to be used as a required means of egress. The concern is that, because of possible power outages, escalators and moving sidewalks may not provide a safe and reliable means of egress that is available for use at all times.

Elevators are not typically used for unassisted evacuation during fire emergencies. However, in taller buildings, fire fighters use the elevators for both staging to fight the fire and assisted evacuation. They can verify that the shaft is not full of smoke, that the elevators will remain operational and, since they know the fire location, at which floors the elevator can be safely accessed. In accordance with the exception, elevators are allowed to be part of an accessible means of egress (i.e., assisted evacuation), provided they comply with the requirements of Section 1009.4. Where elevators are required to serve as part of the accessible means of egress is addressed in Section 1009.2.1. There are new provisions for fire service elevators and occupant evacuation elevators for high rises in Sections 403, 3007 and 3008. These specific provisions will provide a level of safety that would meet the intent of the means of egress provisions in Chapter 10.

## SECTION 1004 OCCUPANT LOAD

**1004.1 Design occupant load.** In determining *means of egress* requirements, the number of occupants for whom *means of egress* facilities are provided shall be determined in accordance with this section.

❖ The design occupant load is the number of people intended to occupy a building or portion thereof at any one time; essentially the number for which the means of egress is to be designed. It is the largest number derived by the application of Sections 1004.1 through 1004.6. Occupant density is limited to ensure a reasonable amount of freedom of movement (see Section 1004.2). The design occupant load is also utilized to determine the required plumbing fixture count (see commentary, Chapter 29) and other building requirements, such as automatic sprinkler systems and fire alarm and detection systems (see Chapter 9).

The intent of this section is to indicate the procedure by which design occupant loads are determined. This is particularly important because accurate determination of design occupant load is fundamental to the proper design of any means of egress system.

## MEANS OF EGRESS

**1004.1.1 Cumulative occupant loads.** Where the path of egress travel includes intervening rooms, areas or spaces, cumulative *occupant loads* shall be determined in accordance with this section.

❖ When occupants from an accessory area move through another area to exit, the combined number of occupants must be utilized to determine the capacity that the egress components must be designed to accommodate. It is not the intent of this section to “double count” occupants. For example, the means of egress from a lobby must be sized for the cumulative occupant load of the adjacent office spaces if the occupants must travel through the lobby to reach an exit. Likewise, if an adjacent room has an egress route independent of the lobby, the occupant load of that room would not be combined with the occupant loads of the other rooms that pass through the lobby. If a portion of the adjacent room’s occupant load is to travel through the lobby, only that portion would be combined with the lobby occupant load for determining lobby egress (see Commentary Figure 1004.1.1). This is particularly important in determining the number of ways out of a space or off a story and the required capacity of those elements.

**1004.1.1.1 Intervening spaces or accessory areas.** Where occupants egress from one or more rooms, areas or spaces through others, the design *occupant load* shall be the combined *occupant load* of interconnected accessory or intervening spaces. Design of egress path capacity shall be based on

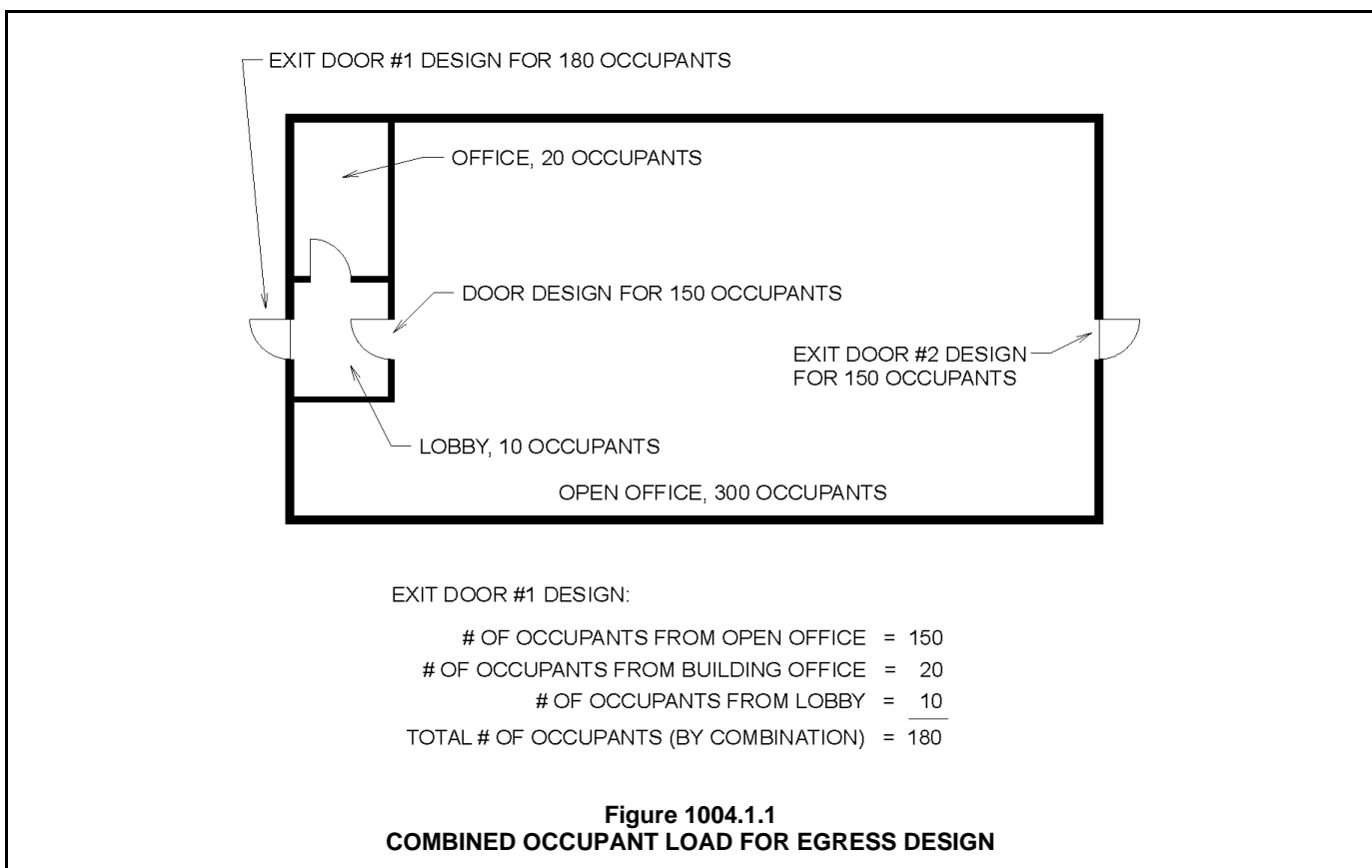
the cumulative portion of *occupant loads* of all rooms, areas or spaces to that point along the path of egress travel.

❖ An example of intervening spaces could be small tenant spaces within a large mercantile. It is common for banks or coffee shops to be located within large grocery stores. Another example would be a dentist’s office where people in the staff and exam room areas would egress through the reception area.

**1004.1.1.2 Adjacent levels for mezzanines.** That portion of the *occupant load* of a *mezzanine* with required egress through a room, area or space on an adjacent level shall be added to the *occupant load* of that room, area or space.

❖ The egress requirements for mezzanines that use exit access stairways to move to the ground level are handled similarly to those spaces with accessory areas addressed in Section 1004.1.1.1, versus the requirements for exiting from multiple stories in Sections 1004.1.1.3, 1005.4.1 and 1006. That is, that portion of the mezzanine occupant load that travels through the space below to get to the exit is to be added to the occupant load of the space on the floor below. The sizing and number of the egress components must reflect this combined occupant load. Section 505.2.3 contains additional criteria for the means of egress from mezzanines or a portion of it is enclosed.

**1004.1.1.3 Adjacent stories.** Other than for the egress components designed for convergence in accordance with Section



1005.6, the *occupant load* from separate stories shall not be added.

- ❖ Second-floor egress requirements that use exit access stairways to move to the ground level are coordinated with the requirements for exiting from multiple stories found in Sections 1005.3.1, 1005.4.1 and 1006. That is, the portion of the second floor occupant load that travels through the floor below to the exit is not to be added to the occupant load of the space on the floor below as you would for a mezzanine. The sizing and number of the egress components do not have to reflect this combined occupant load. The exception to the rule is where there would be egress convergence of two stories at a level between the two stories (see Section 1005.6).

**1004.1.2 Areas without fixed seating.** The number of occupants shall be computed at the rate of one occupant per unit of area as prescribed in Table 1004.1.2. For areas without *fixed seating*, the occupant load shall be not less than that number determined by dividing the floor area under consideration by the *occupant load* factor assigned to the function of the space as set forth in Table 1004.1.2. Where an intended function is not listed in Table 1004.1.2, the *building official* shall establish a function based on a listed function that most nearly resembles the intended function.

**Exception:** Where *approved* by the *building official*, the actual number of occupants for whom each occupied space, floor or building is designed, although less than those determined by calculation, shall be permitted to be used in the determination of the design *occupant load*.

- ❖ The numbers for floor area per occupant load factor in Table 1004.1.2 reflect common and traditional occupant density based on empirical data for the density of similar spaces. The number determined using the occupant load factors in Table 1004.1.2 generally establishes the minimum occupant load for which the egress facilities of the rooms, spaces and building must be designed. The design occupant load is also utilized for other code requirements, such as determining the required plumbing fixture count (see commentary, Chapter 29) and other building requirements, including automatic sprinkler systems and alarm and detection systems (see Chapter 9).

It is difficult to predict the many conditions by which a space within a building will be occupied over time. An assembly banquet room in a hotel, for example, could be arranged with rows of chairs to host a business seminar one day and with mixed tables and chairs to host a dinner reception the next day. In some instances, the room will be arranged with no tables and very few chairs to accommodate primarily standing occupants. In such a situation, the egress facilities must safely accommodate the maximum number of persons permitted to occupy the space. When determining the occupant load of this type of occupancy, the various arrangements (e.g., tables and chairs, chairs only, standing space) should be recognized. The worst-case scenario should be utilized to determine the requirements for the means of

egress elements. This is consistent with the requirements for multiple-use spaces addressed in Section 302.1.

While some of the values in the table utilize the net floor area, most utilize the gross floor area. See the commentary to Table 1004.1.2 and the definitions for "Floor area, gross" and "Floor area, net" in Chapter 2 for additional discussion and examples.

The occupant load determined in accordance with this section is typically the minimum occupant load on which means of egress requirements are to be based. Some occupancies may not typically contain an occupant load totally consistent with the occupant load density factors of Table 1004.1.2. The exception is intended to address the limited circumstances where the actual occupant load is less than the calculated occupant load. Previously, designing for a reduced occupant load was permitted only through the variance process. With this exception, the building official can make a determination if a design that would use the actual occupant load was permissible. The building official may want to create specific conditions for approval. For example, the building official could choose to permit the actual occupant load to be utilized to determine the plumbing fixture count, but not the means of egress or sprinkler design; the determination could be that the reduced occupant load may be utilized in a specific area, such as in the storage warehouse, but not in the factory or office areas. Another point to consider would be the potential of the space being utilized for different purposes at different times, or the potential of a future change of tenancy without knowledge of the building department. Any special considerations for such unique uses must be documented and justified. Additionally, the owner must be aware that such special considerations will impact the future use of the building with respect to the means of egress and other protection features.

**TABLE 1004.1.2.** See page 10-12.

- ❖ Table 1004.1.2 establishes minimum occupant densities based on the function or actual use of the space (not group classification). The table presents the maximum floor area allowance per occupant (i.e., occupant load factor) based on studies and counts of the number of occupants in typical buildings. The use of this table, then, results in the minimum occupant load for which rooms, spaces and the building must be designed. While an assumed normal occupancy may be viewed as somewhat less than that determined by the use of the table factors, such a normal occupant load is not necessarily an appropriate design criterion. The greatest hazard to the occupants occurs when an unusually large crowd is present. The code does not limit the occupant load density of an area, except as provided for in Section 1004.2, but once the occupant load is established, the means of egress must be designed for at least that capacity. If it is intended that the occupant load will exceed that calculated in accordance with the table, then the occupant load is to be

based on the estimated actual number of people, but not to exceed the maximum allowance in accordance with Section 1004.2. Therefore, the occupant load of the office or business areas in a storage warehouse or nightclub is to be determined using the occupant load factor most appropriate to that space—one person for each 100 square feet (9 m<sup>2</sup>) of gross floor area.

The use of net and gross floor areas as defined in Chapter 2 is intended to provide a refinement in the occupant load determination. The gross floor area technique applied to a building only allows the deduction of the plan area of the exterior walls, vent shafts and interior courts from the plan area of the building.

The net floor area permits the exclusion of certain spaces that would be included in the gross floor area. The net floor area is intended to apply to the actual occupied floor areas. The area used for permanent building components, such as shafts, fixed equipment, thicknesses of walls, corridors, stairways, toilet rooms, mechanical rooms and closets, is not included in net floor area. For example, consider a restaurant dining area with dimensions measured from the inside of the enclosing walls of 80 feet by 60 feet (24 384 mm by 18 288 mm) (see Commentary Figure 1004.1.2). Within the restaurant area is a 6-inch (152 mm) privacy wall running the length of the room [80 feet by 0.5 feet = 40 square feet (3.7 m<sup>2</sup>)], a fireplace [40 square feet (3.7 m<sup>2</sup>)] and a cloak room [60 square feet (5.6 m<sup>2</sup>)]. Each of these areas is deducted from the restaurant area, resulting in a net floor area of 4,660 square feet (433 m<sup>2</sup>). Since the restaurant intends to have unconcentrated seating that involves loose tables and chairs, the resulting occupant load is 311 persons (4,660 divided by 15). As the definition of “Floor area, net” indicates, certain spaces are to be excluded from the gross floor area to derive the net floor area. The key point in this definition is that the net floor area is to include the actual occupied area and does not include spaces uncharacteristic of that occupancy.

In determining the occupant load of a building with mixed groups, each floor area of a single occupancy must be separately analyzed, such as required by Section 1004.6. The occupant load of the business portion of an office/warehouse building is determined at a rate of one person for each 100 square feet (9 m<sup>2</sup>) of office space, whereas the occupant load of the warehouse portion is determined at the rate of one person for each 300 square feet (28 m<sup>2</sup>). There may even be different uses within the same room. For example, a restaurant dining room would have seating but may also have a waiting area with standing room, a take-out window with a queue line or employee areas behind a bar or reception desk.

If a specific type of facility is not found in the table, the occupancy it most closely resembles should be utilized. For example, a training room in a business office may utilize the 20-square-foot (1.86 m<sup>2</sup>) net established for educational classroom areas, or a dance or karate studio may use the occupant load for rinks and pools for the studio areas.

Table 1004.1.2 presents a method of determining

**TABLE 1004.1.2  
MAXIMUM FLOOR AREA ALLOWANCES PER OCCUPANT**

FUNCTION OF SPACE	OCCUPANT LOAD FACTOR <sup>a</sup>
Accessory storage areas, mechanical equipment room	300 gross
Agricultural building	300 gross
Aircraft hangars	500 gross
Airport terminal	
Baggage claim	20 gross
Baggage handling	300 gross
Concourse	100 gross
Waiting areas	15 gross
Assembly	
Gaming floors (keno, slots, etc.)	11 gross
Exhibit Gallery and Museum	30 net
Assembly with fixed seats	See Section 1004.4
Assembly without fixed seats	
Concentrated (chairs only-not fixed)	7 net
Standing space	5 net
Unconcentrated (tables and chairs)	15 net
Bowling centers, allow 5 persons for each lane including 15 feet of runway, and for additional areas	7 net
Business areas	100 gross
Courtrooms—other than fixed seating areas	40 net
Day care	35 net
Dormitories	50 gross
Educational	
Classroom area	20 net
Shops and other vocational room areas	50 net
Exercise rooms	50 gross
H-5 Fabrication and manufacturing areas	200 gross
Industrial areas	
Inpatient treatment areas	240 gross
Outpatient areas	100 gross
Sleeping areas	120 gross
Kitchens, commercial	200 gross
Library	
Reading rooms	50 net
Stack area	100 gross
Mall buildings—covered and open	See Section 402.8.2
Mercantile	
Areas on other floors	60 gross
Basement and grade floor areas	30 gross
Storage, stock, shipping areas	300 gross
Parking garages	200 gross
Residential	200 gross
Skating rinks, swimming pools	
Rink and pool	50 gross
Decks	15 gross
Stages and platforms	15 net
Warehouses	500 gross

For SI: 1 square foot = 0.0929 m<sup>2</sup>.

a. Floor area in square feet per occupant.

the absolute base minimum occupant load of a space that the means of egress is to accommodate.

The table occupant loads are based on the stereotypical configuration of spaces. For example, the dorm requirements were written based on dormitories with sleeping rooms with two to four students, a gang bathroom and a meeting/study lounge on each floor. Dormitory buildings that operate like army barracks may have a heavier occupant load, while facilities with groups of rooms with private bathrooms, living and even kitchenette areas may have a lower occupant load. Industrial facilities are based on typical fabricating plants. Warehouses are based on consistent in and out movement of product by employees. Factories with largely mechanized operations or warehouses that contain long-term storage are other examples where discussion with the building official and the application of the exception in Section 1004.1.2 might be considered.

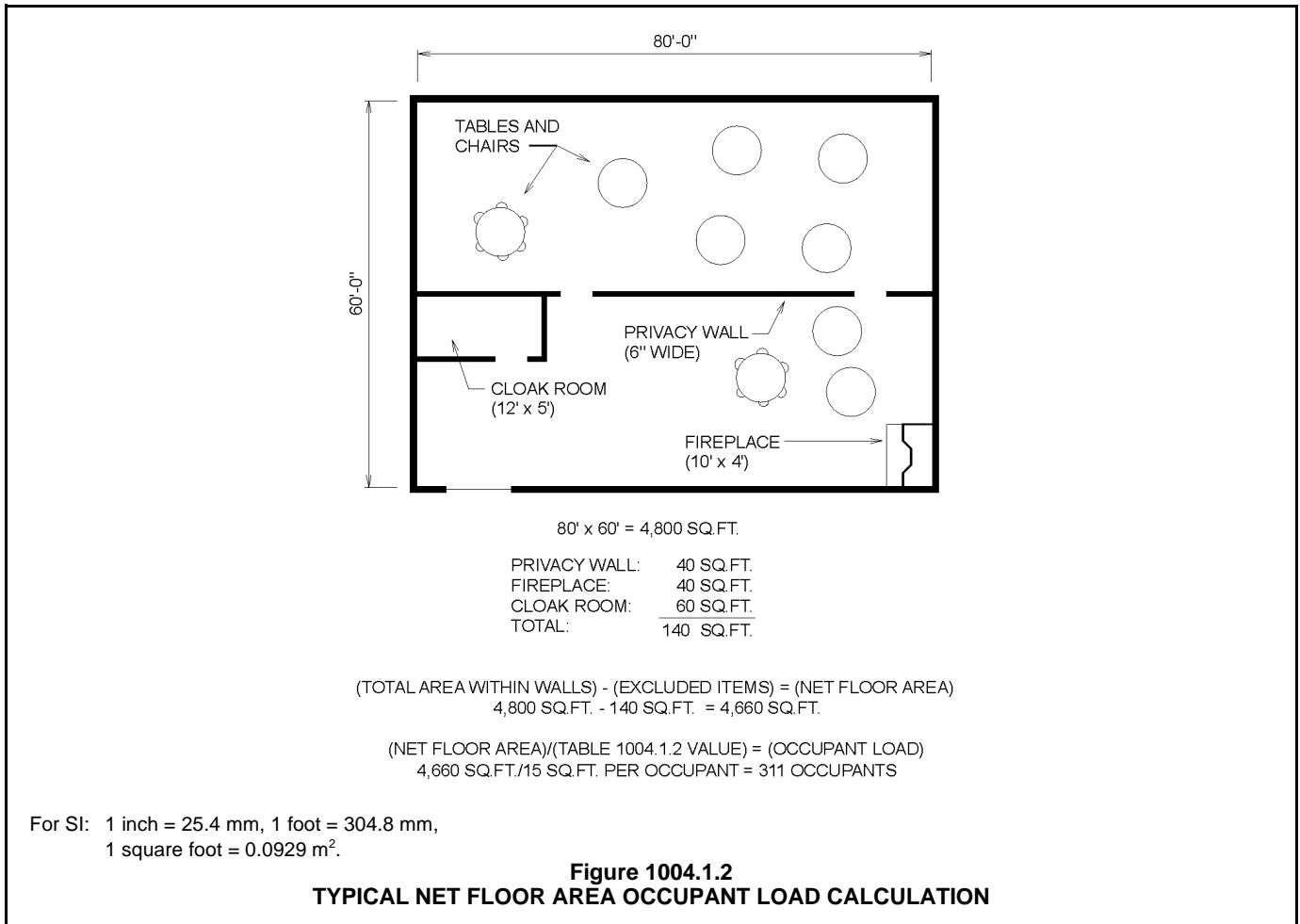
In addition to the table, Section 402 contains the basis for calculating the occupant load of a covered mall building; however, Table 1004.1.2 should be used for determining the occupant load of each anchor store.

**1004.2 Increased occupant load.** The *occupant load* permitted in any building, or portion thereof, is permitted to be

increased from that number established for the occupancies in Table 1004.1.2, provided that all other requirements of the code are met based on such modified number and the *occupant load* does not exceed one occupant per 7 square feet (0.65 m<sup>2</sup>) of occupiable floor space. Where required by the *building official*, an *approved aisle*, seating or fixed equipment diagram substantiating any increase in *occupant load* shall be submitted. Where required by the *building official*, such diagram shall be posted.

❖ An increased occupant load is permitted above that developed by using Table 1004.1.2, for example, by utilizing the actual occupant load. However, if the occupant load exceeds that which is determined in accordance with Section 1004.1.2, the building official has the authority to require aisle, seating and equipment diagrams to confirm that all occupants have access to an exit, the exits provide sufficient capacity for all occupants and compliance with this section is attained.

The maximum area of 7 square feet (0.65 m<sup>2</sup>) per occupant should allow for sufficient occupant movement in actual fire situations. This is not a conflict with the standing space provisions of 5 square feet (0.46 m<sup>2</sup>) net in accordance with Table 1004.1.2. Standing space is typically limited to a portion of a larger area, such as the area immediately in front of the bar or the



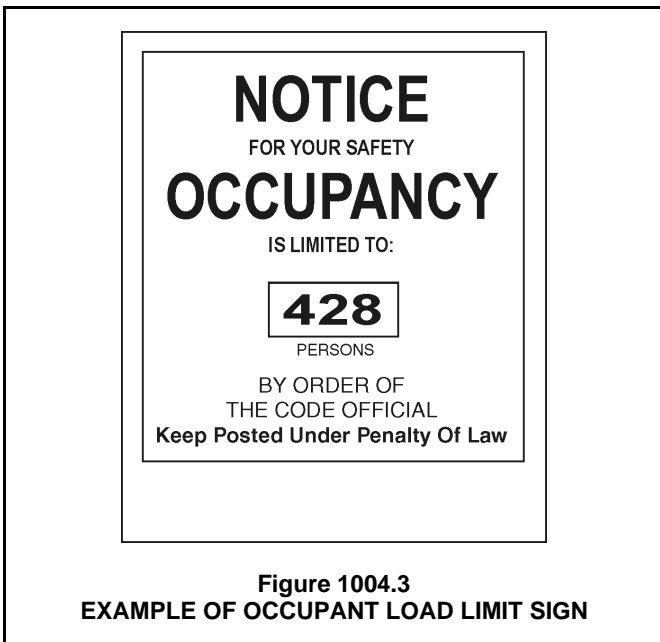
waiting area in a restaurant, while the rest of the dining area would use 15 square feet (1.4 m<sup>2</sup>) net per occupant.

**1004.3 Posting of occupant load.** Every room or space that is an assembly occupancy shall have the *occupant load* of the room or space posted in a conspicuous place, near the main *exit* or *exit access doorway* from the room or space. Posted signs shall be of an approved legible permanent design and shall be maintained by the owner or the owner’s authorized agent.

❖ Each room or space used for an assembly occupancy is required to display the approved occupant load. The placard must be posted in a visible location (near the main entrance) (see Commentary Figure 1004.3 for an example of an occupant load limit sign).

The posting is required to provide a means by which to determine that the maximum approved occupant load is not exceeded. This permanent and readily visible sign provides a constant reminder to building personnel and is a reference for building officials during periodic inspections. The posted occupant load could also be an indication that the room was designed for a layout of just tables and chairs, not a layout of chairs only (see Section 302.1).

While the composition and organization of information in the sign are not specified, information must be recorded in a permanent manner. This means that a sign with changeable numbers would not be acceptable.



**Figure 1004.3**  
**EXAMPLE OF OCCUPANT LOAD LIMIT SIGN**

**1004.4 Fixed seating.** For areas having *fixed seats* and *aisles*, the *occupant load* shall be determined by the number of *fixed seats* installed therein. The *occupant load* for areas in which *fixed seating* is not installed, such as waiting spaces, shall be

determined in accordance with Section 1004.1.2 and added to the number of *fixed seats*.

The *occupant load* of *wheelchair spaces* and the associated companion seat shall be based on one occupant for each *wheelchair space* and one occupant for the associated companion seat provided in accordance with Section 1108.2.3.

For areas having *fixed seating* without dividing arms, the *occupant load* shall be not less than the number of seats based on one person for each 18 inches (457 mm) of seating length.

The *occupant load* of seating booths shall be based on one person for each 24 inches (610 mm) of booth seat length measured at the backrest of the seating booth.

❖ The occupant load in an area with fixed seats is readily determined. In spaces with a combination of fixed and loose seating, the occupant load is determined by a combination of the occupant density number from Table 1004.1.2 and a count of the fixed seats.

For bleachers, booths and other seating facilities without dividing arms, the occupant load is simply based on the number of people that can be accommodated in the length of the seat. Measured at the hips, an average person occupies about 18 inches (457 mm) on a bench. In a booth, additional space is necessary for “elbow room” while eating. In a circular or curved booth or bench, the measurement should be taken just a few inches from the back of the seat, which is where a person’s hips would be located (see Commentary Figure 1004.4).

Some assembly spaces may have areas for standing or waiting. For example, some large sports stadiums have “standing room only” areas used for sell-out games. The Globe Theater in England has standing room in an area at the front of the theater. This section is not intended to assign an occupant load to the typical circulation aisles in an assembly space. Occupant load for wheelchair spaces should be based on the number of wheelchairs and companion seats that the space was designed for. As specified in Section 1004.6, if the wheelchair spaces may also be utilized for standing space or removable seating, the occupant load must be determined by the worst-case scenario.

**1004.5 Outdoor areas.** *Yards, patios, courts* and similar outdoor areas accessible to and usable by the building occupants shall be provided with *means of egress* as required by this chapter. The *occupant load* of such outdoor areas shall be assigned by the *building official* in accordance with the anticipated use. Where outdoor areas are to be used by persons in addition to the occupants of the building, and the path of egress travel from the outdoor areas passes through the building, *means of egress* requirements for the building shall be based on the sum of the *occupant loads* of the building plus the outdoor areas.

**Exceptions:**

1. Outdoor areas used exclusively for service of the building need only have one *means of egress*.

2. Both outdoor areas associated with Group R-3 and individual dwelling units of Group R-2.

❖ This section addresses the means of egress of outdoor areas such as yards, patios and courts. The primary concern is for those outdoor areas, used for functions that may include occupants other than the building occupants or the building occupants alone, where egress from the outdoor area is back through the building to reach the exit discharge. An example is an interior court of an office building where assembly functions are held during normal business hours for persons other than the building occupants. When court occupants must egress from the interior court back through the building, the building's egress system is to be designed for the building occupants, plus the assembly occupants from the interior court. Another example would be an outdoor dining area that exited back through the restaurant.

The occupant load is to be assigned by the building official based on use. It is suggested that the design occupant load be determined in accordance with Section 1004.1.2.

Exception 1 describes conditions where the occupant load is very limited, such as areas where an interior courtyard had strictly plants or mechanical equipment. If the courtyard was open for building occupants, other than maintenance personnel, to use the space, the space must be designed with the occupant loads in Table 1004.1.2. Balconies or patios associated with individual dwelling units, in Exception

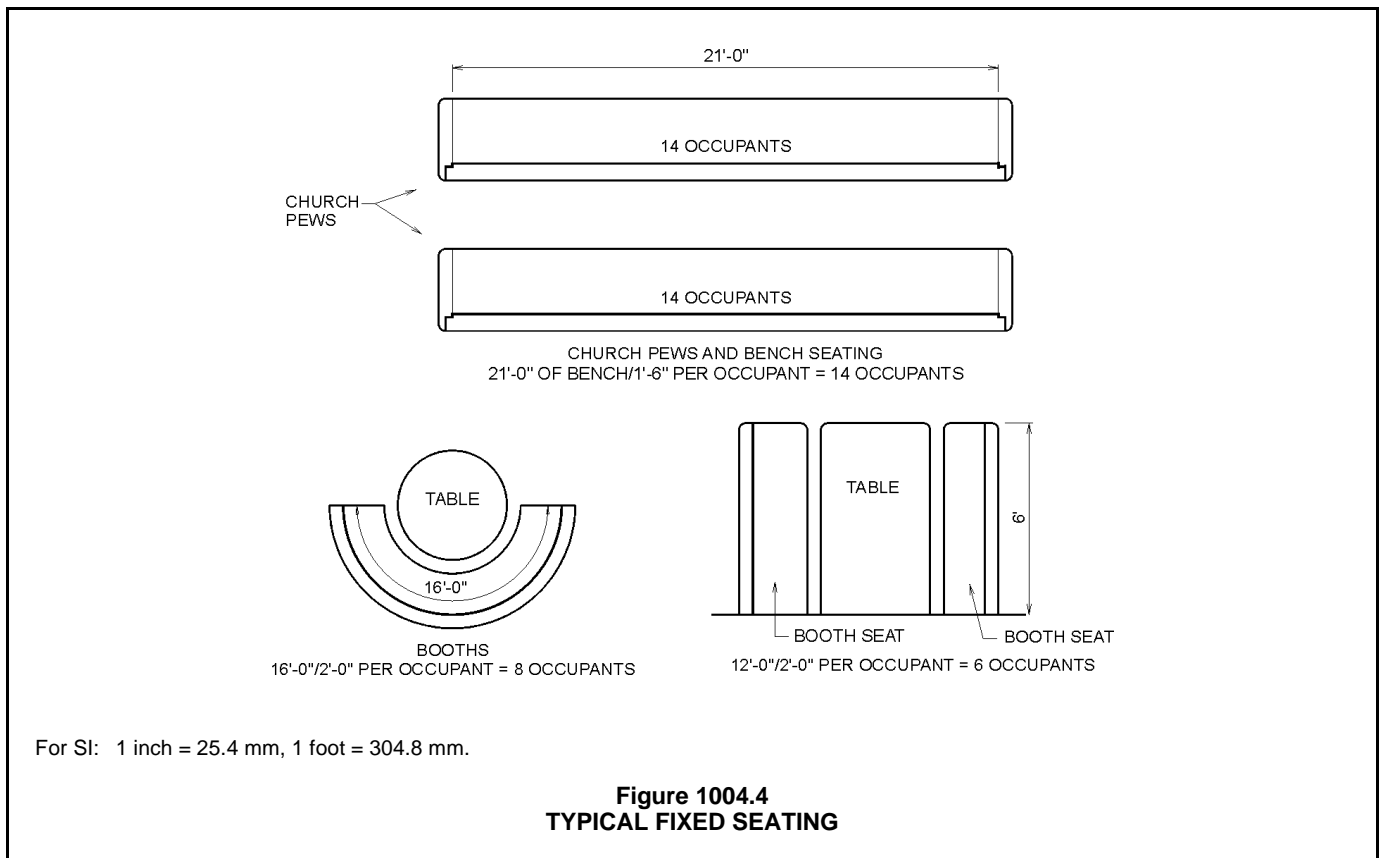
2, would typically be used by the occupants of the unit. Means of egress can be back through the building in accordance with Section 1016.2.

**1004.6 Multiple occupancies.** Where a building contains two or more occupancies, the *means of egress* requirements shall apply to each portion of the building based on the occupancy of that space. Where two or more occupancies utilize portions of the same *means of egress* system, those egress components shall meet the more stringent requirements of all occupancies that are served.

❖ Since the means of egress systems are designed for the specific occupancy of a space, the provisions of this chapter are to be applied based on the actual occupancy conditions of the space served.

For example, a hospital is classified as Group I-2 and normally includes the associated administrative or business functions found in the same building. Chapter 3 would permit the entire building to be constructed to the more restrictive provisions for Group I-2; however, each area of the building need only have the means of egress designed in accordance with the actual occupancy conditions, such as Groups I-2 and B. If the corridor serves only the occupants in the business use (i.e., administrative staff), and is not intended to serve as a required means of egress for patients, the corridor need only be 36 or 44 inches (914 or 1118 mm) in width, depending on the occupant load.

Where the corridor is used by both Group I-2 and B occupancies, it must meet the most stringent require-



**Figure 1004.4**  
**TYPICAL FIXED SEATING**

ment. For example, if a corridor in the business area is also used for the movement of beds (i.e., exit access from a patient care area), it would need to be a minimum of 96 inches (2438 mm) in clear width.

## SECTION 1005 MEANS OF EGRESS SIZING

**1005.1 General.** All portions of the *means of egress* system shall be sized in accordance with this section.

**Exception:** *Aisles* and *aisle accessways* in rooms or spaces used for assembly purposes complying with Section 1029.

❖ This section is a charging paragraph for sizing for the means of egress system in a tenant space, floor or building. The exception is based on the understanding that means of egress paths within assembly areas have unique criteria based on the high occupant load and possibility of stepped or sloped aisles.

**1005.2 Minimum width based on component.** The minimum width, in inches (mm), of any *means of egress* components shall be not less than that specified for such component, elsewhere in this code.

❖ The code requires the utilization of two methods to determine the minimum width of egress components. While this section provides a methodology for determining required widths based on the design occupant load calculated in accordance with Section 1004.1, other sections provide minimum widths of various components. The actual width that is provided is to be the larger of the two widths.

**1005.3 Required capacity based on occupant load.** The required capacity, in inches (mm), of the *means of egress* for any room, area, space or story shall be not less than that determined in accordance with Sections 1005.3.1 and 1005.3.2.

❖ For this section, the sum of the capacities of the means of egress components that serve each space must equal or exceed the occupant load of that space. For example, the combined width of all of the exit stairways from a floor needs to be considered to determine if the stairways have adequate capacity for everyone to evacuate the building. All elements must meet the minimum width requirements specified in other sections (e.g., Section 1010.1.1 for doors; Sections 1009.3 and 1011.2 for stairs).

This section establishes the necessary width of each egress component on a “per-occupant” basis. Means of egress components are separated between “stairs” and “other;” “other” being doors, doorways, corridors, ramps, aisles, etc.

The traditional unit of measurement of egress capacity was based on a “unit exit width” that was to simulate the body ellipse with a basic dimensional width of 22 inches (559 mm)—approximately the shoulder width of an average adult male. This unit exit width was combined with assumed egress movement (such as single file or staggered file) to result in

an egress capacity per unit exit width for various occupancies. This assumption simplifies the dynamic egress process since contemporary studies have indicated that people do not egress in such precise and predictable movements. As traditionally used in the codes, the method of determining capacity per unit of clear width implies a higher level of accuracy than can realistically be achieved. The resulting factors preserve the features of the past practices that can be documented, while providing a more straightforward method of determining egress capacity.

**1005.3.1 Stairways.** The capacity, in inches, of *means of egress stairways* shall be calculated by multiplying the *occupant load* served by such *stairways* by a means of egress capacity factor of 0.3 inch (7.6 mm) per occupant. Where *stairways* serve more than one story, only the occupant load of each story considered individually shall be used in calculating the required capacity of the *stairways* serving that story.

### Exceptions:

1. For other than Group H and I-2 occupancies, the capacity, in inches, of *means of egress stairways* shall be calculated by multiplying the *occupant load* served by such *stairways* by a means of egress capacity factor of 0.2 inch (5.1 mm) per occupant in buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2 and an *emergency voice/ alarm communication* system in accordance with Section 907.5.2.2.
  2. Facilities with *smoke-protected assembly seating* shall be permitted to use the capacity factors in Table 1029.6.2 indicated for stepped aisles for *exit access* or *exit stairways* where the entire path for *means of egress* from the seating to the *exit discharge* is provided with a smoke control system complying with Section 909.
  3. Facilities with outdoor *smoke-protected assembly seating* shall be permitted to the capacity factors in Section 1029.6.3 indicated for stepped aisles for *exit access* or *exit stairways* where the entire path for *means of egress* from the seating to the *exit discharge* is open to the outdoors.
- ❖ The capacity factor for stairways is larger than “other egress components” because of the slowdown of travel to negotiate the steps. When the required occupant capacity of an egress component is determined, multiplication by the appropriate factor results in the required clear width of the component in inches, based on capacity. Similarly, if the clear width of a component is known, division by the appropriate factor results in the permitted capacity of that component.

Per Exception 1, other than in Group H or I-2, if the building is sprinklered and has an emergency voice/ alarm communication system, the capacity factor for stairways is permitted to be reduced to 0.2 inches (5.1 mm) per occupant.

Smoke-protected seating is permitted to use a lower capacity number to determine the width of the egress components within the seating bowl. When designing the stepped aisles within the seating bowl, the provisions for Section 1029 are applicable. When designing components outside of the seating bowl, Section 1005.3 is applicable. Per Exceptions 2 and 3, if both the seating bowl and the entire route out of the building is smoke protected, the entire route can use the lower capacity numbers specified in Section 1029. For example, if an outdoor stadium has an enclosed concourse that spectators use to enter and exit the stadium seating, the smoke-protected capacity numbers can be used to design the stepped aisles in the stadium, but the higher numbers for stairways must be used to size the stairways in the concourse. Only if the concourse is also open to the outside air can the smoke-protected seating capacity numbers be used for the entire means of egress route. See the definition of "Smoke-protected assembly seating." See also Sections 1029.6.2 and 1029.6.3.

The following illustrate typical calculations for stairways from a nonsprinklered, two-story, two-exit office building:

1. Determine the minimum required stairway width with a second-floor occupant load of 350:
  - 350 occupants divided by 0.3 inch = 105 inches (2667 mm) minimum;
  - 105 inches divided by two stairways is 52½ inches (1334 mm) minimum per stairway; or
  - Section 1009.1 prescribes that the width of an interior stairway cannot be less than 44 inches (1118 mm).

The capacity criteria are more restrictive and, therefore, the minimum required width for each stairway is 52½ inches (1334 mm).

2. Determine the minimum required stairway width with a second-floor occupant load of 90:
  - 90 occupants divided by 0.3 inches (7.62 mm) = 27 inches (686 mm) minimum;
  - 27 inches (686 mm) divided by two stairways is 13½ inches (343 mm); or
  - Section 1011.1 prescribes that the width of an interior stairway cannot be less than 44 inches (1118 mm). Note that the stair width reduction in Section 1011.2, Exception 1, is applicable only when the entire occupant load of a story is less than 50.

The minimum clear width requirements are more restrictive and, therefore, the minimum required width for each stairway is 44 inches (1118 mm).

The maximum capacity of a 44-inch (1118 mm) stairway is 44 inches divided by 0.3 inches (7.62 mm) per occupant = 146 occupants. Therefore, a floor level with two exit stairways could have 292 occu-

pants before the capacity would control the stairway egress width.

Using the exception for sprinklered buildings, a 44-inch (1118 mm) stairway divided by 0.2 inches (5.08 mm) per occupant = 220 occupants. Therefore, a floor level with two exit stairways could have 440 occupants before the capacity would control the stairway egress width.

Keep in mind that accessible means of egress stairways in nonsprinklered buildings require a minimum clear width of 48 inches (1219 mm) between handrails.

**1005.3.2 Other egress components.** The capacity, in inches, of *means of egress* components other than *stairways* shall be calculated by multiplying the *occupant load* served by such component by a means of egress capacity factor of 0.2 inch (5.1 mm) per occupant.

**Exceptions:**

1. For other than Group H and I-2 occupancies, the capacity, in inches, of *means of egress* components other than *stairways* shall be calculated by multiplying the *occupant load* served by such component by a means of egress capacity factor of 0.15 inch (3.8 mm) per occupant in buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2 and an *emergency voice/alarm communication* system in accordance with Section 907.5.2.2.
  2. Facilities with *smoke-protected assembly seating* shall be permitted to use the capacity factors in Table 1029.6.2 indicated for level or ramped *aisles* for *means of egress* components other than *stairways* where the entire path for *means of egress* from the seating to the *exit discharge* is provided with a smoke control system complying with Section 909.
  3. Facilities with outdoor *smoke-protected assembly seating* shall be permitted to the capacity factors in Section 1029.6.3 indicated for level or ramped *aisles* for *means of egress* components other than *stairways* where the entire path for *means of egress* from the seating to the *exit discharge* is open to the outdoors.
- ❖ The capacity factor for "other egress components" (e.g., doors, gates, corridors, aisles, ramps) is less than stairways because of the slowdown of travel to negotiate the steps. When the required occupant capacity of an egress component is determined, multiplication by the appropriate factor results in the required clear width of the component in inches, based on capacity. Similarly, if the clear width of a component is known, division by the appropriate factor results in the permitted capacity of that component.
- Per Exception 1, other than in Group H or I-2, if the building is sprinklered and has an emergency voice/alarm communication system, the capacity factor for doors, corridors, aisles, etc., is permitted to be reduced to 0.15 inches (3.8 mm) per occupant.

Smoke-protected seating is permitted to use a lower capacity number to determine the width of the egress components. When designing the ramped or level aisles and aisle accessways within the seating bowl, the provisions for Section 1029 are applicable. When designing components outside of the seating bowl, Section 1005.3 is applicable. Per Exceptions 2 and 3, if both the seating bowl and the entire route out of the building is smoke protected, the entire route can use the lower capacity numbers. For example, if an outdoor stadium has an enclosed concourse that spectators use to enter and exit the stadium seating, the smoke-protected capacity numbers can be used to design the ramped or level aisles in the stadium, but the higher numbers for other egress components must be used to size the corridors or ramps in the concourse. Only if the concourse is also open to the outside air can the smoke-protected seating capacity numbers be used for the entire means of egress route. See the definition of "Smoke-protected assembly seating." See also Sections 1029.6.2 and 1029.6.3.

For example, two exit access doorways from a room with an occupant load of 300 would each have a required capacity of not less than 150. Based on the minimum required clear door width [32-inch (813 mm) clear width per door divided by 0.2 inch (5.08 mm) per occupant = 160 occupants], two 32-inch (813 mm) clear width doors would meet both the minimum clear width (Section 1010.1.1) and the capacity requirements. Two exits from a space with an occupant load of 450 would each have a required capacity of not less than 225, necessitating more doors or larger door leaves.

Using the exception, the door capacity would increase [32-inch (813 mm) clear width per door divided by 0.15 inch (3.08 mm) per occupant = 213 occupants].

**1005.4 Continuity.** The minimum width or required capacity of the *means of egress* required from any story of a building shall not be reduced along the path of egress travel until arrival at the public way.

❖ The requirement that both the minimum widths and required capacity from any floor are to be provided all the way along the exit to the termination, typically down the stairway to the exterior exit door at the level of exit discharge, results in an egress width that is adequate for the exit discharge.

The sum total capacity of the exits that serve a floor is not to be less than the occupant load of the floor as determined by Section 1004.1. If an exit, such as a stairway, also serves a second floor and the required capacity of the exit serving the occupants of the second floor is greater than the first floor, the greater capacity would govern the egress components that the occupants of the floors share. For example, if an exit stairway serves two floors, with occupant loads of 300 on the lower floor and 500 on the upper floor, assuming that two stairways serve each floor, the two stairways would be designed for a capacity of 250

people each, using the upper-floor occupant load of 500 as the basis of determination. Note that the doors to the stairways on the lower floor would be designed for a capacity of 150 and the doors to the stairways on the upper floor would be designed for a capacity of 250. Reversing these two floors would result in the portion of the stairways that serves the upper floor to be designed for a capacity of 150 and the stairways that serve the lower floor to be designed for 250. Requiring the egress component to be designed for the largest tributary occupant load accommodates the worst-case situation.

Also note that the capacity of the exits is based on the occupant load of one floor. The occupant loads are not combined with other floors for the exit design. It is assumed that the peak demand or flow of occupants from more than one floor level at a common point in the means of egress will not occur simultaneously, except as provided for in Sections 1005.6 (Egress convergence) and 1004.1.1.2 (Adjacent levels for mezzanines).

**1005.5 Distribution of minimum width and required capacity.** Where more than one *exit*, or access to more than one *exit*, is required, the *means of egress* shall be configured such that the loss of any one *exit*, or access to one *exit*, shall not reduce the available capacity or width to less than 50 percent of the required capacity or width.

❖ It is critical that the distribution of both egress capacity and minimum width are examined. Where multiple means of egress are required, the loss of any one path cannot reduce the available capacity or width to less than 50 percent. The 50-percent minimum of the required egress capacity and width results in a fairly uniform distribution of egress paths. This requirement does not, however, require that the capacities be equally distributed when *more* than two means of egress are provided. An egress design with a dramatic imbalance of egress component capacities relative to occupant load distribution should be reviewed closely to avoid a needless delay in egressing a story or area. The balancing of the means of egress components, in accordance with the distribution of the occupant load, is reasonable and, in some cases, necessary for facilities having mixed occupancies with dramatically different occupant loads.

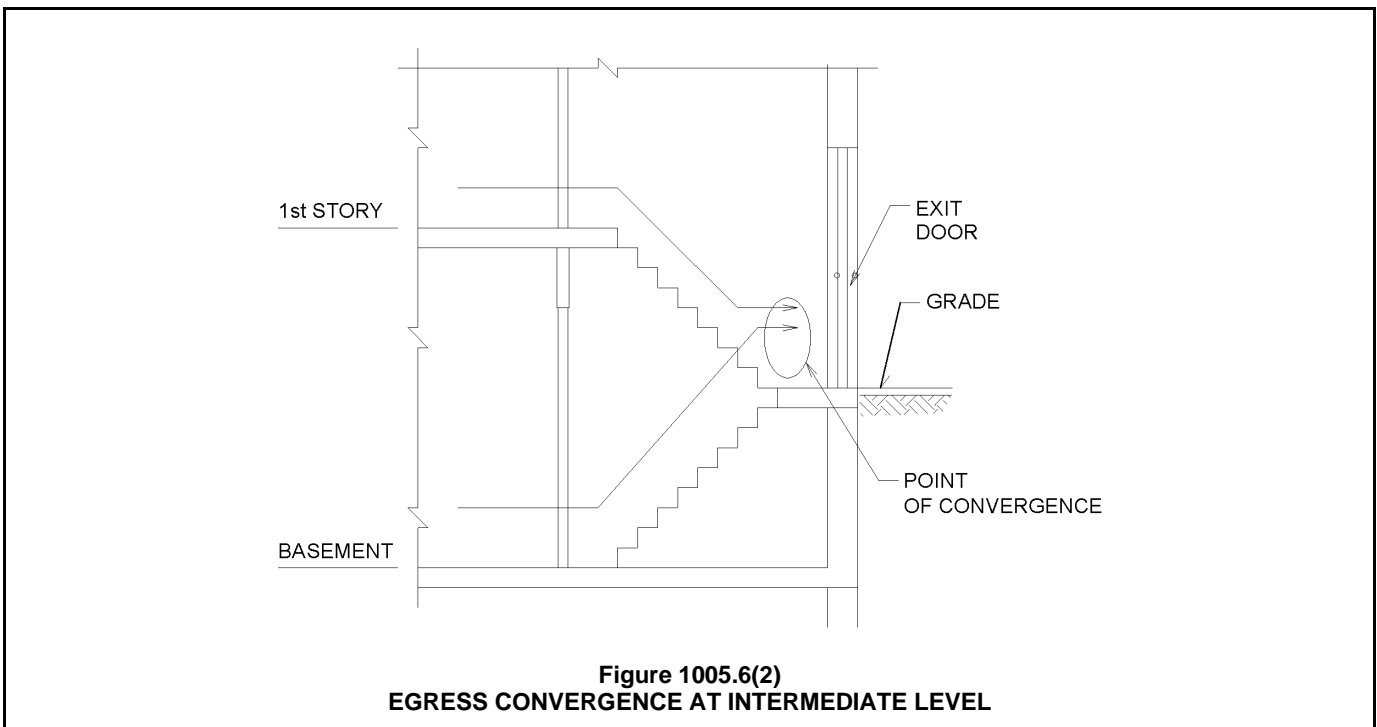
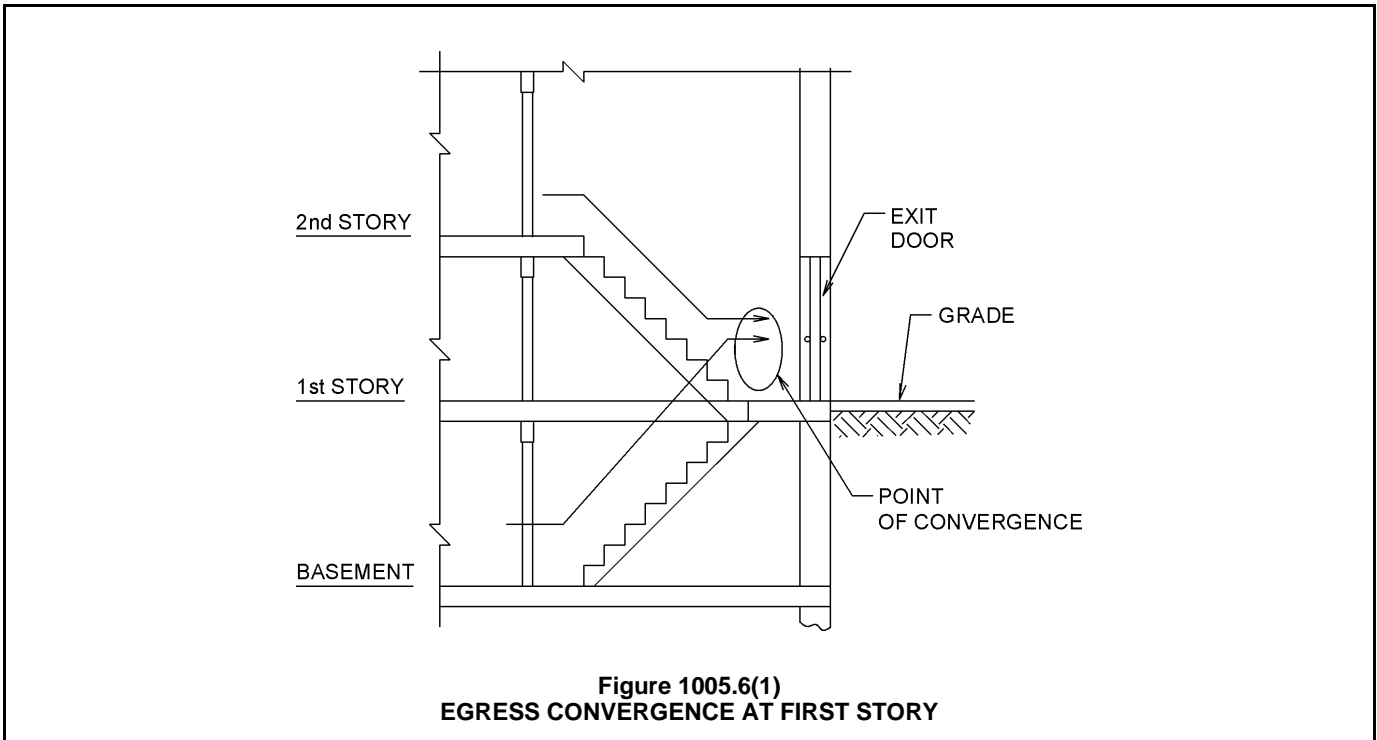
**1005.6 Egress convergence.** Where the *means of egress* from stories above and below converge at an intermediate level, the capacity of the *means of egress* from the point of convergence shall be not less than the largest minimum width or the sum of the required capacities for the *stairways* or *ramps* serving the two adjacent stories, whichever is larger.

❖ Convergence of occupants can occur whenever the occupants of an upper floor travel down and occupants of a lower floor travel up and meet at a common, intermediate egress component on the route to the exit discharge. The intermediate component may or may not be another occupiable floor and, most often, is an exit door [see Commentary Figures 1005.6(1) and 1005.6(2)].

The entire premise of egress convergence is based on the assumption of simultaneous notification (i.e., all occupants of all floors begin moving toward the exits at the same time). As illustrated in Commentary Figure 1005.6(3), the occupants of the first floor will have exited the building by the time most of the occupants of the second floor have reached the exit discharge door. However, as illustrated in Commentary

Figure 1005.6(1), the occupants of a basement will reach the discharge door simultaneously with the second-floor occupants, thereby creating a bottleneck and the need for sizing the affected component for a larger combined occupant load.

An egress convergence situation can also be created when an intermediate floor level is not present, as illustrated in Commentary Figure 1005.6(2). Again,



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under the assumption of simultaneous notification, occupants of both floors would reach the exit discharge door at approximately the same time, invoking the requirements for increased egress capacity.

**1005.7 Encroachment.** Encroachments into the required *means of egress* width shall be in accordance with the provisions of this section.

❖ This section addresses maximum encroachment into the required width along the path of travel for means of egress. Types of encroachment are door leaves, door hardware, handrails, trim and protruding objects. These requirements are referenced for aisles (Section 1018.1), corridors (Section 1020.3), exit passageways (Section 1024.2) and exit courts (Section 1028.4.1). Along stairways, handrail projections are permitted per Section 1014.8.

**1005.7.1 Doors.** Doors, when fully opened, shall not reduce the required width by more than 7 inches (178 mm). Doors in any position shall not reduce the required width by more than one-half.

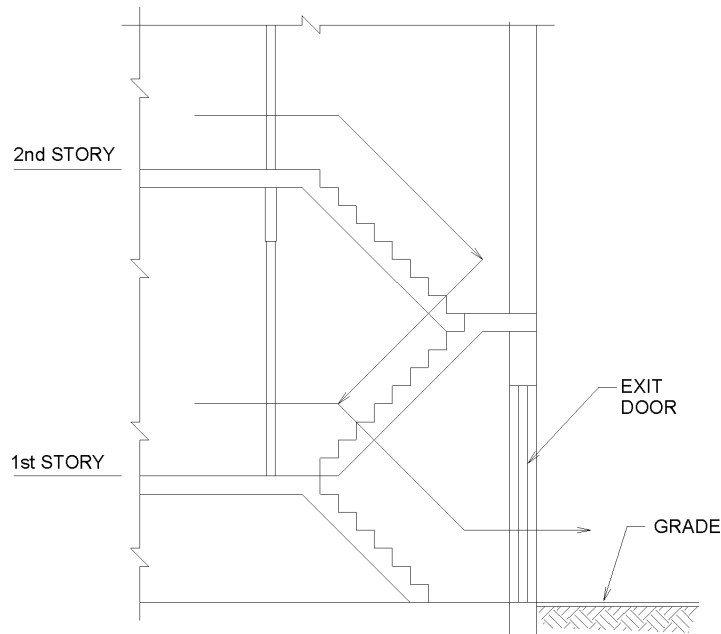
### Exceptions:

1. Surface-mounted latch release hardware shall be exempt from inclusion in the 7-inch maximum (178 mm) encroachment where both of the following conditions exist:
  - 1.1. The hardware is mounted to the side of the door facing away from the adjacent wall where the door is in the open position.
  - 1.2. The hardware is mounted not less than 34 inches (865 mm) nor more than 48 inches (1219 mm) above the finished floor.

2. The restrictions on door swing shall not apply to doors within individual *dwelling units* and *sleeping units* of Group R-2 occupancies and *dwelling units* of Group R-3 occupancies.

❖ Projections or restrictions in the required width can impede and restrict occupant travel, causing egress to occur less efficiently than expected. The swinging of a door, such as from a room into a corridor, and any handrails along the route are permitted projections.

Historically, this section has looked at doors on one wall at a time. Doors located across the hall from one another are not considered additive when considering protrusion limits. Doors would not typically be opened to the full extent at exactly the same moment, nor can they remain open at 90 degrees and totally blocking the hall because of the maximum limitation of 7 inches (178 mm) when fully open (typically approaching 180 degrees). Regarding door encroachment, there are two tests. The arc created by the door's outside edge cannot project into more than one-half of the required corridor width. When opened to its fullest extent, the door cannot project more than 7 inches (178 mm) into the required width, which is the dimension of the leaf thickness excluding the hardware as shown in Commentary Figure 1005.7.1. Door hardware encroachment is addressed separately in Exception 1. These projections are permitted because they are considered to be temporary and do not significantly impede the flow. Occupants will compensate for the projection by a reduction in the natural cushion they retain between themselves and a boundary, known as the edge effect.



**Figure 1005.6(3)**  
**NO EGRESS CONVERGENCE**

Per Exception 2, the door swing restrictions do not apply within dwelling units since the occupant load is very low. Based on the intent of this section, other situations that could be approved by the official having jurisdiction would be situations where the opening door would not block the egress, such as the door at the end of a corridor, or the room was not typically occupied, such as a janitor's closet.

The provision in Exception 1 indicates that hardware facing the corridor when the door is fully open need not be considered when determining the allowable door encroachment into a corridor of 7 inches (178 mm) maximum. The allowance is applicable provided the hardware is mounted within a height range of 34 inches to 48 inches (865 to 1220 mm), which is consistent with the range for means of egress door hardware height as established in Section 1010.1.9.2. Where hardware extends across a door, such as panic hardware, the 4-inch (102 mm) projection in the door opening is addressed in Section 1010.1.1.1.

**1005.7.2 Other projections.** *Handrail* projections shall be in accordance with the provisions of Section 1014.8. Other nonstructural projections such as trim and similar decorative features shall be permitted to project into the required width not more than 1½ inches (38 mm) on each side.

**Exception:** Projections are permitted in corridors within Group I-2 Condition 1 in accordance with Section 407.4.3.

❖ Handrails are not required along corridors, level aisles, exit passageways and exit corridors; however, if provided, Section 1014.8 would be applicable. Handrails are sometimes provided along the hallways in hospitals or nursing homes to aid the residents. Bumper guards along the walls are not handrails.

Items such as baseboards, chair rails, pilasters, etc., are limited to protruding over the *required* width of the corridor a maximum of 1½ inches (38 mm); however, once again, Section 1003.3.3 would be applicable

when the corridor was wider than required.

The exception is in recognition of a situation unique to nursing homes (Group I-2, Condition 1). IBC Section 407.4.3 includes allowances for furniture in corridors to address the need of patients needing a place to sit to rest as well as the new style of design that emphasizes the residential aspects of the environment.

**1005.7.3 Protruding objects.** Protruding objects shall comply with the applicable requirements of Section 1003.3.

❖ This section is a reminder that protruding objects are applicable when looking at encroachments into a confined path of travel. The difference, however, is that door and other projections are applied to the required minimum width, while protruding object provisions apply to paths of travel even when wider than required.

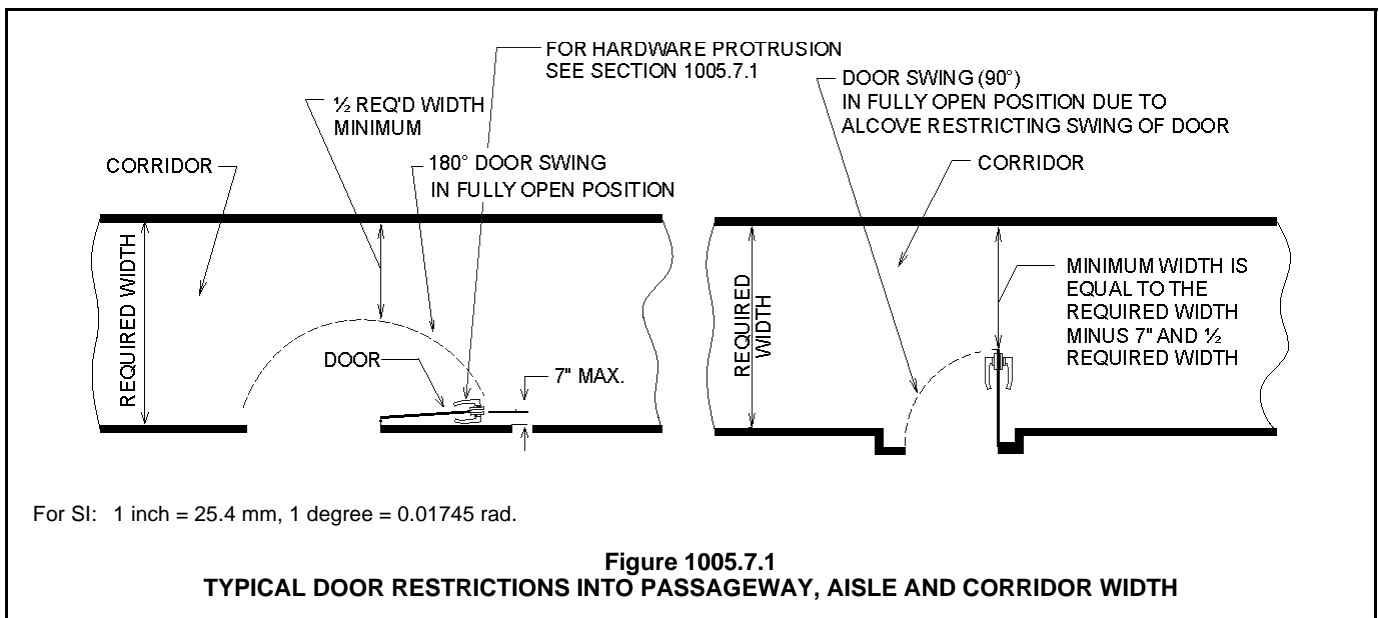
### SECTION 1006 NUMBER OF EXITS AND EXIT ACCESS DOORWAYS

**1006.1 General.** The number of *exits* or *exit access doorways* required within the *means of egress* system shall comply with the provisions of Section 1006.2 for spaces, including *mezzanines*, and Section 1006.3 for *stories*.

❖ The criteria in this section to determine the number of ways to leave rooms or spaces (including mezzanines) and stories are based on an empirical judgment of the associated risks.

**1006.2 Egress from spaces.** Rooms, areas or spaces, including *mezzanines*, within a *story* or *basement* shall be provided with the number of *exits* or access to *exits* in accordance with this section.

❖ This section dictates the minimum number of paths of travel an occupant is to have available to avoid a fire incident in the occupied room or space. While providing multiple egress doorways from every room is



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unrealistic, a point does exist where alternative egress paths must be provided based on the number of occupants at risk, the distance any one occupant must travel to reach a doorway and the relative hazards associated with the occupancy of the space. Generally, the number of egress doorways required from any room or space coincides with the occupant load threshold criteria set forth for the minimum number of exits required from a story (see Section 1006.3).

**1006.2.1 Egress based on occupant load and common path of egress travel distance.** Two exits or exit access doorways from any space shall be provided where the design occupant load or the common path of egress travel distance exceeds the values listed in Table 1006.2.1.

### Exceptions:

1. In Group R-2 and R-3 occupancies, one means of egress is permitted within and from individual dwelling units with a maximum occupant load of 20 where the dwelling unit is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2 and the common path of egress travel does not exceed 125 feet (38 100 mm).
  2. Care suites in Group I-2 occupancies complying with Section 407.4.
- ❖ This section dictates the minimum number of paths of travel an occupant is to have available to avoid a fire incident in the occupied room or space. While providing multiple egress doorways from every room is unrealistic, a point does exist where alternative egress paths must be provided based on the number of occupants at risk, the distance any one occupant must travel to reach a doorway and the relative hazards associated with the occupancy of the space.

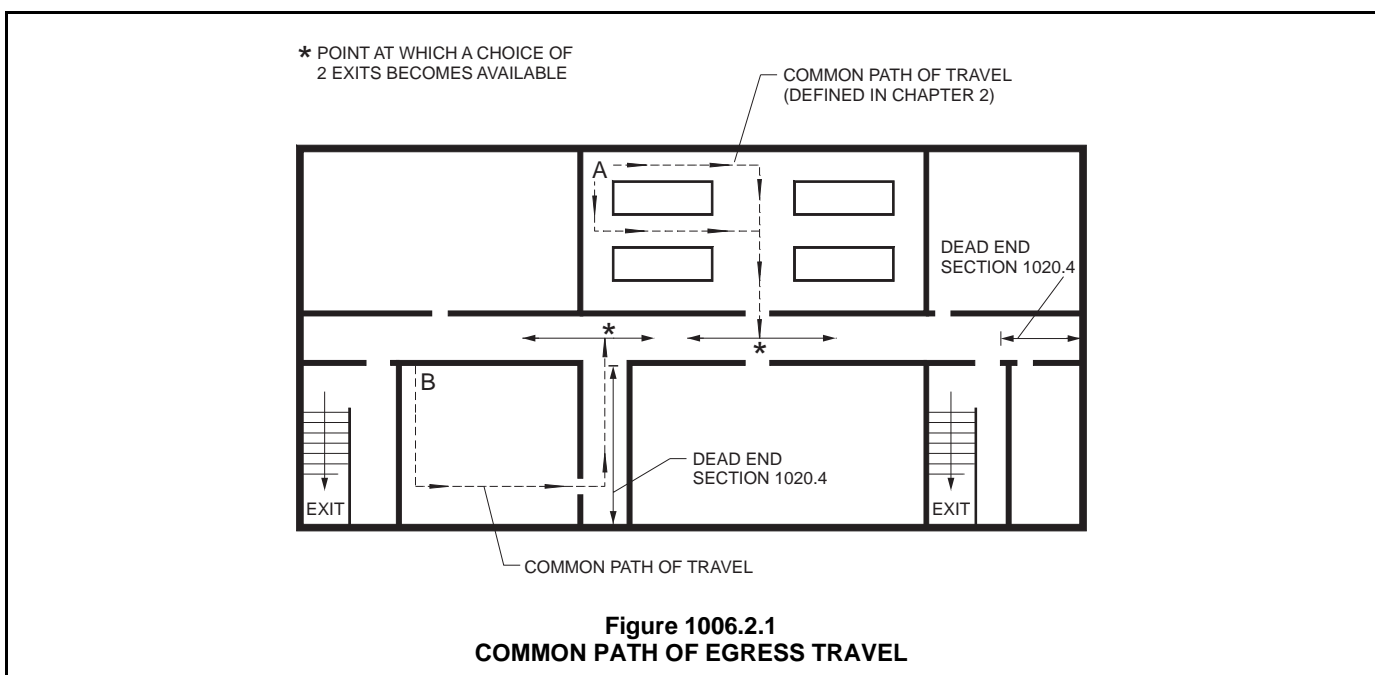
Generally, the number of egress doorways required from any room or space coincides with the occupant load threshold criteria set forth for determining the minimum number of exits required from a story (see Section 1006.3).

The limiting criteria in Table 1006.2.1 for rooms or spaces permitted to have a single exit access doorway are based on an empirical judgment of the associated risks.

If the occupants of a room are required to egress through another room, as permitted in Sections 1004.1.1.1 and 1016.2, the rooms are to be combined to determine if multiple doorways are required from the combined rooms. For example, if a suite of offices shares a common reception area, the entire suite with the reception area must meet both the occupant load and the travel distance criteria. The same logic would hold true for a space with a mezzanine (see Section 1004.1.1.2).

It should be noted that where two doorways are required, the remoteness requirement of Section 1007.1 is applicable.

The common path of travel is the distance measured from the most remote point in a space to the point in the exit path where the occupant has access to two required exits in separate directions. The distance limitations are applicable to all paths of travel that lead out of a space or building where two exits are required. An illustration of this distance is found in Commentary Figure 1006.2.1. The illustration reflects two examples of a common path of travel where the occupants at points A and B are able to travel in only one direction before they reach a point at which they have a choice of two paths of travel to the required exits from the building. Note that from point A, the occupants have two available paths, but these merge to form a single path out of the space. This is also



considered a common path of travel. The common path of travel is considered part of the overall travel distance limitations in Section 1017.2.

While a Group R-3 occupancy is typically a single-exit space, it is included in the table to address mixed-use buildings.

Exception 1 allows for individual dwelling units to be considered a space with one means of egress, provided they meet the same common path of travel requirements in Table 1006.2.1. If the building is sprinklered with an NFPA 13 or 13R system, the occupant load for the unit can be 20 (4,000-square-foot apartment/200 square feet per occupant = 20 occupants), whereas if the unit complies with the table, the occupant load is limited to 10 people per unit (2,000-square-foot apartment/200 square feet per occupant = 10 occupants).

Exception 2 allows for hospital patient rooms and care suites to egress in accordance with the specific criteria in IBC Section 407.4, including the common path of egress travel provisions (Table 1006.2.1, Note d). Other areas in Group I-2 occupancies are addressed in Table 1006.2.1.

**TABLE 1006.2.1.** See below.

❖ The table represents an empirical judgment of the risks associated with a single means of egress from a room or space based on the occupant load in the

room, the travel distance to the exit access door and the inherent risks associated with the occupancy (such as occupant mobility, occupant familiarity with the building, occupant response and the fire growth rate). The number 49 is for consistency with other occupant load thresholds, such as panic hardware (see Section 1010.1.10).

Since the occupants of Groups I and R may be sleeping and, therefore, not able to detect a fire in its early stages without staff supervision or room detectors, the number of occupants in a single egress room or space is limited to 10. See the exceptions to Section 1006.2.1 for Group R-2 and R-3 individual units and Group I-2 patient rooms and care suites.

Because of the potential for rapidly developing hazardous conditions, the single egress condition in Groups H-1, H-2 and H-3 is limited to a maximum of three persons. Because the materials contained in Groups H-4 and H-5 do not represent the same fire hazard potential as those found in Groups H-1, H-2 and H-3, the occupant load for spaces with one means of egress is increased.

Because of the reduced occupant density in Group S and the occupants' normal familiarity with the building, the single egress condition is permitted with an occupant load of 29.

In nonsprinklered business, storage and utility buildings, the length of the common path of egress

**TABLE 1006.2.1  
SPACES WITH ONE EXIT OR EXIT ACCESS DOORWAY**

OCCUPANCY	MAXIMUM OCCUPANT LOAD OF SPACE	MAXIMUM COMMON PATH OF EGRESS TRAVEL DISTANCE (feet)		
		Without Sprinkler System (feet)		With Sprinkler System (feet)
		Occupant Load		
		OL ≤ 30	OL > 30	
A <sup>c</sup> , E, M	49	75	75	75 <sup>a</sup>
B	49	100	75	100 <sup>a</sup>
F	49	75	75	100 <sup>a</sup>
H-1, H-2, H-3	3	NP	NP	25 <sup>b</sup>
H-4, H-5	10	NP	NP	75 <sup>b</sup>
I-1, I-2 <sup>d</sup> , I-4	10	NP	NP	75 <sup>a</sup>
I-3	10	NP	NP	100 <sup>a</sup>
R-1	10	NP	NP	75 <sup>a</sup>
R-2	10	NP	NP	125 <sup>a</sup>
R-3 <sup>e</sup>	10	NP	NP	125 <sup>a</sup>
R-4 <sup>e</sup>	10	75	75	125 <sup>a</sup>
S <sup>f</sup>	29	100	75	100 <sup>a</sup>
U	49	100	75	75 <sup>a</sup>

For SI: 1 foot = 304.8 mm.

NP = Not Permitted.

- a. Buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2. See Section 903 for occupancies where *automatic sprinkler systems* are permitted in accordance with Section 903.3.1.2.
- b. Group H occupancies equipped throughout with an *automatic sprinkler system* in accordance with Section 903.2.5.
- c. For a room or space used for assembly purposes having *fixed seating*, see Section 1029.8.
- d. For the travel distance limitations in Group I-2, see Section 407.4.
- e. The length of *common path of egress travel* distance in a Group R-3 occupancy located in a mixed occupancy building or within a Group R-3 or R-4 *congregate living facility*.
- f. The length of *common path of egress travel* distance in a Group S-2 *open parking garage* shall be not more than 100 feet.

travel is greater for single-exit spaces when the occupant load for that space is 30 or less. Business, factories and nontransient residential buildings get an increase in the common path of travel in recognition of the additional fire safety offered by a fully sprinklered building. While a Group R-4 is required to be sprinklered, the additional travel distance is not granted where they choose to use an NFPA 13D system as permitted in Section 903.3.1.3. Common path of egress travel does not apply to stories or buildings with one exit. The definition for "Common path" indicates the provisions are only applicable when access to two or more exits is required. See Section 1021.2 for travel limitations for single-exit one-, two- and three-story buildings and Section 1015.1 for spaces with one exit.

Note a indicates if the travel distance increase is based on an NFPA 13 or NFPA 13R sprinkler system being provided throughout the building, whichever is applicable to that occupancy. Where a Group R-4 occupancy can use an NFPA 13D system, the travel distance is indicated in the "without sprinkler system" column. The table does not currently provide information for a Group R-3 occupancy with an NFPA 13D system. Note b is a general reminder for special requirements for sprinklers in Group H.

The reference in Note c to Section 1029.8 is to allow for the unique common path of travel requirements in spaces with assembly seating, such as in a lecture room or sports facility.

Note d is a reference to the common path of travel provisions specific to Group I-2 care rooms and suites that are specifically addressed in IBC Section 407.4.

As indicated in Note e, while Group R-3 dwellings are typically only required to have one exit (see Section 1006.2.1 Exception 1 and Section 1006.3.2, Exception 5), there can be a situation where a Group R-3 unit is included in a mixed-use building. In these situations, the travel distance limitations for common path of travel in the table are applicable.

Note f is an allowance for the common path of travel in an open parking garage to be 100 feet (30 480 mm) when the occupant load is greater than 30 and there is no sprinkler system provided. This is in recognition of the minimal possibility of smoke accumulation due to the openness requirements and the low fuel loads for open parking garages.

**1006.2.1.1 Three or more exits or exit access doorways.** Three *exits* or *exit access doorways* shall be provided from any space with an occupant load of 501 to 1,000. Four *exits* or *exit access doorways* shall be provided from any space with an occupant load greater than 1,000.

❖ Large facilities with high occupant loads are required to have more than two exits leading from each story. This is so that at least one exit will be available in case of a fire emergency and to increase the likelihood that a large number of occupants can be accommodated by the remaining exits when one exit is not available. Section 1005.5 specifies that the loss

of one exit must not reduce the available exit capacity by more than 50 percent. This is reiterated in Sections 1029.2 and 1029.3 for spaces with assembly seating with more than 300 occupants. Exits should be separated in accordance with Section 1007.1.2. While an equal distribution of exit capacity among all the exits is not required, a proper design would consider occupant load distribution as well as reasonable capacity distribution so as to avoid a severe dependence on one exit or bottlenecks in anticipated high-use areas.

**1006.2.2 Egress based on use.** The numbers of *exits* or access to *exits* shall be provided in the uses described in Sections 1006.2.2.1 through 1006.2.2.5.

❖ Five types of spaces, because of their levels of hazard, have egress requirements based on use rather than occupant load and travel distance.

**1006.2.2.1 Boiler, incinerator and furnace rooms.** Two *exit access doorways* are required in boiler, incinerator and furnace rooms where the area is over 500 square feet (46 m<sup>2</sup>) and any fuel-fired equipment exceeds 400,000 British thermal units (Btu) (422 000 KJ) input capacity. Where two *exit access doorways* are required, one is permitted to be a fixed ladder or an *alternating tread device*. *Exit access doorways* shall be separated by a horizontal distance equal to one-half the length of the maximum overall diagonal dimension of the room.

❖ This section requires two exit access doorways for the specified mechanical equipment spaces because of the level of hazards in this type of space. A fixed ladder or an alternating tread device is permitted for service personnel to egress where two doorways are required. The remoteness of the exit access doorways specified in this section provides two paths of travel to exit the room so that if one doorway is not available, the alternate path can be used.

**1006.2.2.2 Refrigeration machinery rooms.** Machinery rooms larger than 1,000 square feet (93 m<sup>2</sup>) shall have not less than two *exits* or *exit access doorways*. Where two *exit access doorways* are required, one such doorway is permitted to be served by a fixed ladder or an *alternating tread device*. *Exit access doorways* shall be separated by a horizontal distance equal to one-half the maximum horizontal dimension of the room.

All portions of machinery rooms shall be within 150 feet (45 720 mm) of an *exit* or *exit access doorway*. An increase in *exit access* travel distance is permitted in accordance with Section 1017.1.

Doors shall swing in the direction of egress travel, regardless of the *occupant load* served. Doors shall be tight fitting and self-closing.

❖ The reasons for these requirements are the same as for Section 1006.2.2.1. Travel distance is to be limited in accordance with Section 1017.2. For example, the travel distance limit for a large refrigeration machinery room classified as Group F-1 that has a sprinkler system throughout the entire building in accordance

with NFPA 13 would be 250 feet (76 200 mm) based on Table 1017.2. The 150-foot (45 720 mm) maximum distance to an exit or exit access doorway that is specified in this section would not apply in this example. The 150-foot (45 720 mm) travel distance is intended to be applied where a sprinkler system is not installed and to shorten the time that occupants would be exposed to the hazards within the machinery room.

**1006.2.2.3 Refrigerated rooms or spaces.** Rooms or spaces having a floor area larger than 1,000 square feet (93 m<sup>2</sup>), containing a refrigerant evaporator and maintained at a temperature below 68°F (20°C), shall have access to not less than two *exits* or *exit access doorways*.

*Exit access* travel distance shall be determined as specified in Section 1017.1, but all portions of a refrigerated room or space shall be within 150 feet (45 720 mm) of an *exit* or *exit access doorway* where such rooms are not protected by an approved *automatic sprinkler system*. Egress is allowed through adjoining refrigerated rooms or spaces.

**Exception:** Where using refrigerants in quantities limited to the amounts based on the volume set forth in the *International Mechanical Code*.

❖ Refrigeration rooms also have a higher hazard level. The exception is intended to apply if Chapter 11 of the *International Mechanical Code*® (IMC®) does not require a separate refrigeration machinery room due to the small amount of refrigerant used (see the commentary to Section 1104 of the IMC for further explanation of the machinery room requirements).

**1006.2.2.4 Day care means of egress.** Day care facilities, rooms or spaces where care is provided for more than 10 children that are 2½ years of age or less, shall have access to not less than two *exits* or *exit access doorways*.

❖ Day care occupancies are limited to a maximum of 10 occupants for rooms or spaces with infants and toddlers before two exits are required from a room. This limit is in consideration of needing a quick means of egress for children who would need to be carried or led for evacuation (i.e., children under 2½ years of age).

There is an exception for the Group I-4 classification in IBC Section 308.6.1 that allows day care facilities with up to 100 children 2½ years of age or less with care rooms having direct access to the exterior to be classified as Group E. An exterior door to the outside from infant and toddler rooms can serve as the second exit to meet this section. It is not the intent that a day care classified as Group E, with children 2½ years of age or less, could use the means of egress requirements for Group E for these rooms.

**1006.2.2.5 Vehicular ramps.** Vehicular ramps shall not be considered as an *exit access ramp* unless pedestrian facilities are provided.

❖ A vehicle-only ramp may be considered as one of the required exit access ramps if pedestrian walkways

are provided along the ramp. The low-slope ramps that are lined with parking spaces are not considered vehicle ramps. In open parking garages, according to Section 1019.3, Exception 6, the exit access stairways and ramps are not required to be enclosed since an open parking structure is designed to permit the ready ventilation of the products of combustion to the outside by exterior wall openings (see IBC Section 406.5.2). Also, parking structures are characterized by open floor areas that allow the occupants to observe a fire condition and choose a travel path that would avoid the fire threat.

**1006.3 Egress from stories or occupied roofs.** The *means of egress* system serving any *story* or occupied roof shall be provided with the number of *exits* or access to *exits* based on the aggregate *occupant load* served in accordance with this section. The *path of egress travel* to an *exit* shall not pass through more than one adjacent *story*.

❖ Emergency evacuation from a multistory building will typically involve stairways or ramps as the vertical element for the means of egress route. The number of required ways off the story (via exit or exit access elements) is based on the occupant loads shown in Table 1006.3.1. These stairways and ramps must comply with the general provisions (Sections 1011 and 1012 respectively), and can be exit access (Section 1019) or exits (Section 1023 and 1027). When exit access stairways or ramps are part of that route, the measurement of the exit access travel distance will include travel from the most remote point on the floor, to and down the exit access stairway or ramp and from the bottom of the stairway or ramp to an enclosure for an exit stairway or ramp or exterior exit door (see Section 1017.3). Vertical travel is slower than horizontal travel, so the exit access stairway or ramp in a building with two or more exits should not be used for more than one story before an exit is reached.

**1006.3.1 Egress based on occupant load.** Each *story* and occupied roof shall have the minimum number of independent *exits*, or access to *exits*, as specified in Table 1006.3.1. A single *exit* or access to a single *exit* shall be permitted in accordance with Section 1006.3.2. The required number of *exits*, or *exit access stairways* or *ramps* providing access to *exits*, from any *story* or occupied roof shall be maintained until arrival at the *exit discharge* or a *public way*.

❖ This section starts out saying that every occupant on a story must have access to the required number of means of egress as specified:

- Per Table 1006.3.1—at least two means of egress per floor;
- Three means of egress for floors with greater than 500 occupants and four means of egress for floors with greater than 1,000 occupants;
- Per Sections 1006.3.2.1 and 1006.3.2.2—limited allowance for a single means of egress from a floor.

Saying “means of egress” instead of “exits” acknowledges that direct entrances to exits on each story are not always mandatory since access to exits (i.e., exit access stairways or ramps) on some stories is permissible within certain limitations. This allows some freedom of design when, for instance, required exit stairways may not be available without passing through other tenant spaces. The intent is to allow for a balance of security concerns providing adequate safety for emergency evacuation.

If a designer chooses to use horizontal exits instead of exit stairways or exit ramps, those specific provisions are addressed in Section 1026. For buildings built into a hillside, an exit door directly to the outside would also provide the same or better level of protection as an interior exit element. It is not the intent of this provision to prohibit horizontal exits or direct exterior exit doors as an option.

Once the number of means of egress is determined, those paths must remain available until occupants leave the building (see Commentary Figure 1006.3.1). The need for exits to be independent of each other cannot be overstated. Each occupant of each floor must be provided with the required number of exits without having to pass through one exit to gain access to another. Each exit is required to be independent of other exits to prohibit such areas from merging downstream and becoming, in effect, one exit.

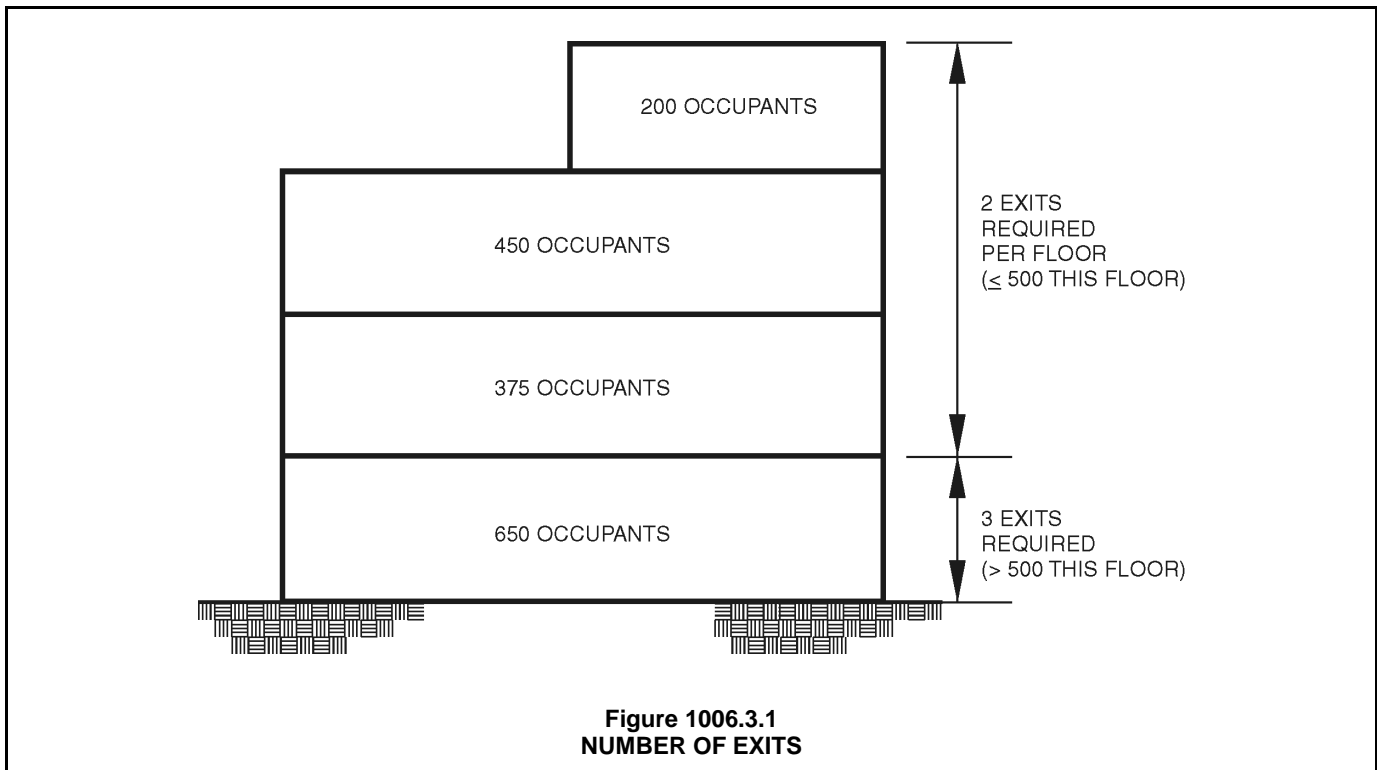
**TABLE 1006.3.1  
MINIMUM NUMBER OF EXITS OR  
ACCESS TO EXITS PER STORY**

OCCUPANT LOAD PER STORY	MINIMUM NUMBER OF EXITS OR ACCESS TO EXITS FROM STORY
1-500	2
501-1,000	3
More than 1,000	4

❖ Table 1006.3.1 specifies that the minimum number of exits available to each occupant of a floor is based on the total occupant load of that floor. This is so that at least one exit will be available in case of a fire emergency and to increase the likelihood that a larger number of occupants can be accommodated by the remaining exits when one exit is not available. While an equal distribution of exit capacity among all of the exits is not required, a proper design would not only balance capacity with the occupant load distribution, but also consider a reasoned distribution of capacity to avoid a severe dependence on one exit.

**1006.3.2 Single exits.** A single *exit* or access to a single *exit* shall be permitted from any *story* or occupied roof where one of the following conditions exists:

1. The *occupant load*, number of *dwelling units* and *exit access* travel distance do not exceed the values in Table 1006.3.2(1) or 1006.3.2(2).
2. Rooms, areas and spaces complying with Section 1006.2.1 with *exits* that discharge directly to the exte-



**Figure 1006.3.1  
NUMBER OF EXITS**

rior at the *level of exit discharge*, are permitted to have one *exit* or access to a single *exit*.

3. Parking garages where vehicles are mechanically parked shall be permitted to have one *exit* or access to a single *exit*.
4. Group R-3 and R-4 occupancies shall be permitted to have one *exit* or access to a single *exit*.
5. Individual single-story or multistory *dwelling units* shall be permitted to have a single *exit* or access to a single *exit* from the *dwelling unit* provided that both of the following criteria are met:
  - 5.1. The *dwelling unit* complies with Section 1006.2.1 as a space with one *means of egress*.
  - 5.2. Either the *exit* from the *dwelling unit* discharges directly to the exterior at the *level of exit discharge*, or the *exit access* outside the *dwelling unit*'s entrance door provides access to not less than two approved independent *exits*.

❖ The base assumption is that all stories of a building shall have access to at least two separate ways out for emergencies.

Single-exit stories can have access to an exit from any floor, therefore, single-exit stories can use an open exit access stairway for as many stories as permitted by Sections 1006.3.2 and 1019.3.3 provided they meet the exit access of travel distance limitations for that use in Sections 1006.2.1 and 1006.3.2 and Tables 1006.2.1, 1006.3.2(1) and 1006.3.2(2).

A story can have a single exit if the design meets one of the five items listed.

Item 1 states what situations permit one exit by a reference to Tables 1006.3.2(1) and 1006.3.2(2). If a story can meet the provisions for occupant load, number of units and travel distance in Table 1006.3.2(1) or 1006.3.2(2), then that story can have one means of egress. See the commentary for Tables 1006.3.2(1) and 1006.3.2(2) for information on single-exit buildings.

Item 2 references Table 1006.2.1 for single-exit spaces. Table 1006.2.1 is intended to be applicable to rooms and spaces on a floor, but not to an entire floor level. One of the main concerns has been that vertical travel takes longer than horizontal travel in emergency exiting situations. However, if the single-exit space can exit directly to the exterior rather than egress into an interior corridor, a higher level of safety is provided. While the term "building" limits the area addressed to that bordered by exterior walls or fire walls, a common application of Item 2 is on a tenant-by-tenant basis. For example, a single-story strip mall may not meet the provisions for a building with one means of egress but each tenant area meets the provisions for a space with one means of egress in accordance with Section 1006.1. This tenant could exist as either a stand-alone single-exit building or as a single-exit tenant space that exits into an interior corridor. Is it not just as safe to permit this tenant to exist as part of a larger building with the door exiting

directly to the exterior? See also the commentary to Tables 1006.3.2(1) and 1006.3.2(2).

While not specifically stated in this section, there is a situation where the single means of egress can be used from a multilevel tenant space. When the combined occupant load of the space and a mezzanine meets the occupant load in Table 1006.2.1 and the common path of travel distance measured from the most remote point down the exit access stairway and to the exterior exit doorway, the ground floor space and its mezzanine can be considered a space with one means of egress.

Item 3 allows for one exit from all stories in a parking garage where the cars are mechanically parked. This is in recognition of the extremely low occupant load in this unique type of building. The single exit would be for maintenance and service personnel who could be on the different levels. Exit access travel would still have to meet Table 1017.2. If this facility is an open parking garage, it could have one exit access stairway compliant with Sections 1017.2, Exception 1, and 1006.3.2, Exception 1.

Group R-3 is limited to no more than two dwelling units per building. Often these units are townhouse style with direct exits at grade or one unit on top of another. Residents in Group R-3 and R-4 congregate residences typically operate as a single-family home. The Fair Housing Act includes no discrimination based on familial status (i.e., family cannot be determined by blood or marriage). Many court cases have been filed under the Fair Housing Act (FHA) requiring that group homes be permitted to operate similar to a single-family home as a point of nondiscrimination. For additional information on the FHA, see the commentaries at the beginning of Chapter 11 and under IBC Section 1107. In either configuration, per Item 4, each unit is required to have only one exit leading from the building. In a multistory unit, any interior stairway would be considered an exit access stairway (Section 1019.3, Exception 2) and would be part of the exit access travel distance in Table 1017.2.

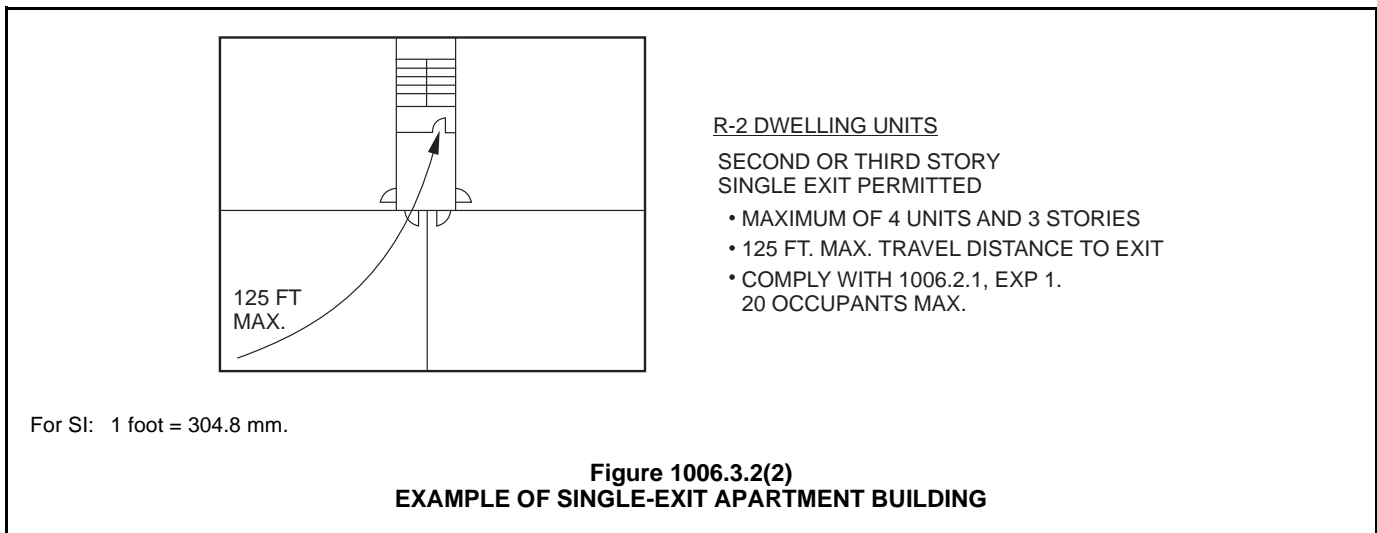
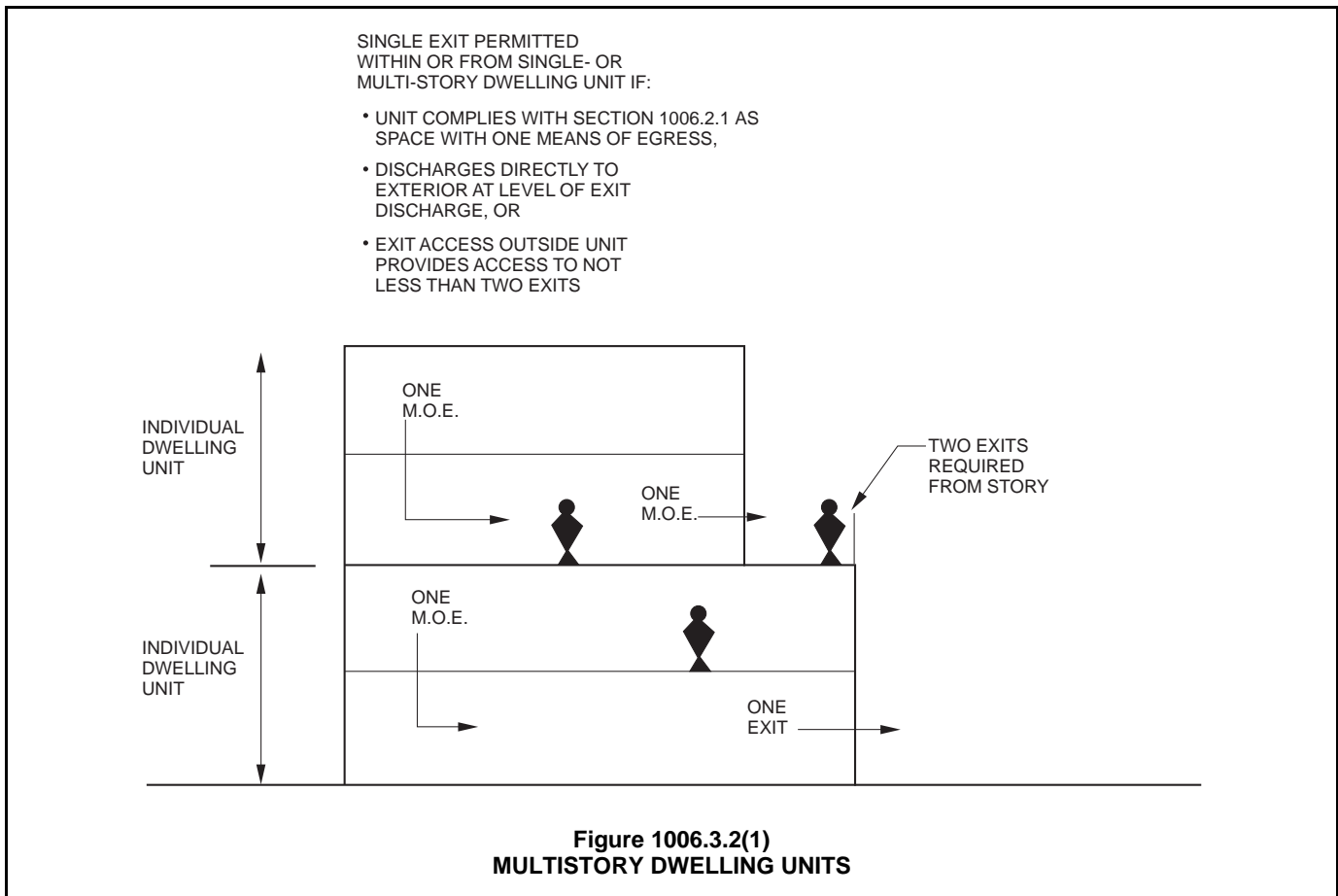
Item 5 is based on decades of practice within an individual dwelling. Item 4 addresses single exits for a Group R-3 building; one or two apartments could be provided in a mixed-use building and still be considered Group R-3. This exception could be used within the unit. Multistory apartments may also be provided within Group R-2 high-rise residential buildings.

In Group R-2, R-3 and R-4 facilities with multistory dwelling units, the means of egress from a dwelling or sleeping unit is typically permitted to be from one level only. In a Group R-2 apartment- or townhouse-style building, if the building is sprinklered with an NFPA 13 or 13R system and the common path of travel from the most remote point on any level to the exit door from the unit itself is 125 feet (22 860 mm) maximum (see Section 1006.2.1), that unit may have only one means of egress. Section 1006.2.1, Exception 1, provides for an occupant load of 20, rather than the 10 occupants allowed in Table 1006.3(2).

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Therefore, this could allow apartments of up to 4,000 square feet (185.81 m<sup>2</sup>). An exit access stairway would be permitted within the unit as part of the exit access travel distance (Section 1019.3, Exception 2). Once the occupants exit the unit itself, however, they must be outside at grade or the floor level must have access to two or more means of egress for all tenants, depending on the number required for the building as a whole [see Commentary Figures 1006.3.2(1)

and 1006.3.2(3)]. The common path of egress within the unit would be part of the overall exit access travel distance of 250 feet (45 720 mm) required in Table 1017.2). It is not the intent to allow this exception for apartment-style dwelling units in conjunction with the allowances for a single-exit building. The emergency escape and rescue opening addressed in Section 1029 does not count toward the required number of exits.



**TABLE 1006.3.2(1).** See below.

❖ Per Note b, this table addresses when single exits can be provided from stories in Group R-2 occupancies having dwelling units only, such as apartments and condominiums. For Group R-2 occupancies with sleeping units, such as dormitories, sororities, fraternities, convents, monasteries or boarding houses, see Table 1006.3.2(2). The second row is to clarify that buildings containing Group R-2 single-exit buildings cannot be four stories or taller. In addition to meeting the number of dwelling units per floor and exit access travel distance, these buildings must be equipped throughout with an NFPA 13 or 13R sprinkler system and an emergency escape and rescue opening must be provided in every bedroom (Note a). The exit access travel distance would be measured from the most remote point in the unit to the exit from the floor. This is different from the travel distance in Section 1006.2.1, Exception 1 where the travel distance is measured to the door of the unit. However, in order to be able to use the single-exit building provisions, each unit must also meet the single-exit space requirements, so the occupant load of each apartment is limited. See Commentary Figures 1006.3.2(2) and 1006.3.2(3) for examples of the differences. Formal committee interpretation 21-14 states that this table allows for groups of four units on a story to have access to a single exit. These units would have to be separated in accordance with IBC Section 420, but

would not have to be separated by fire barriers or fire walls.

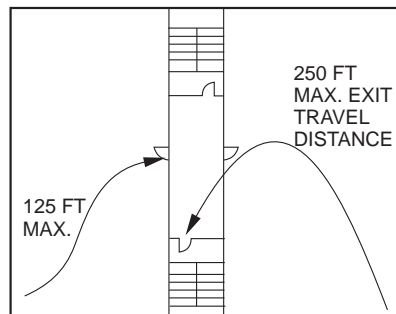
See the commentary to Table 1006.3.2(2) for additional discussion on single-exit building options.

This table is not intended to work in combination with Section 1006.3.2, Exception 5. That section requires a minimum of two exits from the floor.

**TABLE 1006.3.2(2).** See page 10-30.

❖ Buildings with one exit are permitted where the configuration and occupancy meet certain characteristics so as not to present an unacceptable fire risk to the occupants. Buildings that are relatively small in size have a shorter travel distance and fewer occupants; thus, having access to a single exit does not significantly compromise the safety of the occupants since they will also be alerted to and get away from the fire more quickly. It is important to note that the provisions in Section 1006.3.2 apply to individual stories. Multiple single-exit spaces or units may exist in the same building, including those cases where differing occupancies exist. Therefore, Tables 1006.3.2(1) and 1006.3.2(2) can address mixed occupancy buildings (see Section 1006.3.2.1).

Occupants of a story of limited size and configuration may have access to a single exit, provided that the building does not have more than one level below the first story above the grade plane. The limitation on the number of levels above and below the first story is intended to limit the vertical travel an occu-



SINGLE EXIT WITHIN AND FROM UNIT

- 250 FT. MAX. EXIT TRAVEL DISTANCE
- NO LIMIT ON NUMBER OF UNITS
- 125 FT. MAX. COMMON PATH OF TRAVEL (TO APARTMENT DOOR)
- 20 OCCUPANT MAX. PER UNIT PER SECTION 1006.3.2, ITEM 5

For SI: 1 foot = 304.8 mm.

**Figure 1006.3.2(3)**  
**EXAMPLE OF SINGLE-EXIT APARTMENT WITHIN A TWO-EXIT BUILDING**

**TABLE 1006.3.2(1)**  
**STORIES WITH ONE EXIT OR ACCESS TO ONE EXIT FOR R-2 OCCUPANCIES**

STORY	OCCUPANCY	MAXIMUM NUMBER OF DWELLING UNITS	MAXIMUM COMMON PATH OF EGRESS TRAVEL DISTANCE
Basement, first, second or third story above grade plane	R-2 <sup>a, b</sup>	4 dwelling units	125 feet
Fourth story above grade plane and higher	NP	NA	NA

For SI: 1 foot = 3048 mm.

NP = Not Permitted.

NA = Not Applicable.

a. Buildings classified as Group R-2 equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2 and provided with *emergency escape and rescue openings* in accordance with Section 1030.

b. This table is used for R-2 occupancies consisting of *dwelling units*. For R-2 occupancies consisting of *sleeping units*, use Table 1006.3.2(2).

**MEANS OF EGRESS**

pant must accomplish to reach the exit discharge in a single-exit building (see Section 1006.3.2.2).

Only one exit is required from a story where permitted by Table 1006.3.2(1) or 1006.3.2(2) regardless of the number of exits required from other stories in the building. For example, a Group B occupancy on the second floor of a two-story building is only required to have one exit from the story, provided its occupant load does not exceed 29 and the maximum exit access travel distance to the exit stairway does not exceed 75 feet (22 860 mm). The number of occupants and travel distances on the first floor do not affect the determination of the second story as a single-exit story. Other stories are also regulated independently as to number of exits. For mixed-occupancy floors or floors where tenant spaces have separate exits, see Section 1006.3.2.1.

Tables 1006.3.2(1) and 1006.3.2(2) list the characteristics a building must have to be of single-exit construction, including occupancy, maximum height of building above grade plane, maximum occupants or dwelling units per floor and exit access travel distance per floor. The occupant load of each floor is determined in accordance with the provisions of Section 1004.1. The exit access travel distance is measured along the natural and unobstructed path to the exit, as described in Section 1017.3. If the occupant load or common path of travel is exceeded, two exits are required from each floor in the building.

The enclosure required for the exit in a two- or three-story, single-exit building is identical to any other complying exit (e.g., interior stairs, exterior stairs, etc.). Similarly, the fire-resistance rating required for opening protectives is identical to that required by IBC Section 716. Exit access stairways could be used in two-story buildings, with or without basements, where permitted by Sections 1019.3 and 1006.3.1.

Per Note c, Group R-2 sleeping units, such as con-

gregate residences, fraternities, sororities, dormitories, convents or monasteries, use Table 1021.2(2). Table 1006.3.2(1) addresses dwelling units in Group R-2 occupancies. Effectively, this section allows for one-story congregate residences to have a single exit where there are 10 or fewer occupants on that first floor or basement. The travel distance from the most remote part of a unit to the exit must be less than 75 feet (22 860 mm). The maximum occupant load would limit the congregate residence to 2,000 square feet (185.81 m<sup>2</sup>) maximum per floor. Per Note a, the congregate residence must be sprinklered throughout with an NFPA 13 or 13R system and all bedrooms must have an emergency escape and rescue opening (Section 1029.1). Alternatively, a congregate residence could use Section 1006.3.2, Item 4. Emergency escape windows would be required, but a single exit for upper floors would be allowed as well as an NFPA 13D sprinkler system where permitted by Section 903.2.8.

Table 1006.3.2(2) allows for two-story business, factory, mercantile and storage facilities to have a single-exit stairway or exit access stairway (see Section 1019.3) from the second floor if the space meets the maximums of 29 occupants and a 75-foot (22 860 mm) travel distance. The increased travel distance in Note b is not permitted for the second floor. However, there is an increase for travel distance permitted for Group S-2 open parking garages in Note d.

Table 1006.3.2(2) allows for a variety of single-story buildings, with or without basements, which meet the maximum occupant load and exit access travel distance specified. Exit access stairways from the basement would be a viable option where permitted by Section 1019.3.

Again, these tables are based on per-story criteria. These tables would also allow for mixed occupancies, such as four apartments over a restaurant or a business over a day care, as long as occupant loads

**TABLE 1006.3.2(2)  
STORIES WITH ONE EXIT OR ACCESS TO ONE EXIT FOR OTHER OCCUPANCIES**

STORY	OCCUPANCY	MAXIMUM OCCUPANT LOAD PER STORY	MAXIMUM COMMON PATH OF EGRESS TRAVEL DISTANCE (feet)
First story above or below grade plane	A, B <sup>b</sup> , E F <sup>b</sup> , M, U	49	75
	H-2, H-3	3	25
	H-4, H-5, I, R-1, R-2 <sup>a,c</sup> , R-4	10	75
	S <sup>b,d</sup>	29	75
Second story above grade plane	B, F, M, S <sup>d</sup>	29	75
Third story above grade plane and higher	NP	NA	NA

For SI: 1 foot = 304.8 mm.

NP = Not Permitted.

NA = Not Applicable.

- a. Buildings classified as Group R-2 equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2 and provided with *emergency escape and rescue openings* in accordance with Section 1030.
- b. Group B, F and S occupancies in buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 shall have a maximum *exit access* travel distance of 100 feet.
- c. This table is used for R-2 occupancies consisting of *sleeping units*. For R-2 occupancies consisting of *dwelling units*, use Table 1006.3.2(1).
- d. The length of *exit access* travel distance in a Group S-2 *open parking garage* shall be not more than 100 feet.

and travel distances are met. Means of egress could be by a stairway through the floor below or a separate exterior stairway from the upper level. For additional information on a mixed-use floor, see Section 1006.3.2.1.

Formal code interpretation 21-14 states that this table allows for an exit configuration for multiple single-exit spaces for Groups B, M, F and S on the second floor where each group meets Table 1006.3.2(2).

**1006.3.2.1 Mixed occupancies.** Where one *exit*, or *exit access stairway* or *ramp* providing access to *exits* at other *stories*, is permitted to serve individual *stories*, mixed occupancies shall be permitted to be served by single *exits* provided each individual occupancy complies with the applicable requirements of Table 1006.3.2(1) or 1006.3.2(2) for that occupancy. Where applicable, cumulative *occupant loads* from adjacent occupancies shall be considered in accordance with the provisions of Section 1004.1. In each *story* of a mixed occupancy building, the maximum number of occupants served by a single *exit* shall be such that the sum of the ratios of the calculated number of occupants of the space divided by the allowable number of occupants indicated in Table 1006.3.2(2) for each occupancy does not exceed one. Where *dwelling units* are located on a story with other occupancies, the actual number of *dwelling units* divided by four plus the ratio from the other occupancy does not exceed one.

❖ Where multiple tenants or occupancies are located on a specific story, they are to be regulated by a “unity” formula if they want to use the same exit. If they have separate exits, they will be evaluated separately. This would allow for a second floor of a mixed-use occupancy to be evaluated similarly to Section 1016.2, which applies where multiple spaces combine. For example, the second story of a building houses two tenants, one business and one mercantile. Each tenant would be permitted a single, but separate, exit, provided each had an occupant load of less than 30 and a travel distance not exceeding 75 feet (22.860 m) (see Commentary Figure 1006.3.2, Option 2). However, if the tenants wanted to share the same single exit, the combined occupant load would have to be less than 30 (see Commentary Figure 1006.3.2.1, Option 3).

Where the mixed-use stories includes dwelling units, since four dwelling units are allowed per floor in a single-exit building, for the unity formula use 0.25 for one unit, 0.50 for two units and 0.75 for three units.

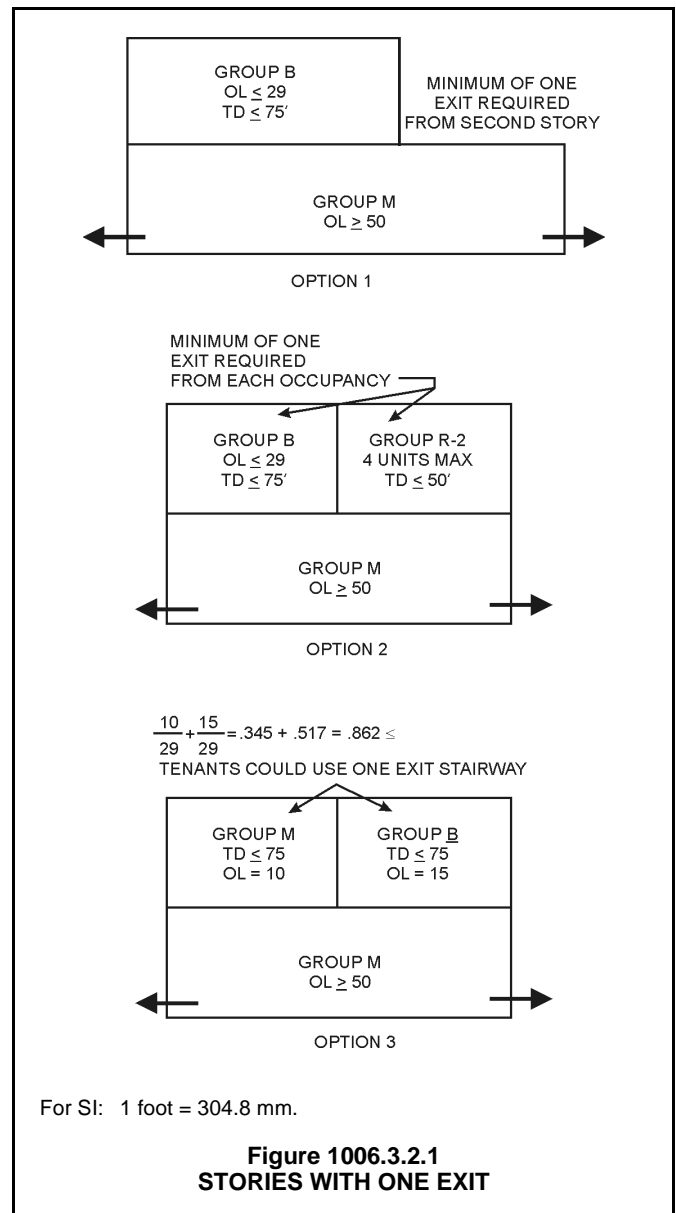
**SECTION 1007  
EXIT AND EXIT ACCESS  
DOORWAY CONFIGURATION**

**1007.1 General.** *Exits*, *exit access doorways*, and *exit access stairways* and *ramps* serving spaces, including individual building *stories*, shall be separated in accordance with the provisions of this section.

❖ The final exits, as well as the doors, stairways and ramps that get occupants to those exits (exit access

elements), need to be unobstructed and obvious at all times for occupants to evacuate the building safely in an emergency situation. This is consistent with the requirements in Section 1010.1 that exit or exit access doors are not to be concealed by curtains, drapes, decorations or mirrors. Whether the doors from the space are exit access doors leading to a hallway or actual exit doors leading to an exit enclosure or directly to the outside, they must be located in accordance with this section.

The need for exits from a space or story to be independent of each other cannot be overstated. Each occupant of each floor must be provided with the required number of exits without having to pass through one exit to gain access to another. Each exit is required to be independent of other exits to prohibit such areas from merging downstream and becoming, in effect, one exit.



The requirement for exits to be continuous is consistent with the exit termination requirements in Section 1023.3 and the exit discharge termination requirements in Section 1024.4. The intent is to provide safety in all portions of the exit by requiring continuity of the fire protection characteristics of the enclosure for the exit stairway or ramp. Exit passageways (see Section 1024) are a continuation of an exit enclosure. This would include, but not be limited to, the fire-resistance rating of the exit enclosure walls and the opening protection rating of the doors.

Section 1028.1, Exceptions 1 and 2, allows for an alternative for direct access to the outside via an intervening lobby or vestibule. Horizontal exits (see Section 1026), while not providing direct access to the outside of the structure, do move occupants to another “building” by moving through a fire wall (see Section 1026 and Section 1028.1, Exception 3) or into a refuge area protected by fire barriers and horizontal assemblies. Horizontal exits are commonly used in hospitals and jails for a defend-in-place type of protection.

**1007.1.1 Two exits or exit access doorways.** Where two exits, exit access doorways, exit access stairways or ramps, or any combination thereof, are required from any portion of the exit access, they shall be placed a distance apart equal to not less than one-half of the length of the maximum overall diagonal dimension of the building or area to be served measured in a straight line between them. Interlocking or scissor stairways shall be counted as one exit stairway.

**Exceptions:**

1. Where interior exit stairways or ramps are interconnected by a 1-hour fire-resistance-rated corridor conforming to the requirements of Section 1020, the required exit separation shall be measured along the shortest direct line of travel within the corridor.
  2. Where a building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2, the separation distance shall be not less than one-third of the length of the maximum overall diagonal dimension of the area served.
- ❖ This section provides a method to determine, quantitatively, remoteness between exits and exit access doors based on the dimensional characteristics of the space served. This measure has been common practice for some years with significant success. Very simply, the method involves determining the maximum dimension between any two points in a floor or a room (e.g., a diagonal between opposite corners in a rectangular room or building or the diameter in a circular room or building). If two doors or exits are required from the room or building (see Sections 1006.2 and 1006.3), the straight-line distance between the center of the thresholds of the doors must be at least one-half of the maximum dimension [see Commentary Figure 1007.1.1(1)].

While technical proof is not available to substantiate this method of determining remoteness, it has been found to be realistic and practical for most building designs. Buildings with exits in a center core and occupied spaces around the perimeter are addressed in Exception 1.

If a scissor stairway is utilized, regardless of the separation of the two entrances, the scissor stair may only be counted as one exit. Two independent stairways within the same enclosure could result in both stairways being usable in an emergency where smoke penetrates the single enclosure (see the definition for “Scissor stairways” in Chapter 2). Interlocking stairways that occur over the same building footprint but within separate enclosures are not “scissor stairways” and can count as two independent exits. Due to concern about smoke migration, careful review of the construction details and verification that they meet all the provisions for fire barriers and horizontal assemblies must be made. Of special concern would be the provisions for continuity, penetrations and joints.

The entrance to the enclosures for exit stairways or ramps shall meet the same arrangement as exit and exit access doorways. The need for exits to be independent of each other cannot be overstated.

In Exception 1, a method of permitting the distance between exits to be measured along a complying corridor connecting the enclosure for the exit stairway or ramp has served to mitigate the disruption to this design concept [see Commentary Figure 1007.1.1(2)].

As reflected in Exception 2, the protection provided by an automatic sprinkler system can reduce the threat of fire buildup so that the reduction in remoteness to one-third of the diagonal dimension is not unreasonable, based on the presumption that it provides the occupants with an acceptable level of safety from fire [see Commentary Figure 1007.1.1(3)]. The automatic sprinkler system must be installed throughout the building in accordance with NFPA 13 or 13R. This reduced separation (one-third diagonal) may also be used when applying the requirements of Exception 1.

In applying the provisions of this section, it is important to recognize any convergence of egress paths that may exist. Commentary Figure 1007.1.1(4) illustrates an assembly room with remotely located exit access doors, but the doors from the entire space are not considered remote in accordance with this section.

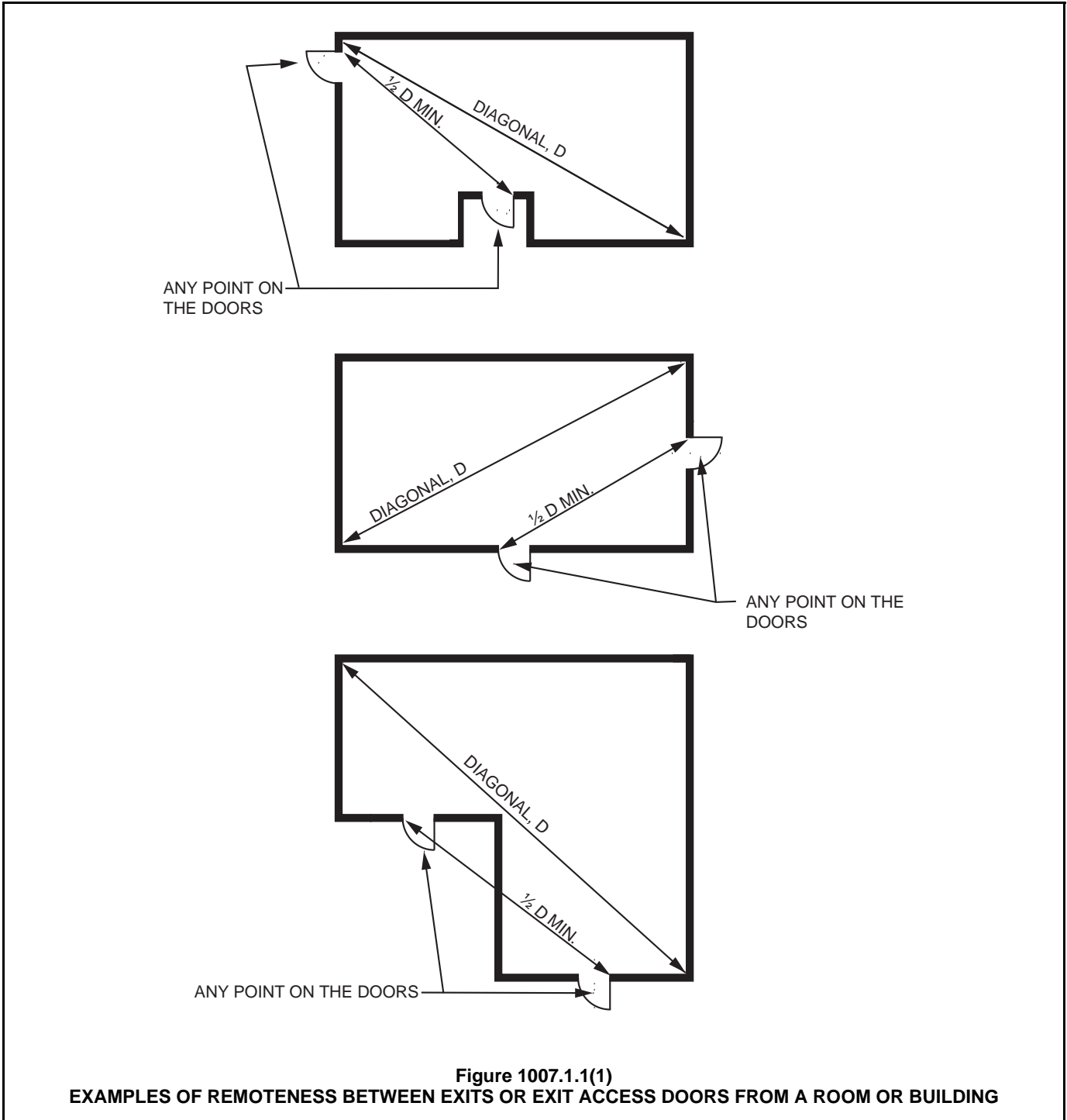
**1007.1.1.1 Measurement point.** The separation distance required in Section 1007.1.1 shall be measured in accordance with the following:

1. The separation distance to exit or exit access doorways shall be measured to any point along the width of the doorway.

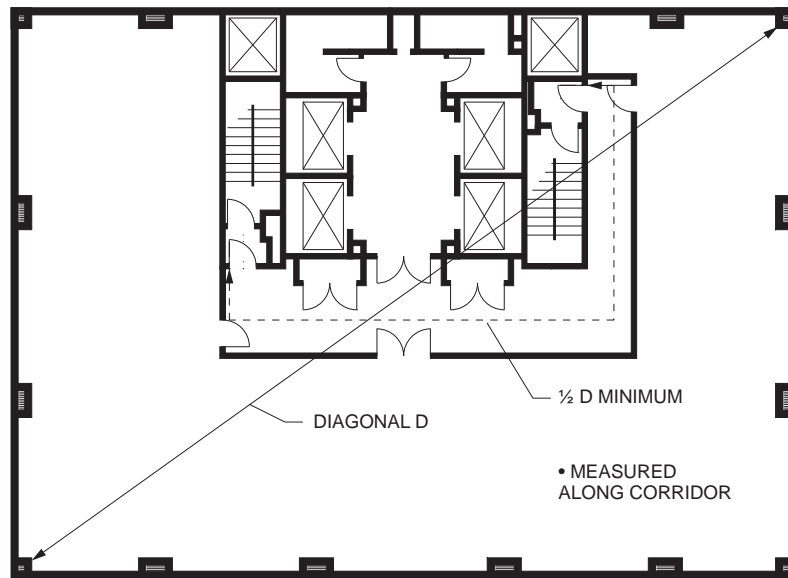
2. The separation distance to *exit access stairways* shall be measured to the closest riser.
3. The separation distance to *exit access ramps* shall be measured to the start of the ramp run.

❖ Where exit access stairways are permitted to be unenclosed, the remoteness measurement for doorways shall begin at the center of the top riser of the unenclosed stairways; this is consistent with the exit access travel distance measurement in Section

1017.3. When enclosure is provided, distances are measured to the door of the enclosure. Typically, travel distance is measured to the center of the door, ramp or stairway; however, there is an allowance for that point to be at any location along the door, stairway or ramp. The intent is to reduce subjectivity in the determination of exit/exit access configuration. The result is that a designer could literally measure to the far extreme edge of the two doorways leading out of a room to meet the separation requirements.



**Figure 1007.1.1(1)**  
**EXAMPLES OF REMOTENESS BETWEEN EXITS OR EXIT ACCESS DOORS FROM A ROOM OR BUILDING**



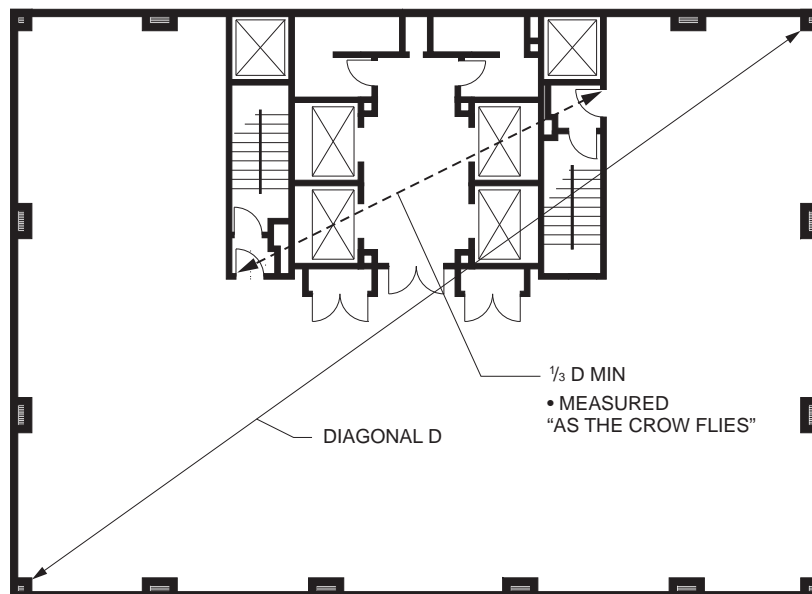
EXAMPLE:

DIAGONAL DIMENSION = 134'-0"

MIN. SEPARATION OF EXITS =  $134' \div 2 = 67'-0'$

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**Figure 1007.1.1(2)**  
**REMOVEDNESS OF INTERCONNECTING BY A 1-HOUR FIRE-RESISTANCE-RATED CORRIDOR**



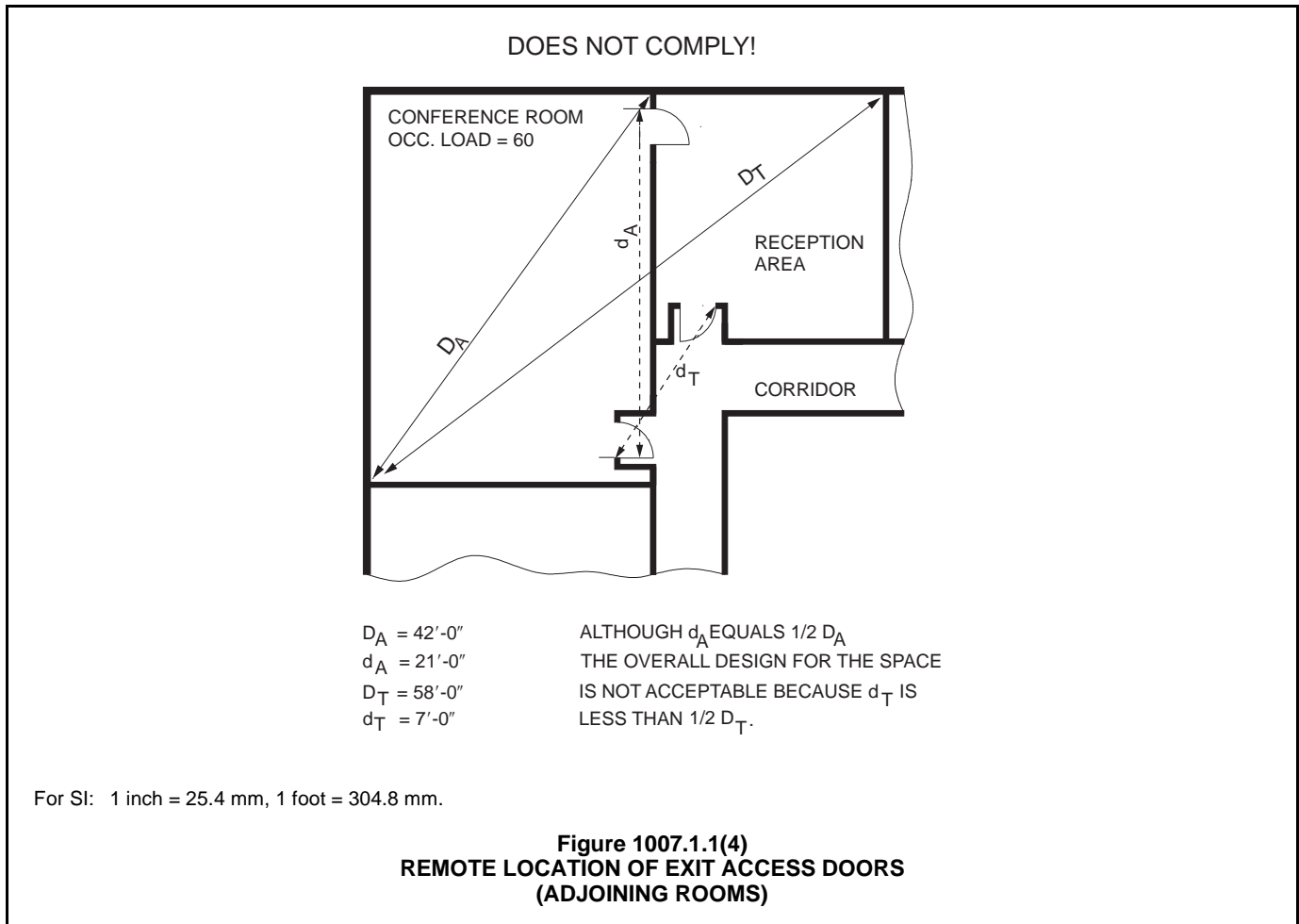
EXAMPLE:

DIAGONAL DIMENSION = 134'-0"

MIN. SEPARATION OF EXITS =  $134' \div 3 = 44'-8"$

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**Figure 1007.1.1(3)**  
**REMOVEDNESS OF EXITS IN A BUILDING WITH AN AUTOMATIC SPRINKLER SYSTEM**



### 1007.1.2 Three or more exits or exit access doorways.

Where access to three or more *exits* is required, not less than two *exit* or *exit access doorways* shall be arranged in accordance with the provisions of Section 1007.1.1. Additional required *exit* or *exit access doorways* shall be arranged a reasonable distance apart so that if one becomes blocked, the others will be available.

❖ When there are three or more required exits from a building or exit access doors from a room, they are to be analyzed identically to the method described in Section 1007.1.1. Two of the exits or exit access doors must meet the remoteness test. Any additional exits or doors can be located anywhere within the floor plan that meets the code requirements, including independence, accessibility, capacity and continuity.

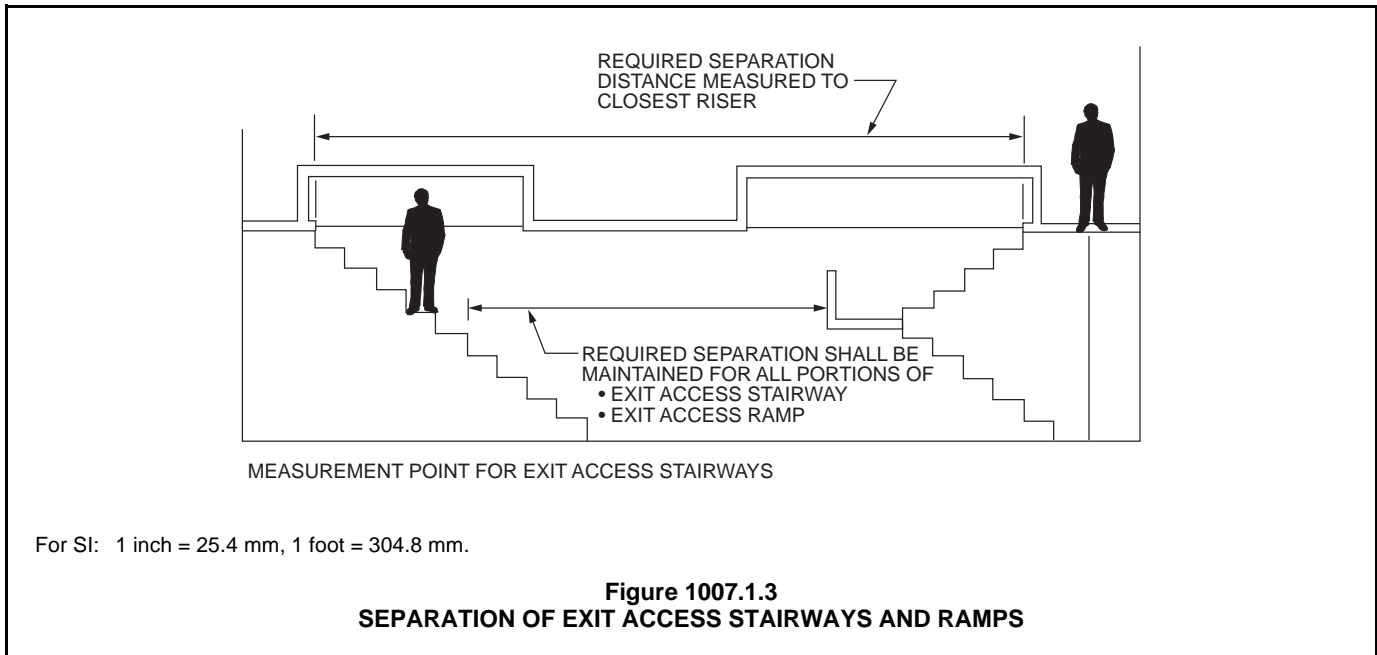
There is no specific separation requirement provided in Section 1007.1.2 for the third exit, but the exits must be located so that one fire event will not block two exits; thus, two doors immediately adjacent would not be acceptable. The appropriate separation is subjective and would be partially dependent on the layout of the space. Using some other provisions in the code for guidance can help. Section 1005.5 states that multiple means of egress need to be sized such that the loss of any one will not reduce the

capacity below 50 percent. This intent is repeated for an assembly space with more than 300 occupants. Sections 1029.2 and 1029.3 can require this space to have a main exit that accommodates one-half of the total occupant load and then require the balance of the exits (means of egress) to provide for the remaining one-half of the occupant load. The “main exit” is typically the result of a single “main entrance” for fee or ticket entry. If there is not a main exit, the exceptions to both Sections 1029.2 and 1029.3 require the means of egress to be “distributed around the perimeter of the building.”

### 1007.1.3 Remoteness of exit access stairways or ramps.

Where two *exit access stairways* or *ramps* provide the required *means of egress* to *exits* at another *story*, the required separation distance shall be maintained for all portions of such *exit access stairways* or *ramps*.

❖ The intent of these provisions are to prohibit open stairways and ramps that meet the separation distance at the first riser or start of the ramp run from converging toward one another such that the separation distance is reduced as the occupants follow the egress path to the lower level. Exit access stairways and ramps have to maintain the separation distance until the travel to the lower floor is complete (see Commentary Figure 1007.1.3).



**1007.1.3.1 Three or more exit access stairways or ramps.** Where more than two *exit access stairways* or *ramps* provide the required *means of egress*, not less than two shall be arranged in accordance with Section 1007.1.3.

❖ See the commentary to Section 1007.1.3, Remoteness of exit access stairways and ramps.

### SECTION 1008 MEANS OF EGRESS ILLUMINATION

**1008.1 Means of egress illumination.** Illumination shall be provided in the *means of egress* in accordance with Section 1008.2. Under emergency power, means of egress illumination shall comply with Section 1008.3.

❖ This section is split into two distinct requirements: Section 1008.2 for egress lighting during typical lighting situations and Section 1008.3 for egress lighting for emergencies when the building has lost normal power.

**1008.2 Illumination required.** The *means of egress* serving a room or space shall be illuminated at all times that the room or space is occupied.

**Exceptions:**

1. Occupancies in Group U.
2. *Aisle accessways* in Group A.
3. *Dwelling units* and *sleeping units* in Groups R-1, R-2 and R-3.
4. *Sleeping units* of Group I occupancies.

❖ All portions of the means of egress serving a space must be illuminated by artificial lighting when that space is occupied, so that the paths of exit travel are always visible and available for evacuation of the occupants during emergencies. The intent is to allow

portions of a building to have the lights turned off when that portion is unoccupied.

Three of the exceptions are for occupancies where the constant illumination of the means of egress would interfere with the use of space, such as sleeping areas or theater seating during a performance.

Bear in mind that means of egress lighting is not emergency lighting. For emergency lighting requirements, see Section 1008.3.

The high-rise provisions in IBC Section 403 utilize the means of egress lighting and emergency lighting in this section. High-rise buildings also require a secondary backup system of luminous egress path markings within enclosed exit stairways (Section 1025). Section 1025.5 requires the enclosed exit stairways to be illuminated for 60 minutes prior to the daily occupancy and during the entire time the building is occupied so that the self-luminous stripes can charge. In a building that is always occupied, such as a hospital or hotel, this would require at least some of the lights in the stairway to be on 24 hours per day.

**1008.2.1 Illumination level under normal power.** The *means of egress* illumination level shall be not less than 1 footcandle (11 lux) at the walking surface.

**Exception:** For auditoriums, theaters, concert or opera halls and similar assembly occupancies, the illumination at the walking surface is permitted to be reduced during performances by one of the following methods provided that the required illumination is automatically restored upon activation of a premises' fire alarm system:

1. Externally illuminated walking surfaces shall be permitted to be illuminated to not less than 0.2 footcandle (2.15 lux).
2. Steps, landings and the sides of ramps shall be permitted to be marked with self-luminous materials in

accordance with Sections 1025.2.1, 1025.2.2 and 1025.2.4 by systems listed in accordance with UL 1994.

- ❖ The intensity of lighting along the entire means of egress, including open plan spaces, aisles, corridors and passageways, exit stairways, exit doors and places of exit discharge at the walking surface or floor level must not be less than 1 footcandle (11 lux). One footcandle (11 lux) is approximately the same lighting level as found outdoors at twilight. It has been found that even this relatively low level of lighting renders enough visibility for occupants to evacuate a building safely.

It is important to note that this lighting level is measured at the floor in order to make the floor surface visible. Levels of illumination above the floor may be higher or lower, thus allowing lights along steps to be used rather than general area lighting.

The exception addresses assembly occupancies where low light level is needed for the function of the space. It is not the intent of the exception to require a fire alarm system but to require a connection to the egress lighting where a fire alarm system is provided. There are two options for that path lighting. Per Exception 1, the level of intensity of aisle lighting in such spaces may be reduced to 0.2 footcandle (2.15 lux), but only during the time of a performance. This intensity of illumination is sufficient to distinguish the aisles and stairs leading to the egress doors and not be a source of distraction during a performance. The option in Exception 2 allows for internally illuminated luminous path stripes (see Section 1025). Since the illumination in the space between shows and the duration of the shows may not be compatible with luminous path markings that charge from a light source, this option is currently not permitted.

**1008.2.2 Exit discharge.** In Group I-2 occupancies where two or more exits are required, on the exterior landings required by Section 1010.6.1, means of egress illumination levels for the exit discharge shall be provided such that failure of any single lighting unit shall not reduce the illumination level on that landing to less than 1 footcandle (11 lux).

- ❖ Section 1006.1, by requiring the means of egress to be illuminated, would include the exit discharge. Often, when moving to the outside of the building, the lighting from the parking lot or street lights will sufficiently light the exit discharge without additional lighting from the building itself. The transition moving from a lighted space to the outside may be an issue at the exit door, therefore, many facilities do provide a light over the exit door on the outside. For hospitals, the fixture provided must have at least two light bulbs, so that if one burns out, the other will still provide sufficient light for this transition.

This proposal was submitted by the Adhoc Health Care Committee, so it is limited to their scope of work. To reduce potential hazards at this important juncture, this could be considered best practice for other occupancies.

**1008.3 Emergency power for illumination.** The power supply for means of egress illumination shall normally be provided by the premises' electrical supply.

- ❖ The main routes for means of egress must be illuminated in times of emergency when the occupants must have a lighted path of exit travel in order to evacuate the building safely. The code is very specific in the description of the areas that are required to be illuminated by the emergency, not the standby power system (see Section 604.2.12).

**1008.3.1 General.** In the event of power supply failure in rooms and spaces that require two or more means of egress, an emergency electrical system shall automatically illuminate all of the following areas:

1. *Aisles.*
2. *Corridors.*
3. *Exit access stairways and ramps.*

- ❖ Where two means of egress are required from a room or space, emergency lighting must be provided along aisle corridors, exit access stairways and ramps. It is not the intent to require the entire space to be lit as during normal use situations addressed in Section 1008.2. However, the main egress paths out of the two exit spaces must be illuminated. This would always include the main corridor in a story with two exits required, and could include paths off that main corridor. For example, an aisle in an open office plan must be illuminated, but not the path within individual offices that egress through the open area. Exit access stairways from a mezzanine or from a second floor (as permitted by Section 1019.3) and the route from the bottom of the stairway to the exit must also be illuminated.

**1008.3.2 Buildings.** In the event of power supply failure in buildings that require two or more *means of egress*, an emergency electrical system shall automatically illuminate all of the following areas:

1. *Interior exit access stairways and ramps.*
2. *Interior and exterior exit stairways and ramps.*
3. *Exit passageways.*
4. Vestibules and areas on the level of discharge used for *exit discharge* in accordance with Section 1028.1.
5. Exterior landings as required by Section 1010.1.6 for *exit doorways* that lead directly to the *exit discharge*.

- ❖ Where two or more exits are required from a story, essential portions of the interior egress system must be illuminated. This includes:

- Exit access stairways from a second floor (as permitted by Section 1019.3) as well as the route from the bottom of the stairway to the exit (see Section 1008.3.1).
- All exit stairways and ramps along their entire length.

## MEANS OF EGRESS

- Exit passageways used in facilities with long travel distances, such as malls, or as an extension of the exit stairway enclosure.
- Means of egress systems that use exit balconies (see Section 1021) or open exterior exit stairways or ramps (see Section 1028).
- Interior exit discharge elements, such as lobbies and vestibules (see Section 1028.1), where stairways discharge into these elements instead of directly to the exterior of a building.
- Exterior portions of the exit discharge. Note that only the portion of the exterior discharge that is immediately adjacent to the building exit discharge door is required to have emergency illumination and not the entire exterior discharge path to the public way.

**1008.3.3 Rooms and spaces.** In the event of power supply failure, an emergency electrical system shall automatically illuminate all of the following areas:

1. Electrical equipment rooms.
  2. Fire command centers.
  3. Fire pump rooms.
  4. Generator rooms.
  5. Public restrooms with an area greater than 300 square feet (27.87 m<sup>2</sup>).
- ❖ The intent of Items 1 through 4 is to have emergency lighting in areas significant for emergency responders or maintenance personnel who may be trying to locate and fix the loss of power issue for the building. Item 5 requires an emergency light in large restrooms. Given the activity, people may need some illumination to quickly get themselves ready to be able to evacuate.

**1008.3.4 Duration.** The emergency power system shall provide power for a duration of not less than 90 minutes and shall consist of storage batteries, unit equipment or an on-site generator. The installation of the emergency power system shall be in accordance with Section 2702.

- ❖ So that there will be a continuing source of electrical energy for maintaining the illumination of the means of egress when there is a loss of the main power supply, the means of egress lighting system must be connected to an emergency electrical system that consists of storage batteries, unit equipment or an on-site generator. This emergency power-generating facility must be capable of supplying electricity for at least 90 minutes, thereby giving the occupants sufficient time to leave the premises. In most cases, where the loss of the main electrical supply is attributed to a malfunction in the distribution system of the electric power company, experience has shown that such power outages do not usually last as long as 90 minutes.

The IFC requirements for emergency power for emergency egress lighting and exit signage in existing buildings only require a 60-minute time duration.

This is not a conflict, but rather recognition of the loss of battery storage capability over a length of time.

**1008.3.5 Illumination level under emergency power.** Emergency lighting facilities shall be arranged to provide initial illumination that is not less than an average of 1 footcandle (11 lux) and a minimum at any point of 0.1 footcandle (1 lux) measured along the path of egress at floor level. Illumination levels shall be permitted to decline to 0.6 footcandle (6 lux) average and a minimum at any point of 0.06 footcandle (0.6 lux) at the end of the emergency lighting time duration. A maximum-to-minimum illumination uniformity ratio of 40 to 1 shall not be exceeded. In Group I-2 occupancies, failure of any single lighting unit shall not reduce the illumination level to less than 0.2 footcandle (2.2 lux).

- ❖ This section provides the criteria of the illumination levels of the emergency lighting system. The initial average level for the main egress paths is the same as for the overall means of egress illumination in Section 1008.2.1. The reduction of illumination recognizes the performance characteristics over time of some types of power supplies, such as batteries. The minimum levels are sufficient for the occupants to egress from the building. In addition, the emergency lighting system is a secondary system that is spaced along the main egress routes. It will not provide the same level of general lighting over the route as what can be provided by the building lighting system.

The maximum illumination uniformity ratio of 40 means that the variation in the illumination levels is not to exceed that number. For example, a minimum of 0.06 footcandle (0.6 lux) would establish a maximum illumination of 2.4 footcandles (24 lux) in an adjacent area. This is to establish a variation limit such that the means of egress can be seen as a person walks from bright to darker areas along the egress path.

Group I-2 nursing homes and hospitals typically use a defend-in-place strategy for patients and residents who require assistance from a staff trained in the fire and safety evacuation plans. Given the possible critical nature of some of the patients and the need to move some people with life-sustaining equipment, there is an additional requirement that the lighting in the main corridors and along the exit path will always have some redundancy in the fixtures providing that illumination. This could be done with either two bulb fixtures, or locating emergency lighting fixtures close enough that if one burned out, light from fixtures on each side would overlap enough to not result in a dark spot.

## SECTION 1009 ACCESSIBLE MEANS OF EGRESS

**1009.1 Accessible means of egress required.** Accessible means of egress shall comply with this section. Accessible spaces shall be provided with not less than one accessible means of egress. Where more than one means of egress are required by Section 1006.2 or 1006.3 from any accessible

space, each *accessible* portion of the space shall be served by not less than two accessible *means of egress*.

**Exceptions:**

1. Accessible *means of egress* are not required to be provided in existing buildings.
  2. One accessible *means of egress* is required from an *accessible mezzanine* level in accordance with Section 1009.3, 1009.4 or 1009.5.
  3. In assembly areas with ramped *aisles* or stepped *aisles*, one accessible *means of egress* is permitted where the *common path of egress travel* is *accessible* and meets the requirements in Section 1029.8.
- ❖ The Access Board has revised and updated its accessibility guidelines for buildings and facilities covered by the Americans with Disabilities Act of 1990 (ADA) and the Architectural Barriers Act of 1968 (ABA). The final ADA/ABA Guidelines, published by the Access Board in July 2004, serve as the basis for the minimum standards when adopted by other federal agencies responsible for issuing enforceable standards. The plan is to eventually use this new document in place of the Uniform Federal Accessibility Standard (UFAS) and ADAAG. The U.S. Department of Justice officially adopted the new federal requirements on September 15, 2010. The new name is the *2010 Standard for Accessible Design*, otherwise known as the 2010 ADA Standard. The 2010 ADA Standard, Section 207/F207, references the 2000 edition of the IBC with 2001 Supplement, as well as the 2003 edition of the IBC, for accessible means of egress requirements. The International Code Council® (ICC®) is very proud to be recognized for its work regarding accessible means of egress in this manner. Refer to the Access Board website ([www.access-board.gov](http://www.access-board.gov)) for more specific information and the current status of this adoption process. Based on the date of the publication and the adoption process, later editions of the IBC are not specifically referenced; however, none of the later editions reduced the accessible means of egress requirements found in the referenced IBC editions, so they should be able to be considered as providing equivalent or better accessibility.

The accessible means of egress locations may not be near the accessible route used for ingress into the building (see Sections 1104 and 1105). For example, a two-story building requires one accessible route to connect all accessible spaces within the building. The accessible route to the second level is typically by an elevator. During a fire emergency, persons with mobility impairments on the second level should move to the exit stairways for assisted rescue, not back the way they came in via the elevator. Signage at the elevator will direct occupants to an exit stairway.

This section establishes the minimum requirements for means of egress facilities serving all spaces that are required to be accessible to people

with physical disabilities. Previously, attention had been focused on response to the civil-rights-based issue of providing adequate access for people with physical disabilities into and throughout buildings. Concerns about life safety and evacuation of people with mobility impairments were frequently cited as reasons for not embracing widespread building accessibility, in the best interests of the disabled community.

The provisions for accessible means of egress are predominantly, though not exclusively, intended to address the safety of persons with a mobility impairment. These requirements reflect the balanced philosophy that accessible means of egress are to be provided for occupants who have gained access into the building but are incapable of independently utilizing the typical means of egress facilities, such as the exit stairways. By making such provisions, the code now addresses means of egress for all building occupants, with and without physical disabilities.

Any space that is not required by the code to be accessible in accordance with Chapter 11 is not required to be provided with accessible means of egress. This may include an entire story, a portion of a story, a mezzanine or an individual room. For example, a mechanical penthouse is not required to be accessible in accordance with Section 1103.2.9; therefore, the mechanical penthouse is not required to have an accessible means of egress.

In new construction and additions, at least two accessible means of egress are required. For example, in buildings, stories or spaces required by Section 1006.3.1 to have three or more exits or exit access doors, a minimum of two accessible means of egress is required. The accessibility requirements are based on the required means of egress from both individual spaces and the building as a whole. Therefore, facilities with multiple large assembly rooms, such as banquet halls or multiplex theaters where the second exit from the space is often a door directly to the outside, may require additional accessible means of egress from the building because of space requirements.

While there are no dispersment requirements specific to accessible means of egress or travel distance limitations where there is no area of refuge requirement (see Sections 1009.3, 1009.4 and 1009.6), the code requires all exits to be distinct, separated and independent. The main intent is that a person with mobility impairments will always have options. If not all exits are accessible, possible entrapment should be a consideration in determining which exits are to be made accessible. In most buildings, the upper floors will already have an accessible route to all stairways. On the first floor, if the issue is accessible exit discharge, see Section 1009.7.

An accessible means of egress is required to provide a continuous path of travel to a public way. This principle is consistent with the general requirements for all means of egress, as reflected in Section

1003.1 and in the definition of “Means of egress” in Chapter 2. This section also emphasizes the intent that accessible means of egress must be available to a person with a mobility impairment, such as a person using a wheelchair, scooter or walker. Some mobility impairments do not allow for self-evacuation along a stairway; therefore, utilization of the exit and exit discharge may require assistance. The safety and fire evacuation plans (see Sections 404 and 1001.4) require planning for all occupants of a building. This assistance is typically with the fire department or other trained personnel, either along the exit stairways or in buildings five stories or taller, with the elevator system or a combination of both (see commentary, Section 1009.2.1). It is required that accessible routes, areas of refuge and exterior areas of rescue assistance are indicated on these plans. These plans must be approved by the local fire official and reviewed annually.

The exceptions address special situations where accessible means of egress requirements need special consideration. Note that these are exceptions for accessible means of egress; not exceptions for accessible entrance requirements (see IBC Section 1105).

Exception 1 indicates that existing buildings undergoing alterations are not required to be provided with accessible means of egress as part of that alteration. In many cases, meeting the requirements for accessible means of egress, especially the 48-inch (1219 mm) clear stair width required in nonsprinklered buildings, would be considered technically infeasible. However, if an accessible means of egress was part of the original construction, it must be maintained in accordance with IEBC Section 410.2 or 705.1.

Exception 2 is a special consideration for mezzanines. The size of mezzanines is limited to a portion of the space below (see IBC Section 505). Most are open to the space below; thus, with the same atmosphere and line of sight, fire recognition is quicker than in a two-story situation. If the elevator used for ingress has not gone into fire department recall, that system could be used for self-evacuation. There are three different scenarios:

1. If the mezzanine is exempted from accessibility, such as a mechanical mezzanine (see Section 1103.2.9), or small enough not to be required to be accessed by an accessible route (see Section 1104.4, Exception 1), no accessible means of egress is required.
2. If a mezzanine is required to be accessible (see IBC Section 1104.4) and meets the provisions for spaces with one means of egress (see Section 1006.2), the exit access stairway must meet the provisions of Section 1009.3. Per Section 1009.3, Exception 1, this can be an open exit access stairway. Per Exception 4, in a nonsprinklered building, a designer would have the option of either an area of refuge or two-way communication at the elevator. Per Exception 5, in sprinklered buildings, the area of refuge would not be required.
3. If a mezzanine is required to be accessible (see IBC Section 1104.4) and is required to have two means of egress, at least one of the means of egress stairways must meet the provisions of Section 1009.3. Per Section 1009.3, Exception 1, this can be an open exit access stairway. Per Exception 4, in a nonsprinklered building, a designer would have the option of either an area of refuge or two-way communication at the elevator. Per Exception 5, in sprinklered buildings, the area of refuge would not be required. Practically speaking, in a sprinklered building, both stairways from the mezzanine will meet Section 1009.3.

While under Scenarios 2 and 3 it is optional to have the elevator meet the requirements of Section 1009.4, the provisions for standby power at elevators are based on fire department assisted rescue. This is an expensive option that would likely never be used during a fire event. Where platform lifts can be used in new construction (see IBC Section 1109.8), they are so limited that it is not likely that they will provide the accessible route to a mezzanine. If the platform lift serves as part of the route to the space, Section 1009.5 allows for platform lifts to serve as part of the accessible route for accessible means of egress when they have standby power.

Exception 3 is in consideration of the practical difficulties of providing accessible routes in assembly areas with sloped floors and stepped aisles. Rooms with more than 50 persons are required to have two means of egress; therefore, each accessible seating location is required to have access to two accessible means of egress. Depending on the slope of the seating arrangement, providing an accessible route to both distinct exits can be difficult to achieve, especially in small theaters. A maximum travel distance of 30 feet (9144 mm) for ambulatory persons moving from the last seat in dead-end aisles or from box-type seating arrangements to where they have access to a choice of means of egress routes has been established in Section 1029.8. In accordance with Exception 3, persons using wheelchair seating spaces have the same maximum 30-foot (9144 mm) travel distance from the accessible seating locations to a cross aisle or out of the room to an adjacent corridor or space where two choices for accessible means of egress are provided. Note that there are increases in travel distance for smoke-protected seating and small spaces, such as boxes, galleries or balconies. For additional information, see Section 1029.8.

**1009.2 Continuity and components.** Each required accessible *means of egress* shall be continuous to a *public way* and shall consist of one or more of the following components:

1. *Accessible routes* complying with Section 1104.

2. *Interior exit stairways* complying with Sections 1009.3 and 1023.
3. *Exit access stairways* complying with Sections 1009.3 and 1019.3 or 1019.4.
4. *Exterior exit stairways* complying with Sections 1009.3 and 1027 and serving levels other than the *level of exit discharge*.
5. Elevators complying with Section 1009.4.
6. Platform lifts complying with Section 1009.5.
7. *Horizontal exits* complying with Section 1026.
8. *Ramps* complying with Section 1012.
9. *Areas of refuge* complying with Section 1009.6.
10. Exterior areas for assisted rescue complying with Section 1009.7 serving exits at the *level of exit discharge*.

❖ This section identifies the various building features that can serve as elements of an accessible means of egress. Accessible routes are readily recognizable as to how they can provide accessible means of egress; however, some nontraditional principles have been established for the total concept of accessible means of egress. This is evident in that stairways and elevators are also identified as elements that can be part of an accessible means of egress. For example, elevators are generally not available for egress during a fire, while stairways are not independently usable by a person using a wheelchair. The concept of accessible means of egress includes the idea that evacuating people with a mobility impairment may require the assistance of others. In some situations, provisions are also included for creating an area of refuge or exterior areas of rescue assistance wherein people can safely await either further instructions or evacuation assistance. Larger refuge areas can also be established by utilizing horizontal exits. All of these elements can be arranged in the manner prescribed in this section to provide accessible means of egress.

It is important to note that the subjects of Item 10, exterior areas for assisted rescue, are intended to be used only at the level of exit discharge (see commentary in Chapter 2 for the defined term, "Level of exit discharge"). Exterior exit stairways that are from other floors are addressed by Item 4.

**1009.2.1 Elevators required.** In buildings where a required *accessible* floor is four or more *stories* above or below a *level of exit discharge*, not less than one required *accessible means of egress* shall be an elevator complying with Section 1009.4.

**Exceptions:**

1. In buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, the elevator shall not be required on floors provided with a *horizontal exit* and located at or above the *levels of exit discharge*.
2. In buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, the elevator shall not be

required on floors provided with a *ramp* conforming to the provisions of Section 1012.

❖ Elevators are the most common and convenient means of providing access to the upper floors in multistory buildings. As such, elevators represent a prime candidate for accessible means of egress from such buildings, especially in light of the difficulties involved in carrying a person up or down a stairway for multiple levels. The primary consideration for elevators as an accessible means of egress is that the elevator will be available and protected during a fire event to allow for fire department assisted rescue. Typically it is not the intent that people use the elevator for self-evacuation due to the hazards associated with smoke in the elevator shaft or the elevator taking people to the floor with a direct fire hazard. There are some new technological advances for "fire service access elevators" and "occupant evacuation elevators" that are discussed in Sections 403, 3007 and 3008.

This section addresses where an elevator must serve as part of an accessible means of egress. See IBC Section 1104 for when elevators are required for the accessible route into a building. By a reference to Section 1009.4, both an area of refuge and a standby source of power for the elevator are required. The standby power requirement establishes a higher degree of reliability that the elevator will be available and usable by reducing the likelihood of power loss caused by fire or other conditions of power failure.

The code defines "Exit Discharge, Level of" as the story at which an exit terminates. In buildings having four or more stories above or below the level of exit discharge, it is unreasonable to rely solely on exit stairways for all of the required accessible means of egress. This is the point at which complete reliance on assisted evacuation down the stairs will not be effective or adequate because of the limited availability of either experienced personnel who are trained to carry people safely (e.g., fire fighters) or the availability of special devices (i.e., self-braking stairway descent equipment or evacuation chairs). In this case, the code requires that at least one elevator, serving all floors of the building, is to serve as one of the required accessible means of egress. This should not represent a hardship, since elevators are typically provided in such buildings for the convenience of the occupants.

On a flat site, "buildings with four or more stories above the level of exit discharge" would typically be a five-story building. The level of exit discharge is the entire first story level (not merely the plane or level of the first floor); therefore, the fifth floor is the fourth story above the level of exit discharge. In a building with multiple basements, a story four stories below the level of exit discharge would be the fourth basement level. The actual vertical distance is the same from the fifth floor above grade down to discharge, as it is from the fourth floor below grade up to discharge. The verbiage is such that a building built on a sloped site

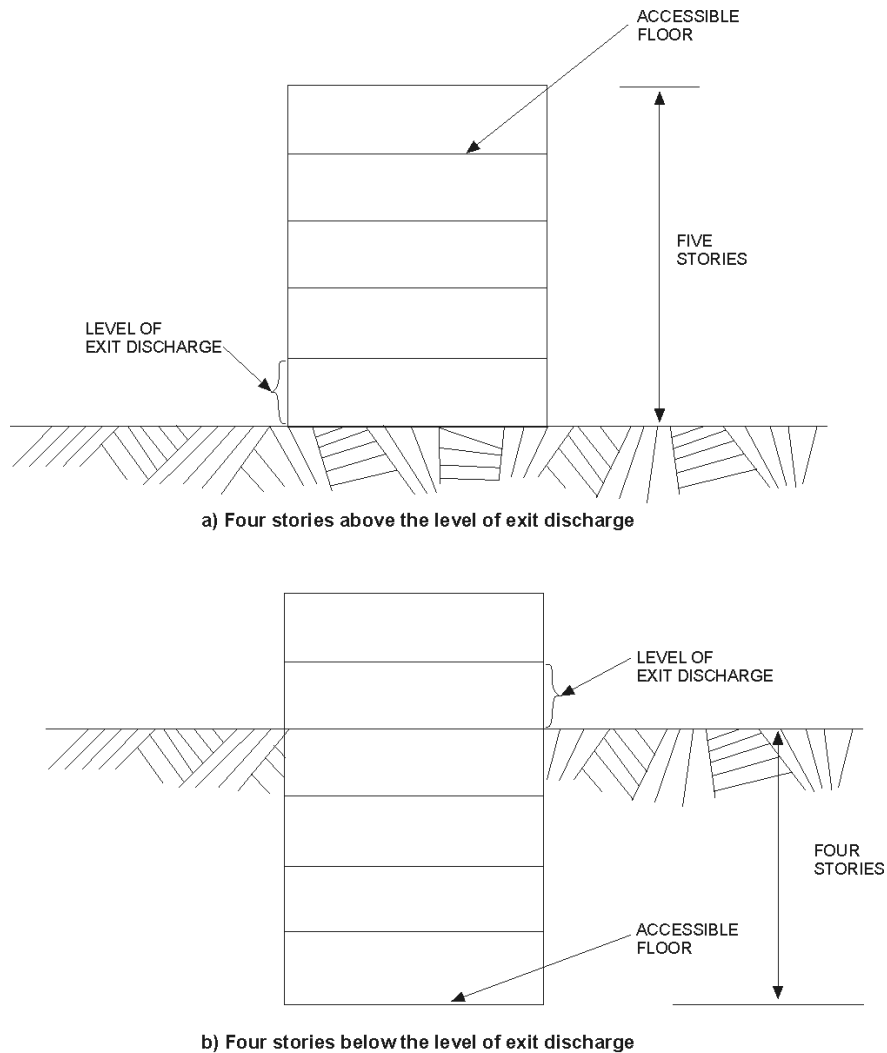
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can take into consideration that people may be exiting the building from different levels on different sides of the building (see Commentary Figure 1009.2.1).

Exception 1 establishes that accessible egress elevator service to floor levels at or above the level of exit discharge is not necessary under specified conditions. The conditions are that the building is equipped throughout with an automatic sprinkler system in accordance with NFPA 13 or NFPA 13R (see Section 903.3.1.1 or 903.3.1.2) and that floors not serviced by an accessible egress elevator are provided with a horizontal exit. The presence of an automatic sprinkler system significantly reduces the potential fire hazard and provides for increased evacuation time. The combination of automatic sprinklers and a horizontal exit provides adequate protection for the occupants despite their distance to the level of exit discharge. This exception does not apply to floor levels below the level of exit discharge, since such lev-

els are typically below grade and do not have the added advantage of exterior openings that are available for fire-fighting or rescue purposes. This option is most often utilized when a defend-in-place approach to occupant protection is utilized, such as in a hospital, nursing home or jail. Keep in mind that the horizontal exit (see Section 1026) creates large refuge areas that have separation requirements and capacity requirements that exceed area of refuge requirements.

Exception 2 specifies that a building sprinklered throughout in accordance with NFPA 13 or NFPA 13R (see Section 903.3.1.1 or 903.3.1.2), with ramp access to each level, such as in a sports stadium, is not required to also have an elevator for accessible means of egress. The reasoning behind this is that the issue of carrying people down stairways does not occur because the ramps may be utilized instead.



**Figure 1009.2.1**  
**ELEVATOR REQUIRED FOR ACCESSIBLE MEANS OF EGRESS**

**1009.3 Stairways.** In order to be considered part of an accessible *means of egress*, a *stairway* between *stories* shall have a clear width of 48 inches (1219 mm) minimum between *handrails* and shall either incorporate an *area of refuge* within an enlarged floor-level landing or shall be accessed from an *area of refuge* complying with Section 1009.6. *Exit access stairways* that connect levels in the same *story* are not permitted as part of an accessible *means of egress*.

**Exceptions:**

1. *Exit access stairways* providing *means of egress* from *mezzanines* are permitted as part of an accessible *means of egress*.
  2. The clear width of 48 inches (1219 mm) between *handrails* is not required in buildings equipped throughout with an *automatic sprinkler* system installed in accordance with Section 903.3.1.1 or 903.3.1.2.
  3. The clear width of 48 inches (1219 mm) between *handrails* is not required for *stairways* accessed from a refuge area in conjunction with a *horizontal exit*.
  4. *Areas of refuge* are not required at *exit access stairways* where two-way communication is provided at the elevator landing in accordance with Section 1009.8.
  5. *Areas of refuge* are not required at *stairways* in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.
  6. *Areas of refuge* are not required at *stairways* serving *open parking garages*.
  7. *Areas of refuge* are not required for *smoke-protected assembly seating* areas complying with Section 1029.6.2.
  8. *Areas of refuge* are not required at *stairways* in Group R-2 occupancies.
  9. *Areas of refuge* are not required for *stairways* accessed from a refuge area in conjunction with a *horizontal exit*.
- ❖ This section addresses stairways between floor levels or to a mezzanine level (see Exception 1). The last sentence indicates that steps that connect raised or lowered areas on the same level are not permitted to be part of an accessible means of egress. People with mobility impairments cannot be asked to wait at the top of steps that may be anywhere in the building; they must be able to get to the stairways where the fire department will be coming into the building.

Stairways (exit or exit access) between floor levels, while not part of an accessible route, can serve as part of the accessible means of egress when they are used as part of an assisted evacuation route. The starting point for these requirements is that the stairways must be 48 inches (1219 mm) clear width between handrails; and either include or be accessed directly by a location where people can wait for

assisted evacuation. This place to wait can be either an “area of refuge” (see Section 1009.6) or a “refuge area” created by a horizontal exit (see Exception 9 and Section 1026).

There are many mobility impairments that can limit or negate a person’s ability to walk up and down the stairs. The taller the building, the higher the percentage of the population that will be affected. For example, an elderly person or a person with a broken foot may be able to get down a couple of flights, but not from an upper floor in a high-rise.

Note that this section is for exit stairways as addressed in Sections 1023 and 1027 and exit access stairways as addressed in Section 1019. Therefore, exit access stairways between stories can be considered part of an accessible means of egress, but exit access steps within the same level, such as steps in a corridor or room leading to an exit or exit access doorway, cannot. Stairways that lead from the level of exit discharge (see the commentary to Chapter 2 for the defined term, “Exit discharge, level of”) to grade are considered part of the exit discharge. When the exit discharge is not accessible, the options are an interior area of refuge complying with Section 1009.6 or an exterior area of assisted rescue in accordance with Section 1009.7. Do not use the provisions in this section.

The dimension of 48 inches (1219 mm) clear width between handrails is sufficient to enable two or three persons to carry a person up or down to the level of exit discharge where access to a public way is afforded.

The enclosed exit stairway, in combination with an area of refuge, can provide for safety from fire in one of two ways. One approach is for the fire-resistance-rated stairway enclosure to afford the necessary safety. To accomplish this, the landing within the stairway enclosure must be able to contain the wheelchair. The concept is that the person in the wheelchair will remain on the stairway landing for a period of time awaiting further instructions or evacuation assistance; therefore, the stairway landing must be able to accommodate the wheelchair without obstructing the use of the stairway by other egressing occupants. An enlarged, story-level landing is required within the stairway enclosure and must be of sufficient size to accommodate the number of wheelchairs [see Section 1009.6 and Commentary Figure 1009.3(1)].

The other approach is to utilize an enclosed exit stairway that is accessed from an area of refuge complying with Section 1009.6. Under this approach, the stairway is made safe by virtue of its access being in an area that is separated and protected from the point of fire origin. An area of refuge can be created by constructing a vestibule adjacent and with direct access to the stair enclosure [see Section 1009.6 and Commentary Figure 1009.3(2)]. This is similar in theory to the approach of an enlarged landing within the stairway enclosure. Again, the general means of

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egress path must be available past the wheelchair spaces.

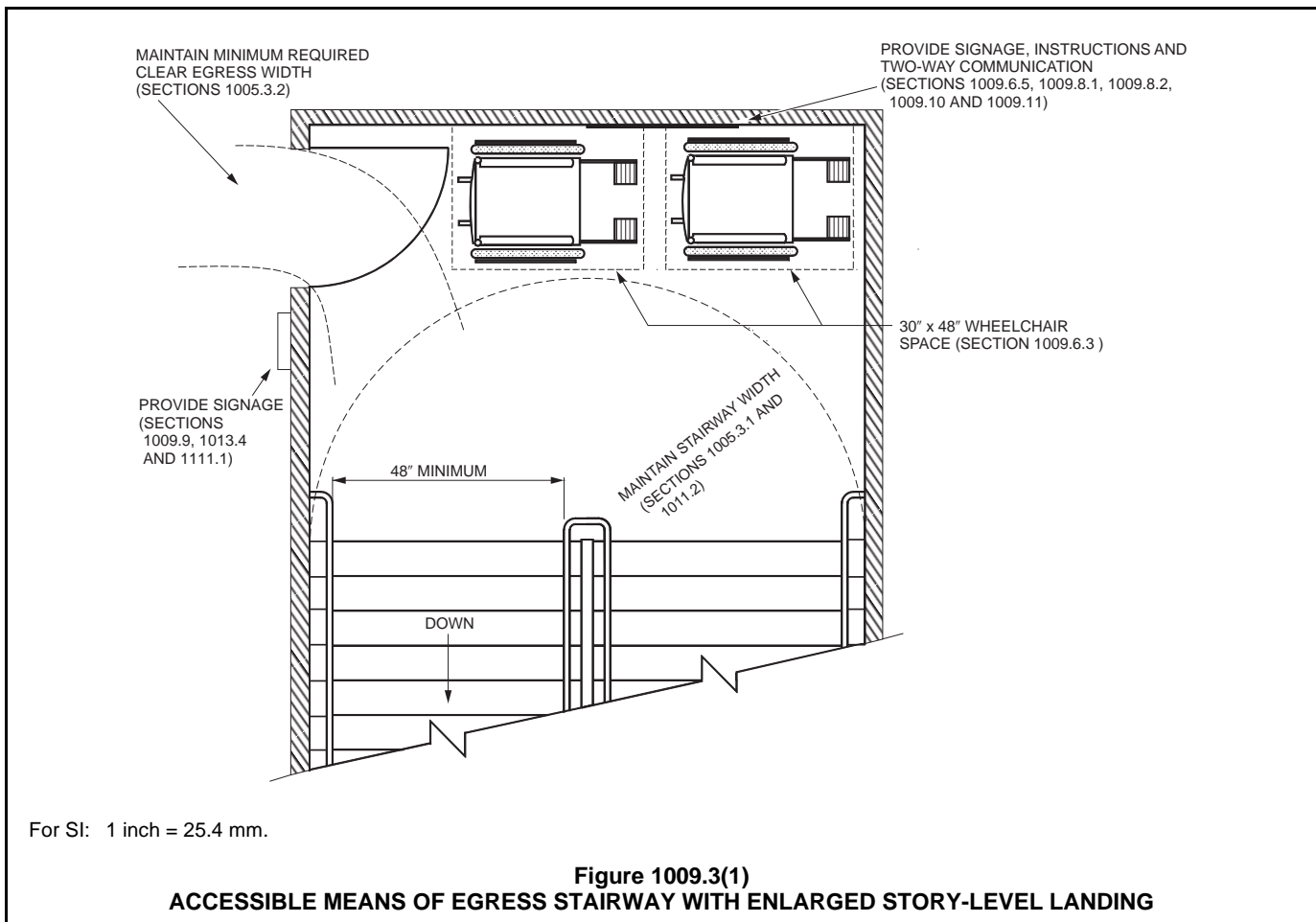
Exceptions may be combined. Exceptions 2 through 9 are either the area of refuge or the 48-inch (1219 mm) stairway width requirement. It is very important to note that an exception for the area of refuge in Section 1009.3 or 1009.4 is not an exception for the accessible means of egress. The accessible route must be available to the stairway or elevator so that people with mobility impairments and emergency responders can meet up as soon as possible.

The exceptions are applicable to all stairways between stories (i.e., exit access, interior exit and exterior exit). The same stairway that serves the ambulatory population for between floor levels can also serve as part of the accessible means of egress. Open exit access stairway requirements for mezzanines and in assembly seating arrangements are addressed in Exceptions 2 and 3 to Section 1009.1.

While the last sentence of Section 1009.3 says that exit access stairways between levels cannot serve as part of an accessible means of egress, Exception 1 allows for exit access stairways between a floor level and a mezzanine. IBC Section 505.1 requires at least a 7-foot clearance below and above a mezzanine. Thus, while it is considered part of the floor below for other parts of the code, there are allowances for the

height difference being similar to a story change in level and the difficulty of providing a ramp for that height. Therefore, the open exit access stairway from the mezzanine can serve as part of an accessible means of egress. In a sprinklered building, Exceptions 2 and 5 would allow for a narrower stairway and no area of refuge. In a nonsprinklered building, Exception 4 would allow for two-way communication at the elevator as an alternative to providing an area of refuge at the top of the open stairway.

Exceptions 2 and 5 are in recognition of the increased level of safety and evacuation time that are afforded in a sprinklered occupancy. The expectation is that a supervised system will reduce the threat of fire by reliably controlling and confining the fire to the immediate area of origin. There is also additional safety afforded by sprinkler system requirements for automatic notification when the system is activated. This has been substantiated by a study of accessible means of egress conducted for the General Services Administration (GSA). A report issued by the National Institute for Standards and Technology (NIST), NIST IR 4770, *Staging Areas for Persons with Mobility Limitations*, concluded that the operation of a properly designed sprinkler system eliminates the life threat to all building occupants, regardless of their individual physical abilities, and is a superior form of protection



as compared to areas of refuge. It was deemed that the ability of a properly designed and operational automatic sprinkler system to control a fire at its point of origin and to limit production of toxic products to a level that is not life-threatening to all occupants of the building, including persons with disabilities, eliminates the need for areas of refuge.

Exceptions 2 and 3 deal with stairway width. Exceptions 4 through 9 are exceptions for the area of refuge. These are not exceptions for the accessible route to the exit, just the area of refuge at the exit.

Exception 2 allows the stairway width to go back to the base requirements in Section 1011.2 in buildings sprinklered in accordance with NFPA 13 or NFPA 13R for both unenclosed and enclosed exit and exit access stairways (see Sections 1011, 1022 and 1027). Exception 2 is often used in conjunction with Exception 5. With the sprinkler system in place, there is more opportunity for the fire department to bring in evacuation chairs or possibly bring people to the elevator for evacuation, thus the extra width for carrying someone down the stairway is not needed. This is safer for both emergency responders and the evacuees.

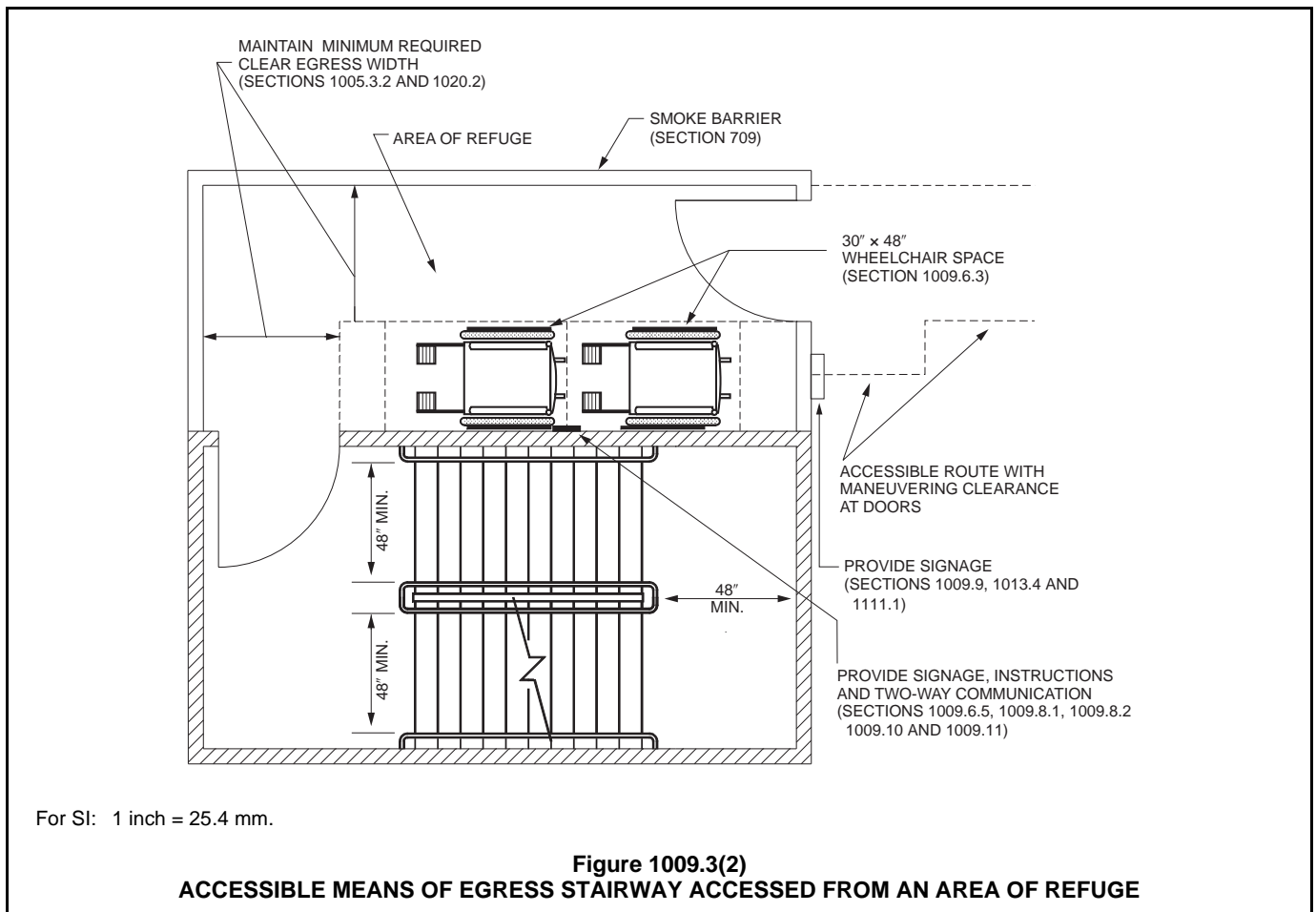
Exception 5 is for the area of refuge for all exit access stairways (see Section 1011) and exit stairways, interior and exterior (see Sections 1023 and

1027), where the building is sprinklered throughout with an NFPA 13 or 13R system. Again, this is not an exception for the accessible route to the exit, just the area of refuge at the exit.

Exception 3 allows the stairway width to go back to the base requirements in Section 1011.2 when the stairway is within the refuge area created by a horizontal exit. This exception considers that the extra exiting time will permit the egress down the stairway to be more deliberate. Horizontal exits are often used in hospitals or jails when the defense scenario is defend in place rather than evacuation.

Exception 5 can be used in conjunction with Exception 9. In the case of a horizontal exit [see Commentary Figure 1009.3(3)], each floor area on either side of the exit is considered a refuge area (see commentary, Section 1026.1) by virtue of the construction and separation requirements for horizontal exits. The discharge area is always assumed to be the nonfire side and, therefore, is protected from fire. Therefore, per Exception 9, stairways within this refuge area are not required to have areas of refuge.

Exceptions 6 and 7 are for structures where the natural ventilation of the products of combustion will be afforded by the exterior openings or smoke protection required of such structures (see IBC Section 406.3 and Sections 909 and 1029.6.2 of the code).



**Figure 1009.3(2)**  
**ACCESSIBLE MEANS OF EGRESS STAIRWAY ACCESSED FROM AN AREA OF REFUGE**

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The most immediate hazard for occupants in a fire incident is exposure to smoke and fumes. Floor areas in open parking structures communicate sufficiently with the outdoors such that the need for protection from smoke is not necessary; therefore, open parking garages are exempted from the requirements for an area of refuge (see also the exception to Section 1009.6.4). Because of this level of natural ventilation, parking garage exit stairways are not required to be enclosed (see Section 1019.3, Exception 6). The logic for exterior sports facilities and smoke-protected seating is the same: if there is no accumulation of smoke, there is no need for areas of refuge, even when a sprinkler system is not included (see Section 1019.3, Exception 7).

Exception 8 is in recognition of the dwelling unit separation and fire-resistance-rated corridors in Group R-2 facilities (see IBC Section 420 and Section 1020 of the code). Effectively, each dwelling unit can serve as a protected area. Since the current text requires all Group R structures to be sprinklered (see Section 903.2.8), Exceptions 2 and 5 could also be utilized.

**1009.4 Elevators.** In order to be considered part of an accessible *means of egress*, an elevator shall comply with the emergency operation and signaling device requirements of Section 2.27 of ASME/CSA B44 A17.1. Standby power shall be provided in accordance with Chapter 27 and Section 3003. The elevator shall be accessed from an *area of refuge* complying with Section 1009.6.

### Exceptions:

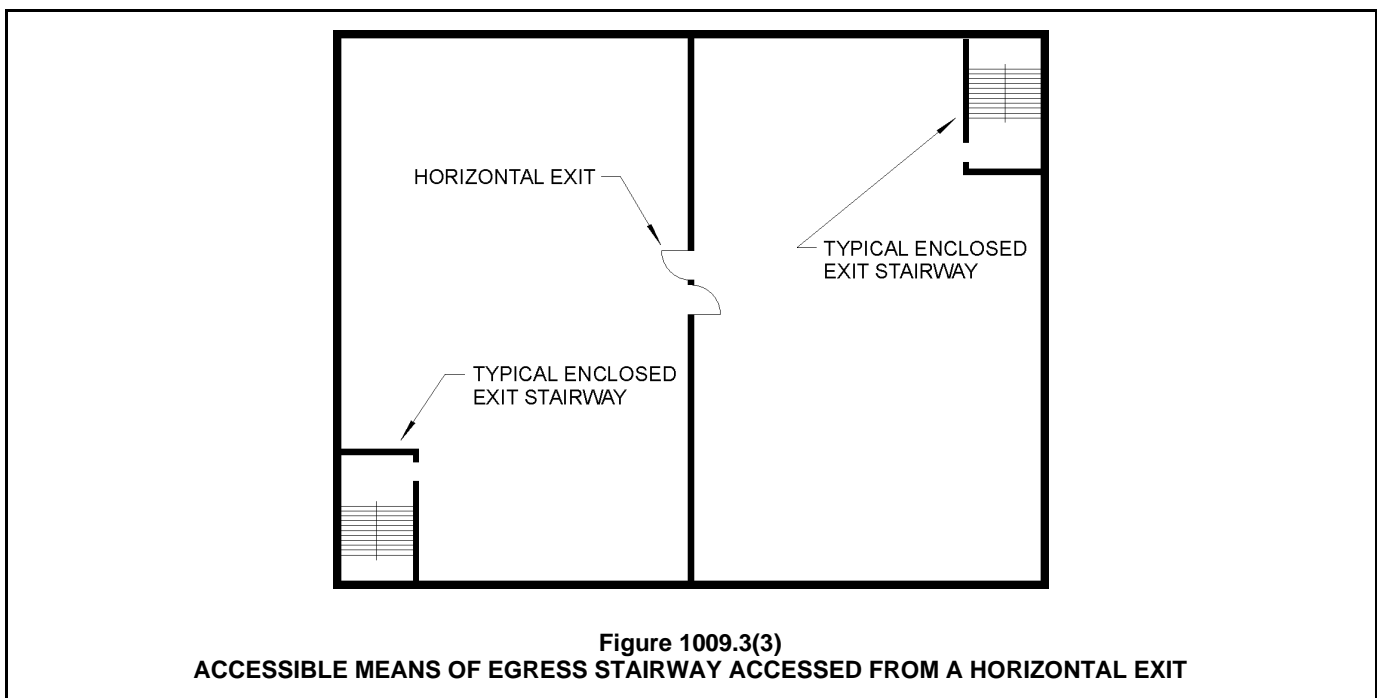
1. *Areas of refuge* are not required at the elevator in *open parking garages*.
2. *Areas of refuge* are not required in buildings and facilities equipped throughout with an *automatic*

*sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.

3. *Areas of refuge* are not required at elevators not required to be located in a shaft in accordance with Section 712.
4. *Areas of refuge* are not required at elevators serving *smoke-protected assembly seating* areas complying with Section 1029.6.2.
5. *Areas of refuge* are not required for elevators accessed from a refuge area in conjunction with a *horizontal exit*.

❖ Elevators are the most common and convenient means of providing access to upper and lower floors in multistory buildings. As such, elevators represent a prime candidate for accessible means of egress from such buildings, especially in light of the difficulties involved in carrying a person in a wheelchair up or down a stairway. The primary consideration for elevators as an accessible means of egress is that the elevator will be available and protected during a fire event. See IBC Sections 403, 3007 and 3008 for new provisions in high-rise buildings for “fire service access elevators” and “occupant evacuation elevators.”

This section addresses the use of an elevator as part of an accessible means of egress by requiring both a backup source of power for the elevator and access to the elevator from an area of refuge. For situations where elevators are required to be part of one of the accessible means of egress, see Section 1009.2.1. Note that an elevator lobby that is off a fire-resistance-rated corridor must also comply with Section 713.14 and IBC Chapter 30. The backup power requirement establishes a higher degree of reliability



**Figure 1009.3(3)**  
**ACCESSIBLE MEANS OF EGRESS STAIRWAY ACCESSED FROM A HORIZONTAL EXIT**

that the elevator will be available and usable by reducing the likelihood of power loss caused by fire or other conditions. Requiring access from an area of refuge affords the same degree of fire safety as described for stairways (see commentary, Section 1009.3). Additionally, the reference to Section 604.2 and IBC Section 3003 clarifies that the elevator will comply with the emergency operation features that relate to operating an elevator under fire conditions (see commentary, Section 604.2.1 and IBC Section 3003). Elevators on an accessible route are also required to meet the accessibility provisions of ICC A117.1 (see commentary, IBC Sections 1109.7 and 3001.3).

Exception 2 is for the area of refuge for all elevators where the building is sprinklered throughout with an NFPA 13 or 13R system. Again, this is not an exception for the accessible route to the exit, just the area of refuge at the elevator with standby power. Exception 2 is in recognition of the increased level of safety and evacuation time that is afforded in a sprinklered occupancy. The expectation is that a supervised system will reduce the threat of fire by reliably controlling and confining the fire to the immediate area of origin. There is also additional safety afforded by sprinkler system requirements for automatic notification when the system is activated. This has been substantiated by a study of accessible means of egress conducted for the GSA. NIST IR 4770 concluded that the operation of a properly designed sprinkler system eliminates the life threat to all building occupants, regardless of their individual physical abilities, and is a superior form of protection as compared to areas of refuge. It was deemed that the ability of a properly designed and operational automatic sprinkler system to control a fire at its point of origin and to limit production of toxic products to a level that is not life threatening to all occupants of the building, including persons with disabilities, eliminates the need for areas of refuge.

If a level in an open parking garage contains accessible parking spaces or is part of the route to and from those spaces, that level is required to have accessible means of egress. Exception 1, for open parking structures, is in recognition of the natural ventilation of the products of combustion that will be afforded by the exterior openings required of such structures (see IBC Section 406.5.2). The most immediate hazard for occupants in a fire incident is exposure to smoke and fumes. Floor areas in open parking structures are sufficiently exposed to the outdoors; thus, the need for protection from smoke is not necessary. Therefore, open parking garages are exempt from the requirements for an area of refuge to access an elevator that is utilized as part of the accessible means of egress. The same idea holds true for smoke-protected seating areas, in accordance with Exception 4. The protection offered by the smoke control system allows for adequate evacuation time before there is danger from smoke and fume accumulation.

Exception 3 allows elevators not required to be enclosed by IBC Section 712 to not have an area of refuge or be accessed by a horizontal exit. If there is no shaft enclosure around the elevator, construction of a smoke-tight compartment immediately in front of the elevator doors would be very difficult. While there are many items listed under IBC Section 712, combined with the height requirements in Section 1009.2.1, typically this would be elevators in atriums or in open and enclosed parking garages. Again, the nature of the location adjacent to an atrium or with the open ramps in parking garages would minimize the chances of smoke accumulation at the elevators.

In the case of a horizontal exit [see Commentary Figure 1009.3(3)], each floor area on either side of the exit is considered a refuge area (see commentary, Section 1026.1) by virtue of the construction and separation requirements for horizontal exits. The discharge area is always assumed to be the nonfire side and, therefore, is protected from fire. Therefore, per Exception 5, any elevator within this refuge area is not required to have areas of refuge.

**1009.5 Platform lifts.** Platform lifts shall be permitted to serve as part of an accessible *means of egress* where allowed as part of a required *accessible route* in Section 1109.8 except for Item 10. Standby power for the platform lift shall be provided in accordance with Chapter 27.

❖ Previously, there have been concerns about whether a platform lift will be reliably available at all times. However, ASME A18.1, the standard for platform lifts, no longer requires key operation. It is important to note that platform lifts are not prohibited by the code. They simply cannot be counted as a required accessible means of egress in other than locations where they are allowed as part of the accessible route into a space (see commentary, IBC Section 1109.8). When platform lifts are utilized as part of an accessible means of egress, they must come equipped with standby power. Per ASME A18.1, the standby power needs to be sufficient to run the platform lift for at least five round trips. Note that platform lifts cannot be used to meet accessible means of egress requirements for a situation that utilizes Section 1109.8, Item 10. Accessible means of egress must be provided at other locations.

IBC Section 1109.8, Item 10, recognizes that existing site constraints may make installation of a ramp or elevator infeasible. An example would be the situation of dealing with existing public sidewalks, easements and public ways in downtown urban areas. This situation would be most common in hilly areas where the street and sidewalk follow grade and the building's floor is level, resulting in steps up or down at entrances. The concern for allowing this as part of the accessible means of egress is due to standby power requiring only five cycles. If a platform lift was utilized to provide entry for a large building, or for a building with a large number of occupants that may use mobility devices, such as a hospital, it was

deemed that there might not be sufficient time or power for everyone to evacuate safely.

In existing buildings undergoing alterations, platform lifts are allowed as part of an accessible route into a building (see commentary, IEBC Sections 410.8.3 and 705.1.3) at any location as long as they are compliant with ASME A18.1. Note that accessible means of egress are not required in existing buildings undergoing an alteration or a change of occupancy (see Section 1007.1 and IEBC Sections 410.6 and 705.1).

**1009.6 Areas of refuge.** Every required *area of refuge* shall be accessible from the space it serves by an accessible *means of egress*.

❖ Areas of refuge, when provided, are an important component of fire and safety evacuation plans for buildings. These areas must be included in the plans required by Section 404 and IBC Section 1001.4.

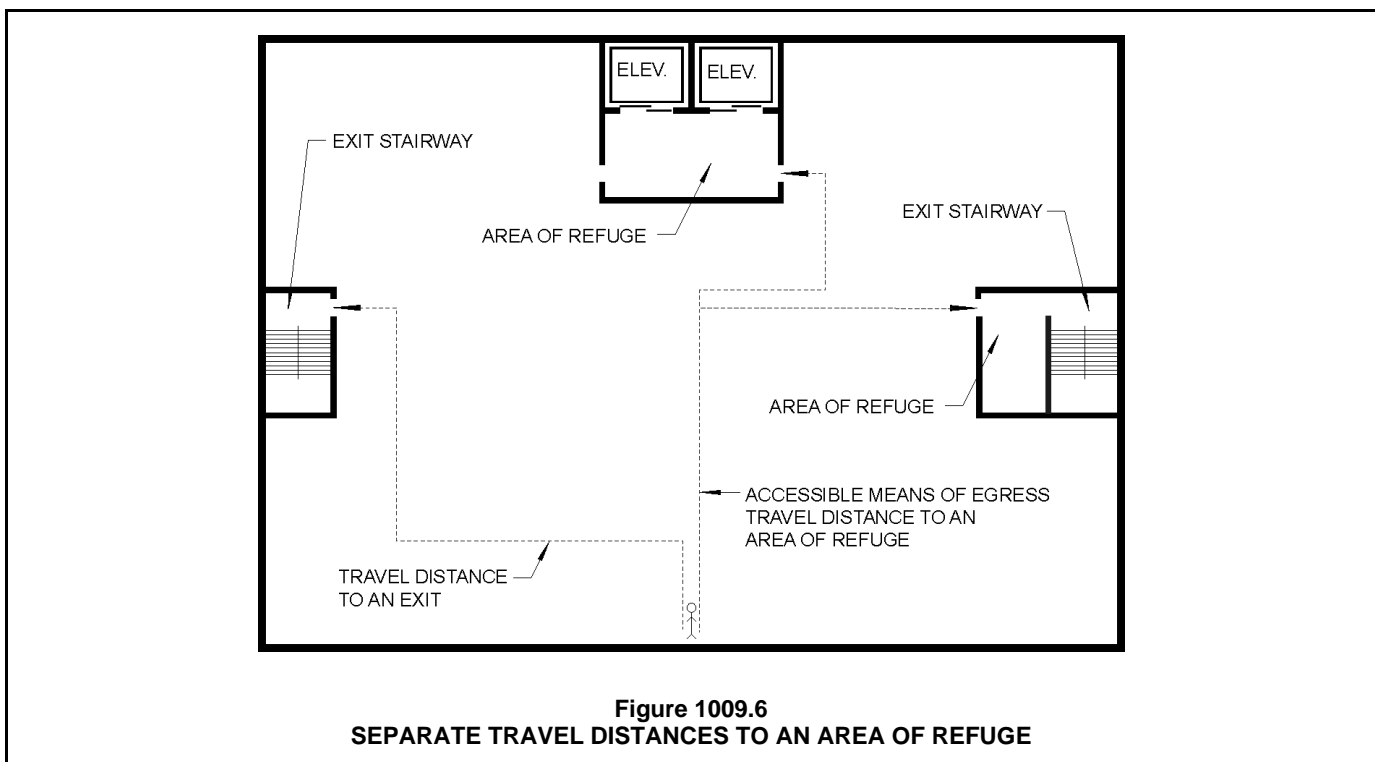
An area of refuge is of no value as part of an accessible means of egress if it is not accessible. The code states an obvious but essential requirement: the path that leads to an area of refuge must qualify as an accessible means of egress. This provision is required so that there will be an accessible route leading from every accessible space to each required area of refuge. See Commentary Figure 1009.6.

**1009.6.1 Travel distance.** The maximum travel distance from any *accessible space* to an *area of refuge* shall not exceed the *exit access* travel distance permitted for the occupancy in accordance with Section 1017.1.

❖ For consistency in principle with the general means of egress design concepts, the code also limits the

travel distance to the area of refuge. The limitation is the same distance as specified in Section 1017.2 for maximum exit access travel distance. This equates the maximum travel distance required to reach an exit with the maximum distance required to reach an area of refuge. It should be noted that an area of refuge is not necessarily an exit in the classic sense. For example, when the area of refuge is an enlarged, story-level landing within an exit stairway, the area of refuge is within the exit and the maximum travel distance for both the conventional exit and the accessible area of refuge is measured to the same point (the entrance to the exit stairway). If the area of refuge is a vestibule immediately adjacent to an enclosed exit stairway, the maximum travel distance for the required accessible means of egress is measured to the entrance of the area of refuge and, for the travel distance to the exit, to the entrance of the exit stairway (see Commentary Figure 1009.6). In the case of accessible means of egress with an elevator, the maximum travel distance may end up being measured along two different paths, with the only consistency between the conventional means of egress and the accessible means of egress being the maximum travel distance (see Commentary Figure 1009.6). The travel distance within an area of refuge is not directly regulated, but will be limited by the general provisions for maximum exit access travel distance, which are always applicable.

In summary, the code takes a reasonably consistent approach for both conventional and accessible means of egress by limiting the distance one must travel to reach a safe area from which further egress to a public way is available.



**Figure 1009.6**  
**SEPARATE TRAVEL DISTANCES TO AN AREA OF REFUGE**

**1009.6.2 Stairway or elevator access.** Every required *area of refuge* shall have direct access to a *stairway* complying with Sections 1009.3 and 1023 or an elevator complying with Section 1009.4.

❖ To ensure that there is continuity in an accessible means of egress, the code requires that every area of refuge have direct access to either an exit stairway (see Section 1009.3) or an elevator (see Section 1009.4). This, again, may be viewed as stating the obvious, but it is necessary so that the egress layout does not involve entering an area of refuge and then having to leave that protected area before gaining access to a stairway or elevator. Once an occupant reaches the safety of an area of refuge, that level of protection must be continuous until the vertical transportation element (the stairway or elevator) is reached.

If one chooses to comply with accessible means of egress requirements by providing an accessible elevator with an area of refuge in the form of an elevator lobby, the elevator shaft and the lobby are required to be constructed in accordance with IBC Section 713.14 and IBC Chapter 30. The requirements provide additional assurance that the elevator will not be rendered unavailable because of smoke movement into the elevator shaft. If the elevator is in a refuge area that is formed by the use of a horizontal exit (i.e., fire walls or fire barriers in accordance with Section 1026.2) or smoke compartments formed by smoke barriers (see IBC Sections 407.5 and 408.6), it is presumed that the refuge area is relatively free from smoke; therefore, the extra protection of IBC Section 713.14 and IBC Chapter 30 may not be needed.

**1009.6.3 Size.** Each *area of refuge* shall be sized to accommodate one *wheelchair space* of 30 inches by 48 inches (762 mm by 1219 mm) for each 200 occupants or portion thereof, based on the *occupant load* of the *area of refuge* and areas served by the *area of refuge*. Such *wheelchair spaces* shall not reduce the *means of egress* minimum width or required capacity. Access to any of the required *wheelchair spaces* in an *area of refuge* shall not be obstructed by more than one adjoining *wheelchair space*.

❖ The number of wheelchair spaces that are required to be provided in an area of refuge is intended to represent broadly the expected population of the average building. As one point of measurement, a 1977 survey conducted by the National Center for Health indicated that one in 333 civilian, noninstitutionalized persons uses a wheelchair. The 1990 ADA currently utilizes the criterion of one space for each 200 occupants, based on the space served by the area of refuge. Given the variations and difficulties involved in accurately predicting a representative ratio for application to all occupancies, it was concluded that a requirement for one space for each 200 occupants based on the area of refuge itself, plus the areas served by the area of refuge, represents a reasonable criterion. Very few buildings would ever require

more than four wheelchair spaces on a floor, since nearly all buildings with an occupant load greater than 400 per floor would be sprinklered and using Exception 5 in Section 1009.3.

Arrangement of the required wheelchair spaces is critical so as not to interfere with the means of egress for ambulatory occupants (see Section 1011.6). Since the design concept is that wheelchair occupants will move to the area of refuge and await further instructions or evacuation assistance, the spaces must be located so as not to reduce the required means of egress width of the stairway, door, corridor or other egress path through the exterior area of egress.

In order to provide for orderly maneuvering of wheelchairs, this section states that access to any of the required wheelchair spaces cannot be obstructed by more than one adjoining wheelchair space. For example, this precludes an arrangement that three or more wheelchairs could be stacked down a dead-end corridor. This also effectively limits the difficulty any given wheelchair occupant would have in reaching or leaving a given wheelchair space, as well as providing easier access to all wheelchair spaces by persons providing evacuation assistance.

**1009.6.4 Separation.** Each *area of refuge* shall be separated from the remainder of the story by a *smoke barrier* complying with Section 709 or a *horizontal exit* complying with Section 1026. Each *area of refuge* shall be designed to minimize the intrusion of smoke.

**Exceptions:**

1. *Areas of refuge* located within an enclosure for *interior exit stairways* complying with Section 1023.
2. *Areas of refuge* in outdoor facilities where *exit access* is essentially open to the outside.

❖ The minimum standard for construction of an area of refuge is a smoke barrier, in accordance with Section 709. This establishes a minimum degree of performance by means of a 1-hour fire-resistance rating, including opening protectives and a minimum degree of performance against the intrusion of smoke into an enclosed area of refuge, as specified in Sections 709.4 and 709.5. By the nature of the connection to the stair enclosure or elevator shaft, the normal smoke barrier requirement for extension from exterior wall to exterior wall is replaced by connection to the shaft enclosure.

An alternative is to provide a refuge area created by a horizontal exit complying with Section 1026. Horizontal exits are formed by fire walls or fire barriers with a minimum fire-resistance rating of 2 hours. The horizontal exit separation must extend vertically through all levels of the building, unless floor assemblies have a fire-resistance rating of not less than 2 hours with no unprotected openings (see Section 1026.2). The other provisions for horizontal exits for additional egress elements, opening protection and capacity must also be complied with.

This section does not require an area of refuge within an exit stairway to be designed to prevent the intrusion of smoke. This was based on a study of areas of refuge conducted by the NIST for the GSA, which concluded that a story-level landing within a fire-resistance-rated exit stairway would provide a satisfactory staging area for evacuation assistance (see Exception 1).

Exception 2 is in recognition that, despite not being a sprinklered venue, where the entire facility is protected from smoke and fumes by the nature of being open to the outside a separation for areas of refuge is not required.

**1009.6.5 Two-way communication.** *Areas of refuge* shall be provided with a two-way communication system complying with Sections 1009.8.1 and 1009.8.2.

❖ If a building includes areas of refuge at the stairway or elevators, each area of refuge must include a two-way communication system. If the building uses one of the exceptions for areas of refuge, Section 1007.8 would still require a two-way communication system at the elevator. This way anyone needing assistance can communicate with a person at a constantly attended location to request evacuation assistance. This system is an important part of the fire and safety evacuation plans required by Section 404 and IBC Section 1001.4. See Sections 1009.8.1 and 1009.8.2 for specific requirements for this system.

**1009.7 Exterior areas for assisted rescue.** Exterior areas for assisted rescue shall be accessed by an *accessible route* from the area served.

Where the *exit discharge* does not include an *accessible route* from an *exit* located on the *level of exit discharge* to a *public way*, an exterior area of assisted rescue shall be provided on the exterior landing in accordance with Sections 1009.7.1 through 1009.7.4.

❖ Section 1009.2 requires the accessible means of egress to have an accessible route along the path for exit access, exit and exit discharge. Stairways that lead from the level of exit discharge (see the commentary to Chapter 2 for the defined term, “Exit discharge, level of”) to grade are considered part of the exit discharge. When the exit discharge is not accessible, the options are an interior area of refuge complying with Section 1009.6 or an exterior area of assisted rescue in accordance with Section 1009.7. The provisions for stairways in Section 1009.3, including the exceptions for sprinklered buildings, are not an option to address nonaccessible exit discharge.

Exterior areas of assisted rescue are intended to be open-air locations for persons with physical disabilities to wait for assisted rescue. There must be an interior or exterior accessible route along the path of travel for access to this location. This allows a person unable to negotiate the exit discharge to get to a location where they can be quickly discovered by the fire department or other emergency responders.

In most situations, interior areas of refuge are not a positive alternative. Tenants tend to use such areas as convenient storage areas. Where persons with mobility impairments can wait for assisted rescue outside of the building, they are effectively protected from interior smoke and fumes—the deadliest of the fire hazards. Being immediately visible at an exit should also result in a shorter period of time before assisted rescue is achieved.

Exterior areas for assisted rescue, when provided, are an important component of the fire and safety evacuation plans for the buildings. These areas must be included in the plans required by Section 404 and IBC Section 1001.4.

The option under Section 1009.7 is commonly used only at the level of exit discharge for the second exit out the back of a building or tenant space. This will be either a single-story building, or the first level of a multistory building, where the secondary exit discharge is not accessible due to changes in elevation around the perimeter. If this is an exterior exit stairway (i.e., more than one story of vertical travel), the provisions in Section 1009.3 would be applicable.

Examples of this issue are:

**Example 1:**

A strip mall would have accessible entrances to each tenant in the front (Section 1105.6). Many have service entrances or loading bays across the back, so the second exit door leads to steps. A ramp installed for accessible exit discharge could: be a prohibitively large structure due to the elevation change; block access to the loading docks; get damaged by the maneuvering trucks; or, be impossible because of space restrictions in a narrow alley.

**Example 2:**

An office building has a second exit that leads to a concrete stoop and the exit discharge is sloped, is uneven or may be blocked by snow. This is just as impassible for a person using a wheelchair as a series of steps. Providing a sidewalk all the way to the front of the building may not be practical because of adjacent buildings or because someone could be travelling adjacent to a burning building.

Sections 1009.7.1 through 1009.7.4 provide criteria for a safe place to wait temporarily for assistance. These address size, separation/protection, openness and any steps leading from the exterior area for assisted rescue.

**1009.7.1 Size.** Each exterior area for assisted rescue shall be sized to accommodate *wheelchair spaces* in accordance with Section 1009.6.3.

❖ The exterior area for assisted rescue must have an enlarged landing area with space for at least one wheelchair for every 200 occupants that will be using that exit. The wheelchair spaces must be located so that they do not obstruct the general means of egress. If these spaces are confined by walls, guards

or edges, they must also meet the alcove provisions in ICC A117.1 so that persons using wheelchairs can maneuver into the space [see Commentary Figure 1009.7.1].

**1009.7.2 Separation.** Exterior walls separating the exterior area of assisted rescue from the interior of the building shall have a minimum *fire-resistance rating* of 1 hour, rated for exposure to fire from the inside. The fire-resistance-rated exterior wall construction shall extend horizontally 10 feet (3048 mm) beyond the landing on either side of the landing or equivalent fire-resistance-rated construction is permitted to extend out perpendicular to the exterior wall 4 feet (1220 mm) minimum on the side of the landing. The *fire-resistance-rated* construction shall extend vertically from the ground to a point 10 feet (3048 mm) above the floor level of the area for assisted rescue or to the roof line, whichever is lower. Openings within such *fire-resistance-rated* exterior walls shall be protected in accordance with Section 716.

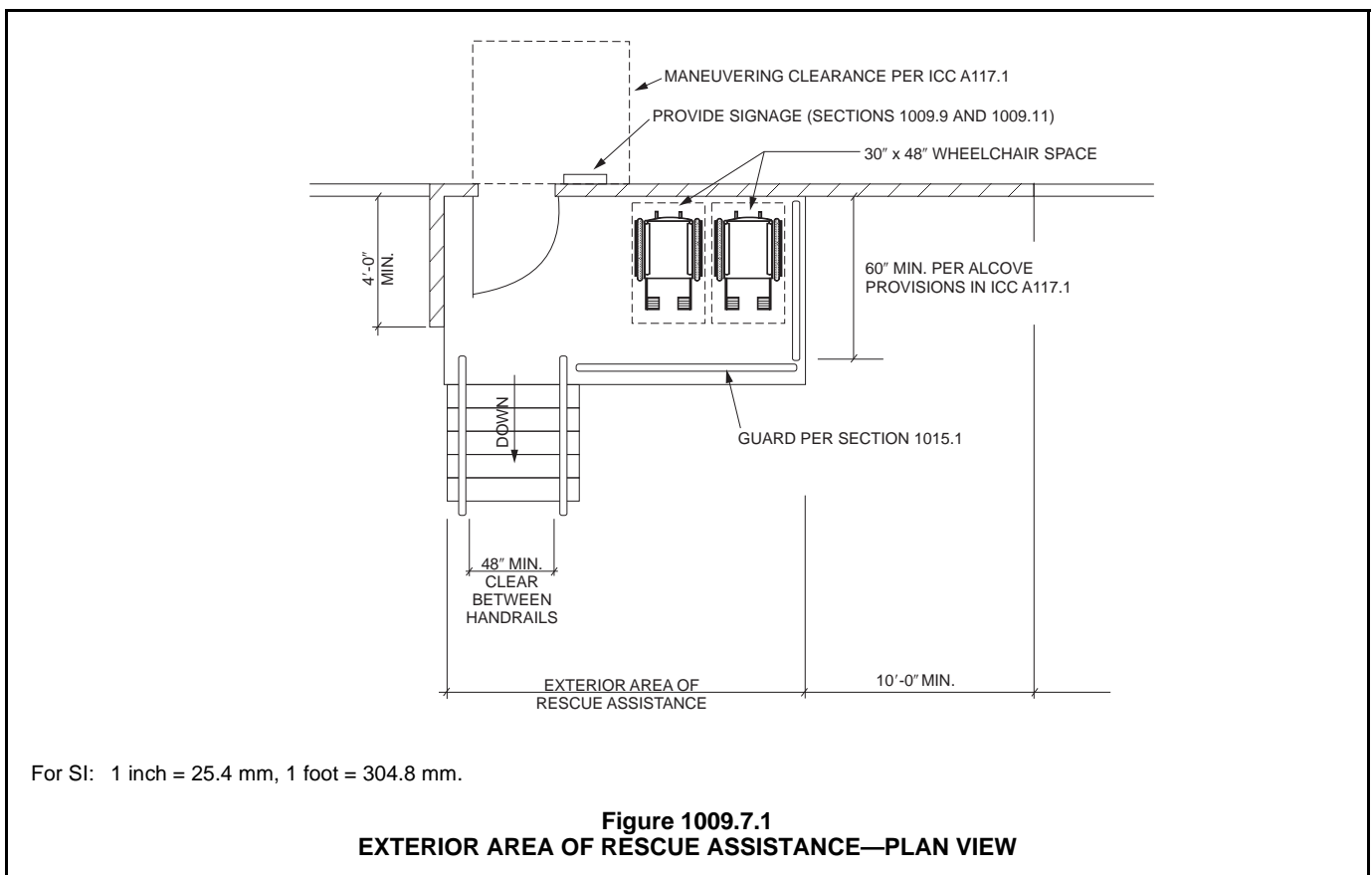
❖ The protection provided by an exterior area for assisted rescue would be equivalent to that required for an interior area of refuge. Note that there is no exception for the exterior area of assisted rescue for buildings that contain sprinkler systems. The separation requirements are similar to exterior exit stairways, rated walls and protected openings for 10 feet (3048 mm) above, below and to the sides of the landing (see Sections 1023.7 and 1027.6). The exceptions for exterior exit stairway protection in Section 1027.6 would not be applicable where the area

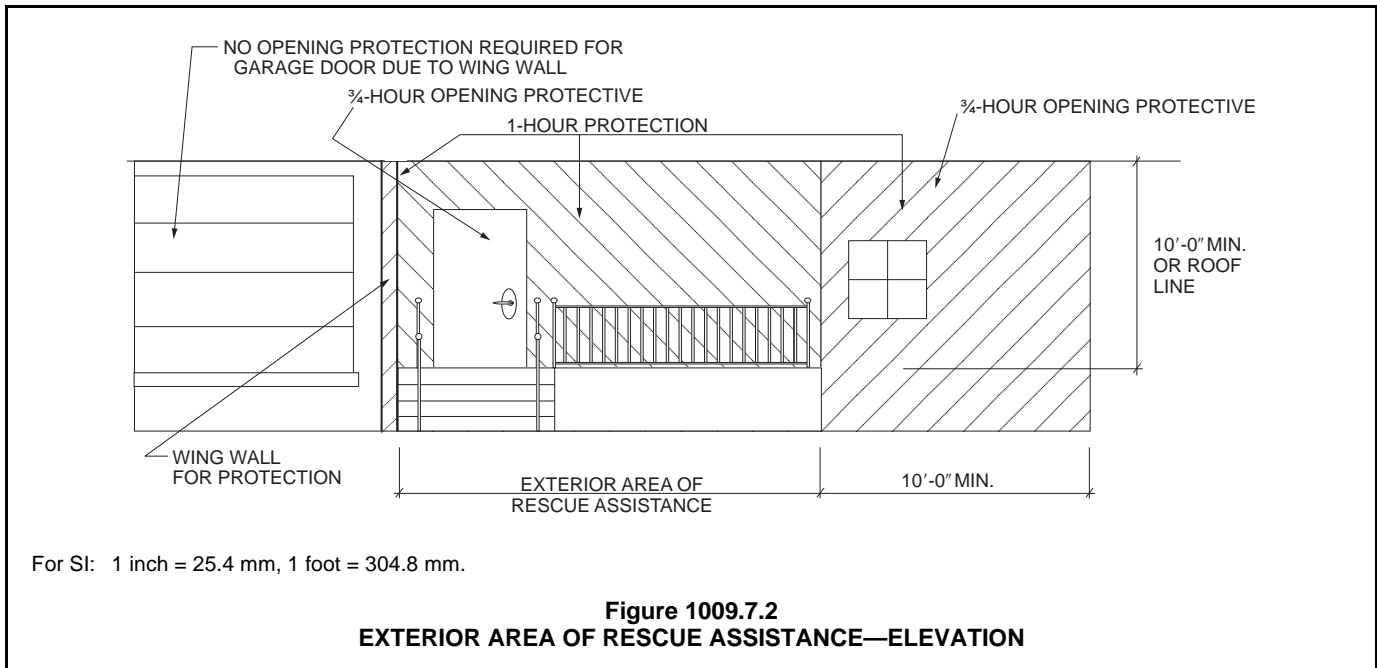
includes an exterior area for assisted rescue (see Commentary Figure 1009.7.2).

The current separation requirements address typical rear exit situations. Other locations may require alternative protection measures to “shield” an exterior area for assisted rescue. The principle of “wing” walls (as used at a fire wall extension) suggests an alternative to  $\frac{3}{4}$ -hour opening protectives at dock doors adjacent to an exterior area for assisted rescue.

Note that providing a rescue location 10 feet (3048 mm) away from an exterior wall does not serve as a viable alternative to a fire-resistance-rated exterior wall. Persons waiting for assistance must have a minimum level of shielding from a fire in the building.

A common situation is for the path of egress travel from the first floor to move through the bottom level of an enclosed exit stairway. If there are steps outside the exit door of the stairway, there is no accessible path for exit discharge. Where approved by the code official (see Section 104.9), the stairway enclosure could be considered equivalent to a protected exterior wall. It is assumed that the fire is in the building somewhere, not in the stairway. A person with a mobility impairment could be provided with a place to wait either inside the stairway enclosure, or outside the building with the stairway enclosure as the separation between them and the fire – as an alternative to Section 1009.7.2. The exterior wall of an interior exit stairway can be nonfire-resistance rated where permitted by Section 1023.7.





**1009.7.3 Openness.** The exterior area for assisted rescue shall be open to the outside air. The sides other than the separation walls shall be not less than 50 percent open, and the open area shall be distributed so as to minimize the accumulation of smoke or toxic gases.

❖ The openness criteria for exterior areas of assisted rescue are similar to the requirements for exterior balconies. The purpose is to ensure that a person at an exterior area of rescue assistance is not in danger from smoke and fumes. The criteria are to address the situation where the rescue area is open to outside air, but a combination of roof overhangs and perimeter walls or guards could still trap enough smoke that the safety of the occupants would be jeopardized.

**1009.7.4 Stairways.** Stairways that are part of the means of egress for the exterior area for assisted rescue shall provide a clear width of 48 inches (1220 mm) between handrails.

**Exception:** The clear width of 48 inches (1220 mm) between handrails is not required at stairways serving buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2.

❖ Any steps that lead from an exterior area for assisted rescue to grade must have a clear width of 48 inches (1219 mm) between handrails. The additional width is to permit adequate room to assist a mobility-impaired person down the steps and to a safe location.

If the building is sprinklered, the exception allows for the stairway to utilize the minimum widths required in Section 1011.2. This is consistent with Section 1009.3, Exceptions 2 and 3.

**1009.8 Two-way communication.** A two-way communication system complying with Sections 1009.8.1 and 1009.8.2 shall be provided at the landing serving each elevator or bank

of elevators on each accessible floor that is one or more stories above or below the level of exit discharge.

**Exceptions:**

1. Two-way communication systems are not required at the landing serving each elevator or bank of elevators where the two-way communication system is provided within areas of refuge in accordance with Section 1009.6.5.
2. Two-way communication systems are not required on floors provided with ramps conforming to the provisions of Section 1012.
3. Two-way communication systems are not required at the landings serving only service elevators that are not designated as part of the accessible means of egress or serve as part of the required accessible route into a facility.
4. Two-way communication systems are not required at the landings serving only freight elevators.
5. Two-way communication systems are not required at the landing serving a private residence elevator.

❖ Unless provided in areas of refuge, in multistory buildings a two-way communication system must be located at the elevator landing of each accessible floor level other than the level of exit discharge. The system is intended to offer a means of communication to individuals with mobility impairment, either permanent or temporary, who need assistance during an emergency situation. Such a system can be useful not only in the event of a fire, but also in the case of a natural or technological disaster by providing emergency responders with the location of individuals who will require assistance in being evacuated from floor levels above or below the discharge level. The ability

of emergency responders to locate persons needing assistance quickly is an important part of the fire and safety plan. The two-way communication system is a critical element in that plan.

Exception 1 exempts the requirement for locating the communication systems at the elevator landings where the building is provided with complying areas of refuge. Since areas of refuge are required by Section 1009.6.5 to be equipped with two-way communication systems, there is limited need to provide such additional systems at the elevator landings. However, where multistory buildings are not provided with areas of refuge, such as is the case with most sprinklered buildings, the installation of communications systems at the elevator landings is important to those individuals unable to negotiate egress stairways during an emergency. As a result, both sprinklered and nonsprinklered multistory buildings will be provided with the means for two-way communication at all accessible floor levels other than the level of exit discharge.

Exception 2 applies to floor levels that utilize ramps as vertical accessible means of egress elements. Where complying ramps are available for independent evacuation, such as occurs in a sports stadium, the two-way communication system is not required at the elevator landings.

Because persons at an exterior area of rescue assistance provided at ground level (i.e., level of exit discharge) are immediately visible and such locations are at high risk for vandalism, two-way communication systems are not required for exterior areas of assisted rescue.

If the option of horizontal exits is utilized, the code does not currently address whether a two-way communication system should be provided within a refuge area without an elevator. Since the horizontal exit is not typically recognizable by a person not familiar with the building plan, the most logical location for the two-way communication, if provided, would seem to be adjacent to the exit stairway that was located within the refuge area.

Exceptions 3, 4 and 5 address types of elevators where two way communications are not required. The two-way communication is intended for anyone to be able to communicate with emergency responders. If it is located in the lobby of the public elevator, a system at a back of house service elevator would be redundant and not easy for most occupants to find. A freight elevator cannot be part of an accessible route, so again, this is not the elevator that occupants would typically use. The ASME A17.1 limits the use of private residence elevators to within or serving individual dwelling units. If a person lives in a unit with an elevator, it is not unreasonable to expect them to address communication needs that may arise on their own, such as carrying a portable or cell phone with them.

**1009.8.1 System requirements.** Two-way communication systems shall provide communication between each required

location and the *fire command center* or a central control point location *approved* by the fire department. Where the central control point is not a *constantly attended location*, a two-way communication system shall have a timed automatic telephone dial-out capability to a monitoring location or 9-1-1. The two-way communication system shall include both audible and visible signals.

- ❖ Use of an elevator, stair enclosure or other area of refuge as part of an accessible means of egress requires a person to wait for evacuation assistance or relevant instructions. The two-way communication system allows this person to inform emergency personnel of his or her location and to receive additional instructions or assistance as needed.

The arrangement and design of the two-way communication system is specified in Section 1009.8.1. In addition to the required locations specified in Section 1009.6.5 for areas of refuge or Section 1009.8 for elevator landings, a communication device is also required to be located in a high-rise building's fire command center or at a central control point whose location is approved by the fire department (see IBC Section 403.4.4 and Section 907.2.13.2 of the code). "Central control point" is not a defined term. However, given the intent and function of the two-way communication system, a central control point is a location where an individual answers the call for assistance and either provides or requests aid for a person who needs help. A suitable central control point is often not available in low-rise buildings or in a high-rise building where the central control point may not be manned on a 24-hour basis. In order that a caller may reach an appropriate emergency location, the fire department must approve the configuration of the system. A central control point could be the lobby of a building constantly staffed by a security officer, an alarm company, a public safety answering point such as a 9-1-1 center or a central supervising station in a Group I occupancy. There could be a combination solution—such as a system configured to automatically call 9-1-1 when the central control point within the building is not manned. The communication system provides visual signals for the hearing impaired and audible signals to assist the vision impaired.

**1009.8.2 Directions.** Directions for the use of the two-way communication system, instructions for summoning assistance via the two-way communication system and written identification of the location shall be posted adjacent to the two-way communication system. Signage shall comply with the ICC A117.1 requirements for visual characters.

- ❖ Guidance to the users of a two-way communication system is also specified. Operating instructions for the two-way communication system must be posted and the instructions are to include a means of identifying the physical location of the communication device. If a signal from a two-way communication system terminates to a public safety answering point, such as a fire department communication center, current 9-1-1 telephone technology only reports the

address of the location of the emergency—it does not report a floor or area from the address reporting the emergency. The “identification of the location” posted adjacent to the communication system should ensure that most discrete location information can be provided to the central control point. This will aid emergency responders, especially in high-rise buildings or corporate campuses with multiple multistory structures. The signage is not required to be raised letters or braille, but is required to meet the style, size and contrast requirements for visual signage in A117.1.

**1009.9 Signage.** Signage indicating special accessibility provisions shall be provided as shown:

1. Each door providing access to an *area of refuge* from an adjacent floor area shall be identified by a sign stating: AREA OF REFUGE.
2. Each door providing access to an exterior area for assisted rescue shall be identified by a sign stating: EXTERIOR AREA FOR ASSISTED RESCUE.

Signage shall comply with the *ICC A117.1* requirements for visual characters and include the International Symbol of Accessibility. Where exit sign illumination is required by Section 1013.3, the signs shall be illuminated. Additionally, visual characters, raised character and braille signage complying with ICC A117.1 shall be located at each door to an *area of refuge* and exterior area for assisted rescue in accordance with Section 1013.4.

❖ Signage enables an occupant to become aware of an area of refuge and/or the exterior area for rescue assistance. The assistance areas must provide signage on or above the door stating either “AREA OF REFUGE” or “EXTERIOR AREA FOR ASSISTED RESCUE” and includes the International Symbol of Accessibility. The approach that the code takes for identification of the area of refuge is comparable to the general provisions for identification of exits, including the requirement for lighted signage. Raised letters and braille stating “EXIT” are also required adjacent to the door for the benefit of persons with a visual impairment.

The current text does not clearly indicate how to identify a refuge area formed by a horizontal exit. In hospitals and jails, where this option is typically utilized, the location of the horizontal exits must be part of the staff training for the fire safety and evacuation plans.

**1009.10 Directional signage.** Directional signage indicating the location of all other *means of egress* and which of those are accessible *means of egress* shall be provided at the following:

1. At *exits* serving a required *accessible* space but not providing an approved accessible *means of egress*.
2. At elevator landings.
3. Within *areas of refuge*.

❖ The additional signage required by this section is intended to advise persons of the locations of all means of egress and which of those also serve as

accessible means of egress. Since not all of the exits will necessarily be accessible means of egress, it is appropriate to provide this information at exit stairways and, particularly, at all elevators, regardless of whether they are part of an accessible means of egress. Directional signage is not required to meet raised character or braille signage requirements. Depending on the facility, this could be as simple as a basic block plan of the main corridors and stairways in the building in relation to the elevator.

**1009.11 Instructions.** In *areas of refuge* and exterior areas for assisted rescue, instructions on the use of the area under emergency conditions shall be posted. Signage shall comply with the ICC A117.1 requirements for visual characters. The instructions shall include all of the following:

1. Persons able to use the *exit stairway* do so as soon as possible, unless they are assisting others.
2. Information on planned availability of assistance in the use of *stairs* or supervised operation of elevators and how to summon such assistance.
3. Directions for use of the two-way communication system where provided.

❖ The instructions provided at the exterior area of rescue assistance and the areas of refuge will differ. The required instructions on the proper use of the area of refuge and the communication system provide a greater likelihood that the communication system will accomplish its intended function and occupants will behave as expected. A two-way communication system will not be of much value if a person in that area does not know how to operate it. Also, since the area of refuge is required by Section 1009.9 to be identified as such, ambulatory occupants may mistakenly conclude that they should remain in that area. The instructions remind ambulatory occupants that they should continue to egress as soon as possible.

For an exterior area of assisted rescue at grade level, a two-way communication system is not required so this portion of the instructions is not needed. However, instructions for any ambulatory persons to move to the exit discharge are still required, as well as information on how assistance will be provided at this location.

Since each building’s means of egress and fire and safety evacuation plans are unique, specific requirements for verbiage are not indicated, but will depend on the situation. The signage is not required to be raised letters or braille, but is required to meet the style, size and contrast requirements for visual signage in A117.1.

## SECTION 1010 DOORS, GATES AND TURNSTILES

**1010.1 Doors.** *Means of egress* doors shall meet the requirements of this section. Doors serving a *means of egress* system shall meet the requirements of this section and Section 1022.2. Doors provided for egress purposes in numbers

greater than required by this code shall meet the requirements of this section.

*Means of egress* doors shall be readily distinguishable from the adjacent construction and finishes such that the doors are easily recognizable as doors. Mirrors or similar reflecting materials shall not be used on *means of egress* doors. *Means of egress* doors shall not be concealed by curtains, drapes, decorations or similar materials.

❖ The general requirements for doors are in this section and the following subsections. The reference to Section 1022.2 is intended to emphasize that exterior exit doors must lead to a route that will allow a path to a public street or alley (see definition for “Public way”). A door that is intended to be used for egress purposes, even though that door may not be required by the code, is also required to meet the requirements of this section. An example may be an assembly occupancy where four doors would be required to meet the required capacity of the occupant load. But assume the designer elects to provide six doors for aesthetic reasons or occupant convenience. All six doors must comply with the requirements of this section.

Doors need to be easily recognizable for immediate use in an emergency condition. Thus, the code specifies that doors are not to be hidden in such a manner that a person would have trouble seeing where to egress.

**1010.1.1 Size of doors.** The required capacity of each door opening shall be sufficient for the *occupant load* thereof and shall provide a minimum clear width of 32 inches (813 mm). Clear openings of doorways with swinging doors shall be measured between the face of the door and the stop, with the door open 90 degrees (1.57 rad). Where this section requires a minimum clear width of 32 inches (813 mm) and a door opening includes two door leaves without a mullion, one leaf shall provide a clear opening width of 32 inches (813 mm). The maximum width of a swinging door leaf shall be 48 inches (1219 mm) nominal. *Means of egress* doors in a Group I-2 occupancy used for the movement of beds shall provide a clear width not less than 41½ inches (1054 mm). The height of door openings shall be not less than 80 inches (2032 mm).

**Exceptions:**

1. The minimum and maximum width shall not apply to door openings that are not part of the required *means of egress* in Group R-2 and R-3 occupancies.
2. Door openings to resident *sleeping units* in Group I-3 occupancies shall have a clear width of not less than 28 inches (711 mm).
3. Door openings to storage closets less than 10 square feet (0.93 m<sup>2</sup>) in area shall not be limited by the minimum width.
4. Width of door leaves in revolving doors that comply with Section 1010.1.4.1 shall not be limited.

5. Door openings within a *dwelling unit* or *sleeping unit* shall be not less than 78 inches (1981 mm) in height.
6. Exterior door openings in *dwelling units* and *sleeping units*, other than the required *exit* door, shall be not less than 76 inches (1930 mm) in height.
7. In other than Group R-1 occupancies, the minimum widths shall not apply to interior egress doors within a *dwelling unit* or *sleeping unit* that is not required to be an *Accessible unit*, *Type A unit* or *Type B unit*.
8. Door openings required to be *accessible* within *Type B units* shall have a minimum clear width of 31.75 inches (806 mm).
9. Doors to walk-in freezers and coolers less than 1,000 square feet (93 m<sup>2</sup>) in area shall have a maximum width of 60 inches (1524 mm).
10. In Group R-1 *dwelling units* or *sleeping units* not required to be *Accessible units*, the minimum width shall not apply to doors for showers or saunas.

❖ The size of a door opening determines its capacity as a component of egress and its ability to fulfill its function in normal use. A door opening must meet certain minimum criteria as to its width and height in order to be used safely and to provide accessibility to people with physical disabilities. Doorways that are not in the means of egress are not limited in size by this section. However, doors that are used for egress purposes, including additional doors over and above the number of means of egress required by the code, are required to meet the requirements of this section unless one of the exceptions applies.

The minimum clear width of an egress doorway for occupant capacity is based on the portion of the occupant load (see Section 1004.1) intended to utilize the doorway for egress purposes, multiplied by the egress width per occupant from Section 1005.1. The capacity of a 32-inch (813 mm) clear width door is  $32/0.2 = 160$  occupants. The 0.15-inch (3.81 mm) allowance for capacity is permitted in sprinklered buildings ( $32/0.15 = 213$  occupants). The clear width of a swinging door opening is the horizontal dimension measured between the face of the door and the door stops when the door is in the 90-degree (1.57 rad) position [see Commentary Figure 1010.1.1(1)].

Using the face of the door as the measurement point is consistent with the provisions of ICC A117.1 and the ADAAG Review Advisory Committee. Further, this measurement is not intended to prohibit other projections into the required clear width, such as latching or panic hardware [see the commentary to Section 1010.1.1.1 and Commentary Figure 1010.1.1(2) for further discussion on the specific projections allowed in the required clear width]. For non-swinging means of egress doors, such as a sliding

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door, the clear width is to be measured from the face of the door jambs.

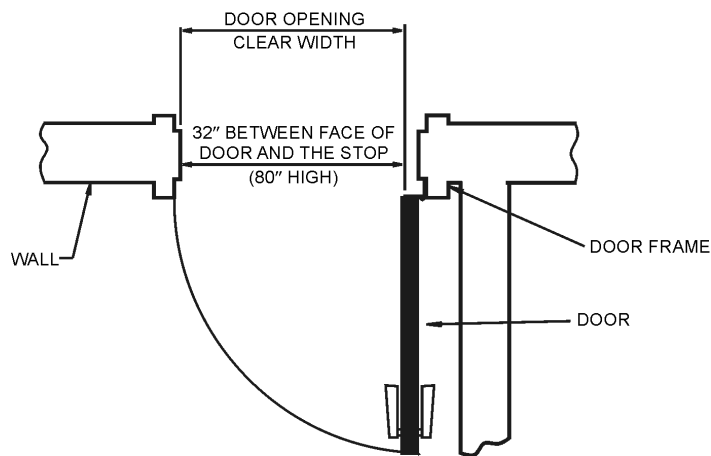
The minimum clear width in a doorway of 32 inches (813 mm) is to allow passage of a wheelchair as well as persons utilizing walking devices or other support apparatus. Similarly, because of the difficulties that a person with physical disabilities would have in opening a pair of doors simultaneously, the 32-inch (813 mm) minimum must be provided by a single door leaf.

Note that in some cases, with standard door construction and hardware, a 36-inch-wide (914 mm) door is the narrowest door that can be used while still providing the minimum clear width of 32 inches (813 mm). A standard 34-inch-wide (864 mm) door has

less than a 32-inch (813 mm) clear opening depending on the thickness of the opposing doorstop, the door thickness and the type of hinge. The building designer must verify that the swinging door specified will in fact provide the required clear width.

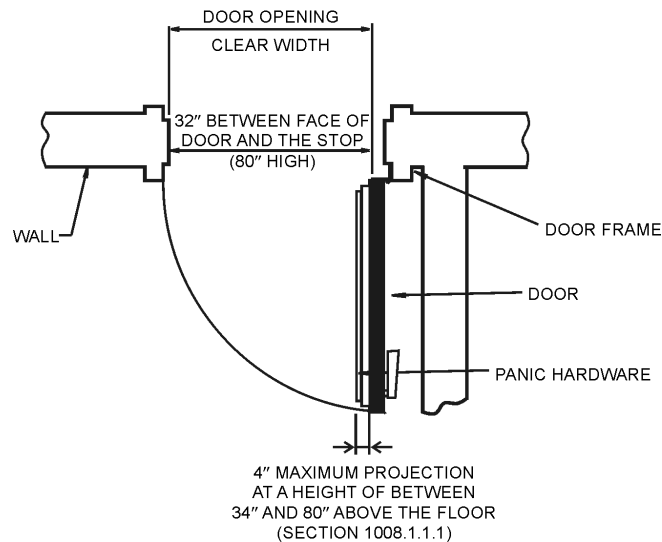
A minimum clear width of 41<sup>1</sup>/<sub>2</sub> inches (1054 mm) is required for doors in any portion of Group I-2 where patients may need to be moved in beds. This is especially important for evacuating patients from the area in the event of a fire.

The maximum width for a means of egress door leaf in a swinging door is 48 inches (1219 mm) because larger doors are difficult to handle and are of sizes that typically are not fire tested. The maximum



For SI: 1 inch = 25.4 mm.

**Figure 1010.1.1(1)**  
**TYPICAL DOOR OPENING CLEARANCE**



For SI: 1 inch = 25.4 mm.

**Figure 1010.1.1(2)**  
**TYPICAL DOOR OPENING CLEARANCE WITH PANIC HARDWARE**

width only applies to swinging doors and not to horizontal sliding doors.

Minimum door heights are required to provide clear headroom for the users. A minimum height of 80 inches (2032 mm) has been empirically derived as sufficient for most users. Note that although the clear height of a doorway is not specified, typical door frame dimensions will render an opening very close to 80 inches (2032 mm) in clear height. The exception in Sections 1003.3.1 and 1010.1.1.1 allows for door closers and doorstops to be as low as 78 inches (1981 mm).

Exception 1 is very limited in scope and is primarily intended to permit decorative-type doors, e.g., café doors, in dwelling units. This exception addresses spaces that are provided with two or more doors when only one means of egress is required. These nonrequired doors are exempted from the minimum and maximum dimensions.

Exception 2 permits the continued use of doors to resident sleeping rooms (cells) in jails (Group I-3) to be a minimum of 28 inches (711 mm), according to current practices.

Exception 3 is for all occupancies. This exception permits doors to storage closets less than 10 square feet (0.9 m<sup>2</sup>) in area to be less than 32 inches (813 mm). This provision is intended to include those closets that can be reached in an arm's length and thus do not require full passage into the closet to be functional.

Exception 4 permits the door leaves in a revolving door assembly to comply with Section 1010.1.4.1, which provides for adequate egress width when the revolving door is collapsed into a breakout position.

Exception 5 permits the doorway within a dwelling or sleeping unit to be a minimum of 78 inches (1981 mm) in clear height. This is deemed acceptable because of the familiarity persons in a dwelling or sleeping unit usually have with the egress system and the lack of adverse injury statistics relating to such doors. Note that this exception does not apply to exterior doors of a townhouse or the main entrance doors leading to the hallway in hotels or apartment buildings. However, exterior doors could use the limited exception for doorstops and closers in Sections 1003.3.1 and 1010.1.1.1.

Exception 6 permits exterior doorways to a dwelling or sleeping unit, except for the required exit door, to be a minimum of 76 inches (1930 mm) in clear height. Accordingly, the required exterior exit door to a dwelling or sleeping unit must be 80 inches (2032 mm) in height (exterior doors are not within the scope of Exception 5), but other exterior doors are allowed to be a height of only 76 inches (1930 mm). This provision allows for the continued use of 76-inch-high (1930 mm) sliding patio doors and swinging doors sized to replace such doors.

Exception 7 allows interior means of egress doors within dwelling or sleeping units to have a clear width less than 32 inches (813 mm). If the dwelling or

sleeping unit is required to be an Accessible, Type A or Type B unit, this exception is not applicable. ICC A117.1 requires door openings within Accessible and Type A units to be 32 inches (813 mm) clear and doors within Type B units to be 31<sup>3</sup>/<sub>4</sub> inches (806 mm) clear. This exception is not applicable to Group R-1. The requirement for all doorways within a Group R-1 unit to be sized to provide access to persons with physical disabilities is applicable to both entrance doors to the units and all doors to rooms in the unit (e.g., bathroom doors). Because of the social interaction and visitation that often occur in lodging facilities, a door opening sized for accessibility (e.g., wheelchairs, walkers, canes, crutches) is deemed necessary to allow people with disabilities to visit a friend's, colleague's or relative's unit. In addition, wider doors provide an additional benefit to all persons handling luggage and bulky items, or for the situation when an Accessible unit is not available. This requirement for Group R-1 occupancies is consistent with the 2010 ADA Standard.

Exception 10 has put in an allowance for sauna and steam room doors in hotels rooms that are not Accessible units. The doors to the bathroom would still have to provide a 32-inch clear width.

Exception 8 addresses the clear width of doors within a Type B dwelling or sleeping unit. The 31<sup>3</sup>/<sub>4</sub>-inch (806 mm) dimension effectively allows for 2-foot, 10-inch (864 mm) doors to be used inside the unit. Again, note that the exterior door to the garden-style apartments or the main door to the hallway from units in an apartment building are not covered by this exception. ICC A117.1 requires the exterior doors of Type B dwelling units to provide a 32-inch (813 mm) clear width. This is consistent with the correlative text in ICC A117.1 for Type B units. Refer to Chapter 11 for additional information related to Type B dwelling and sleeping units.

Exception 9 allows for doors on walk-in freezers and coolers that would allow for the use of small carts to move supplies in and out. Such doors would still have to meet the force requirements in Section 1010.1.3.

**1010.1.1.1 Projections into clear width.** There shall not be projections into the required clear width lower than 34 inches (864 mm) above the floor or ground. Projections into the clear opening width between 34 inches (864 mm) and 80 inches (2032 mm) above the floor or ground shall not exceed 4 inches (102 mm).

**Exception:** Door closers and door stops shall be permitted to be 78 inches (1980 mm) minimum above the floor.

✦ This section of the code provides specific allowances for projection into the required clear widths of means of egress doors. These allowances directly correspond with the method of measuring the required clear width of the door as specified in Section 1010.1.1. A reasonable range of projections for door hardware and trim has been established by these requirements. The use of the means of egress door by a wheelchair occupant will not be significantly

impacted by small projections located in inconspicuous areas. The key to these allowances is their location. Projections are allowed at a height between 34 inches (864 mm) and 80 inches (2032 mm). Below the 34-inch (864 mm) height, the code does not permit any projections since they would decrease the available width for wheelchair operation. The full 32-inch (813 mm) width must be provided at this location. At 34 inches (864 mm) and higher, projections of up to and including 4 inches (102 mm) are permitted. The 4-inch (102 mm) projection is consistent with the allowances of Section 1003.3.3. This section permits door hardware, such as panic hardware, to extend into the clear width, yet maintain accessibility for persons with physical disabilities [see Commentary Figure 1010.1.1(2)].

Allowance must be made for door closers and stops, since their design and function necessitates placement within the door opening. The minimum headroom clearance for door closers and stops is allowed to be 78 inches (1981 mm) [see Commentary Figure 1003.3.1(1)]. The 2-inch (51 mm) projection into the doorway height is reasonable since these devices are normally mounted away from the center of the door opening, thus minimizing the potential for contact with a person moving through the opening. This is consistent with the exception in Section 1003.3.1. Other items that are mounted at the top of the door opening, such as an electromagnetic lock on a pair of doors, would still require an 80-inch (2032 mm) minimum headroom.

While this section deals with door hardware projection within the clear door opening width, door hardware projection into the required width of corridors, aisles, exit passageways and exit discharge is addressed in Section 1005.7.1.

**1010.1.2 Door swing.** Egress doors shall be of the pivoted or side-hinged swinging type.

**Exceptions:**

1. Private garages, office areas, factory and storage areas with an *occupant load* of 10 or less.
2. Group I-3 occupancies used as a place of detention.
3. Critical or intensive care patient rooms within suites of health care facilities.
4. Doors within or serving a single *dwelling unit* in Groups R-2 and R-3.
5. In other than Group H occupancies, revolving doors complying with Section 1010.1.4.1.
6. In other than Group H occupancies, special purpose horizontal sliding, accordion or folding door assemblies complying with Section 1010.1.4.3.
7. Power-operated doors in accordance with Section 1010.1.4.2.
8. Doors serving a bathroom within an individual *sleeping unit* in Group R-1.

9. In other than Group H occupancies, manually operated horizontal sliding doors are permitted in a *means of egress* from spaces with an *occupant load* of 10 or less.

❖ Generally, egress doors are required to be the side-swinging type. The swinging hardware can be either a hinge or a pivot type (see the definition for “Balanced door”). Side-swinging doors are familiar to all occupants in the method of operation. Door designs with pivots are permitted by this section since the door action itself has little difference between the side-hinged-type door.

The code has several conditions where it allows doors that are not side-hinged-swinging types.

Examples of the doors permitted in Exception 1 are overhead garage doors and horizontal sliding doors. Exception 1 allows doors other than the swinging type for the listed uses where the number of occupants is very low.

Exception 2 allows for the sliding-type doors that are commonly used in prisons and jails.

Exception 3 allows for sliding doors between nursing areas and patient rooms in critical care and intensive care suites. Patients are not typically moving around on their own in these areas, visitors are extremely limited, the glass doors allow a better view for nurse supervision and the sliding option allows for equipment locations unaffected by door swing. See also IBC Section 407 and Sections 1010.1.9.6 and 1010.1.9.8 of the code for these types of areas.

Exception 4 allows for sliding-type doors or pocket-type doors within or serving individual units in a non-transient residential occupancy. Residents are typically familiar with the door operation. The use of sliding doors on the interior of dwelling units is permitted by the Fair Housing Accessibility Guidelines (FHAG) and by ICC A117.1 for Accessible, Type A and Type B units.

Exception 5 allows for revolving doors that meet the requirements of Section 1010.1.4.1. Revolving doors are not permitted for egress from high-hazard spaces.

Exception 6 allows for special-purpose horizontal sliding, accordion or folding doors that meet the requirements of Section 1010.1.4.3 to be used in the means of egress. The doors addressed by Section 1010.1.4.3 are commonly in the normally-open position (hidden in their enclosure). In the event of fire or smoke, where these doors are installed in the means of egress, Section 1010.1.4.3 requires the doors to be power operated but also openable manually to the required minimum egress width. This exception is intended to allow wide span openings to be used in a means of egress.

Exception 7 allows for power-operated doors that meet the requirements of Section 1010.1.4.2. This is to enhance the movement of the general population as well as people with mobility impairments to areas

of safety without obstructions, since the specified doors afford simple operation by persons for both typical and emergency operation.

Exception 8 allows for pocket doors between the bathrooms and living or sleeping space within hotel rooms. Since the bathroom is most commonly placed immediately inside the entrance to the room, a side-swinging door could be an obstruction for a person entering carrying suitcases. Familiarity with these types of doors and minimal occupant loads makes this situation acceptable.

Exception 9 partially overlaps the allowances in Exception 1 for horizontal sliding doors by matching the 10 or less occupant load, but extends the use to all other groups except for high hazard. For example, some emergency rooms or clinics use glazed horizontal sliding doors to divide patient care rooms providing for increased privacy and infection control while still allowing visual supervision. Another example would be that a pocket door may be used for access to a bathroom within a private office. The allowance for such a manually operated horizontal sliding door provides greater design flexibility and efficiency, while at the same time maintaining an acceptable level of safety.

**1010.1.2.1 Direction of swing.** Pivot or side-hinged swinging doors shall swing in the direction of egress travel where serving a room or area containing an occupant load of 50 or more persons or a Group H occupancy.

❖ A side-hinged door must swing in the direction of egress travel where the required occupant capacity of the room is 50 or more. As such, a room with two doors and an occupant load of 99 would require both doors to swing in the direction of egress travel, even though each door has a calculated occupant usage of less than 50. At this level of occupant load, the possibility exists that, in an emergency situation, a compact line of people could form at a closed door that swings in a direction opposite the egress flow. This could delay or eliminate the first person's ability to open the door inward with the rest of the queue behind the person.

In a Group H occupancy, the threat of rapid fire buildup, or worse, is such that any delay in egress caused by door swing may jeopardize the opportunity for all occupants to evacuate the premises. For this reason, all egress doors in Group H occupancies are to swing in the direction of egress.

**1010.1.3 Door opening force.** The force for pushing or pulling open interior swinging egress doors, other than fire doors, shall not exceed 5 pounds (22 N). These forces do not apply to the force required to retract latch bolts or disengage other devices that hold the door in a closed position. For other swinging doors, as well as sliding and folding doors, the door latch shall release when subjected to a 15-pound (67 N) force.

The door shall be set in motion when subjected to a 30-pound (133 N) force. The door shall swing to a full-open position when subjected to a 15-pound (67 N) force.

❖ The ability of all potential users to be physically capable of opening an egress door is a function of the forces required to open the door. The 5-pound (22 N) maximum force for pushing and pulling interior swinging doors without closers that are part of the means of egress inside a building is based on that which has been deemed appropriate for people with a physical limitation due to size, age or disability. The operating force is permitted to be higher for all exterior doors, interior swinging doors that are not part of the means of egress, doors that are part of the means of egress but also serve as opening protectives in fire-resistance-rated walls (i.e., fire doors), sliding doors and folding doors. This recognizes that doors with closers, particularly fire doors, require greater operating forces in order to close fully in an emergency where combustion gases may be exerting pressure on the door assembly. Similarly, exterior doors are exempted because air pressure differentials and strong winds may prevent doors from being fully automatically closed.

The opening force is different than the force to retract bolts or operate other types of door hardware. A maximum force of 15 pounds (67 N) is required for operating the latching mechanism. Once unlatched, a maximum force of 30 pounds (133 N) is applied to the latch side of the leaf to start the door in motion by overcoming its stationary inertia. Once in motion, it must not take more than 15 pounds (67 N) of force to keep the door in motion until it reaches its full open position and the required clear width is available. To conform to this requirement on a continual basis, door closers must be adjusted periodically and door fits must also be checked and adjusted when necessary.

**1010.1.3.1 Location of applied forces.** Forces shall be applied to the latch side of the door.

❖ See the commentary for door opening forces in Section 1010.1.3.

**1010.1.4 Special doors.** Special doors and security grilles shall comply with the requirements of Sections 1010.1.4.1 through 1010.1.4.4.

❖ This section simply defines the scope of the code requirements for special doors such as revolving doors, power-operated swinging doors, power-operated horizontal sliding doors and security grilles

**1010.1.4.1 Revolving doors.** Revolving doors shall comply with the following:

1. Revolving doors shall comply with BHMA A156.27 and shall be installed in accordance with the manufacturer's instructions.

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- Each revolving door shall be capable of *breakout* in accordance with BHMA A156.27 and shall provide an aggregate width of not less than 36 inches (914 mm).
- A revolving door shall not be located within 10 feet (3048 mm) of the foot or top of *stairways* or escalators. A dispersal area shall be provided between the *stairways* or escalators and the revolving doors.
- The revolutions per minute (rpm) for a revolving door shall not exceed the maximum rpm as specified in BHMA A156.27. Manual revolving doors shall comply with Table 1010.1.4.1(1). Automatic or power-operated revolving doors shall comply with Table 1010.1.4.1(2).
- An emergency stop switch shall be provided near each entry point of power or automatic operated revolving doors within 48 inches (1220 mm) of the door and between 24 inches (610 mm) and 48 inches (1220 mm) above the floor. The activation area of the emergency stop switch button shall be not less than 1 inch (25 mm) in diameter and shall be red.
- Each revolving door shall have a side-hinged swinging door that complies with Section 1010.1 in the same wall and within 10 feet (3048 mm) of the revolving door.
- Revolving doors shall not be part of an *accessible route* required by Section 1009 and Chapter 11.

❖ Revolving doors must comply with all seven provisions.

Item 1: BHMA A156.27 is the revolving door industry standard and includes numerous safety-related requirements for revolving doors. For example, BHMA A156.27 requires manually operated revolving doors to contain governors to limit the rotational speed of the door. For automatic, or power-operated, revolving doors, BHMA A156.27 includes requirements for numerous sensors and switches, and complex motor controls to safely operate the door.

Item 2: One of the causes contributing to the loss of lives in the 1942 Coconut Grove fire in Boston was that the revolving doors at the club's entrance could not collapse (*breakout*) for emergency egress and there was not an alternative means of egress adjacent to the revolving doors. Thus, in the panic of the fire, the door became jammed and the club's occupants were trapped.

As a result of this fire experience, all revolving doors, including those for air structures, now are required to be equipped with a breakout feature. A breakout operation is where all leaves collapse parallel to each other and to the direction of egress [see Commentary Figure 1010.1.4.1(1)]. A breakout operation creates two openings of approximately equal width. The sum of the widths is not to be less than 36 inches (914 mm) so that a stream of pedestrians may use each side of the opening. BHMA A156.27 includes explicit breakout requirements for the wide range of sizes and configurations of manual and automatic revolving doors.

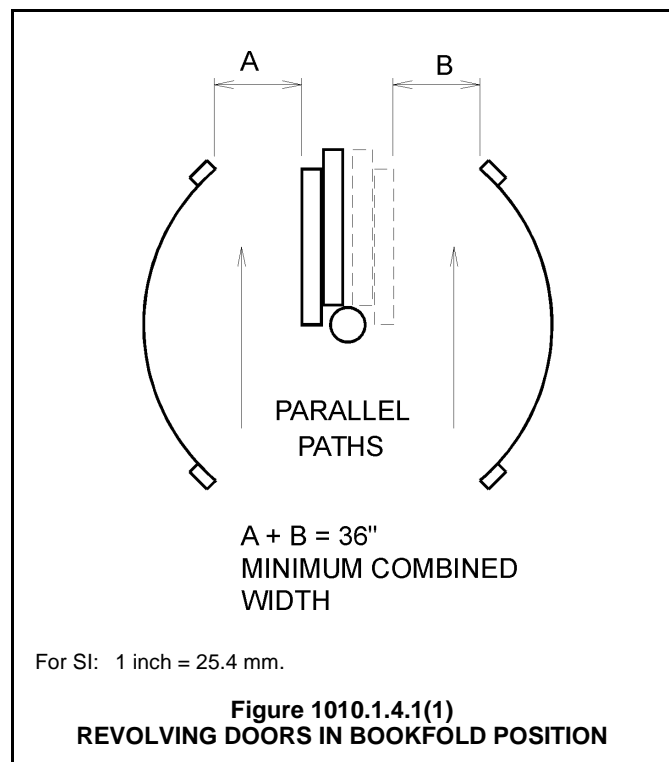
Item 3: If a stairway or escalator delivers users to a

landing in front of a revolving door at a greater rate than the capacity of the door, a compact line of people will develop. Lines of people formed on a stairway or escalator create an unsafe situation, since stairways and escalators are not intended to be used as standing space for persons who may be waiting to use the revolving doors. Therefore, to avoid congestion at a revolving door that under normal operation has a maximum delivery capacity of users, a dispersal area is required between the stairways or escalators and the revolving doors to allow for the queuing of people as they enter the door. Accordingly, to create a dispersal area for users of a revolving door, the door is not to be placed closer than 10 feet (3048 mm) from the foot or top of a stairway or escalator.

Item 4: Door speeds also directly relate to the capacity of a revolving door, which is calculated by multiplying the number of leaves (wings) by the revolutions per minute (rpm). For example, if you have a four-leaf door (four-bay door) moving at 10 rpm, the door will allow 40 people to move in either direction in 1 minute. The larger revolving doors are designed to allow more than one person in each bay, and this should be taken into account when calculating the capacity of a revolving door.

Item 5: An emergency stop switch near each entry point of automatic or power-operated revolving doors provides a method to stop the door's operation.

Item 6: In case a revolving door malfunctions or becomes obstructed, the adjacent area is to be equipped with a conventional side-hinged door to provide users with an immediate alternative way to exit a building. The side-hinged door is intended to be



used as a relief device for people lined up to use the revolving door or who desire to avoid it because of a physical disability or other reason. It also can be used when the revolving door is obstructed or out of service. The swinging door is to be immediately adjacent to the revolving door so that its availability is obvious [see Commentary Figure 1010.1.4.1(2)]. A single swinging door can be located between side-by-side revolving doors in order to comply with this provision.

Item 7: While some revolving doors may be considered part of a means of egress, they cannot be considered part of a required accessible route for either ingress or egress. This requirement is consistent with ICC A117.1, which also prohibits revolving gates and turnstiles along the only accessible route. The side-swinging door required by Item 6 can serve as the accessible entrance or exit required by Section 1009 and IBC Section 1105.

A route through a hinged or sliding door differs remarkably from that provided through a revolving door. For a revolving door, the route includes a turn into the doorway, an arcing path of travel as the door revolves, followed by a change of direction when leaving the door. Items that may cause difficulty for anyone with mobility impairments could involve the overall doorway diameter, the number of leaves and their relative angle, and the configuration of the return walls surrounding the revolving door. Additionally, the speed of the door movement if motorized, or the force required for movement if not motorized, would be a concern for anyone who needed to keep both hands on their device to move forward (e.g., walker or wheelchair).

Automatic revolving doors, if large enough, may be usable by many people who use wheelchairs. However, the intent of this section is that these types of doors not be the only means of passage at an entrance or exit. An alternative door in full compliance with this section is considered necessary because some people with disabilities may be uncertain of the usability, or may not have enough strength or speed to use them. Although manufacturers have developed safety criteria, certain questions remain, such as the appropriate maximum and minimum speeds that would work for persons trying to maneuver a wheelchair through a revolving door.

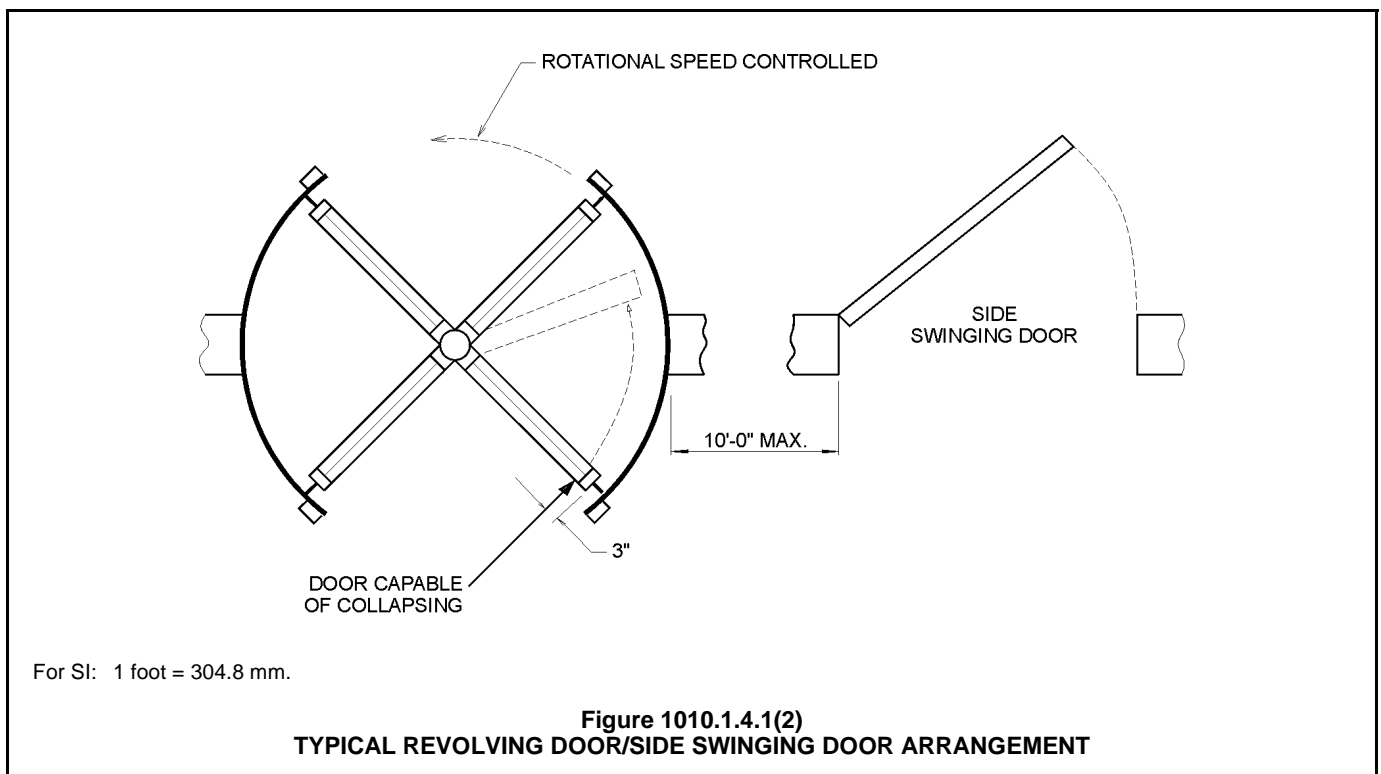
Revolving doors range from (smaller) manually operated revolving door systems to automatic (power operated) revolving doors of small (8-foot) to large (24-foot) diameter. Three configurations of revolving doors are illustrated in Commentary Figures 1010.1.4(3) through 1010.1.4(5).

**TABLE 1010.1.4.1(1)  
MAXIMUM DOOR SPEED MANUAL REVOLVING DOORS**

REVOLVING DOOR MAXIMUM NOMINAL DIAMETER (FT-IN)	MAXIMUM ALLOWABLE REVOLVING DOOR SPEED (RPM)
6-0	12
7-0	11
8-0	10
9-0	9
10-0	8

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

❖ See the commentary for Section 1010.1.4 and Table 1010.1.4.1(2).



MEANS OF EGRESS

**TABLE 1010.1.4.1(2)  
MAXIMUM DOOR SPEED AUTOMATIC OR  
POWER-OPERATED REVOLVING DOORS**

REVOLVING DOOR MAXIMUM NOMINAL DIAMETER (FT-IN)	MAXIMUM ALLOWABLE REVOLVING DOOR SPEED (RPM)
8-0	7.2
9-0	6.4
10-0	5.7
11-0	5.2
12-0	4.8
12-6	4.6
14-0	4.1
16-0	3.6
17-0	3.4
18-0	3.2
20-0	2.9
24-0	2.4

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

❖ Door speeds also directly relate to the capacity of a revolving door, which is calculated for smaller revolving doors by multiplying the number of leaves (wings) by the revolutions per minute (rpm). For example, if you have an 8-foot diameter four-leaf door (four-bay door) moving at 10 rpm, the door will allow 40 people to move in either direction in 1 minute. Larger revolving doors may be designed to allow for more than one person in each bay as the door rotates, which should be taken into account when determining maximum egress capacity of the revolving door.

**1010.1.4.1.1 Egress component.** A revolving door used as a component of a *means of egress* shall comply with Section 1010.1.4.1 and the following three conditions:

1. Revolving doors shall not be given credit for more than 50 percent of the minimum width or required capacity.
2. Each revolving door shall be credited with a capacity based on not more than a 50-person *occupant load*.



**Figure 1010.1.4.1(4)  
EXAMPLE OF AUTOMATIC REVOLVING DOOR  
(8-FOOT DIAMETER)**



**Figure 1010.1.4.1(3)  
EXAMPLE OF MANUAL REVOLVING DOOR  
(7-FOOT DIAMETER)**



**Figure 1010.1.4.1(5)  
EXAMPLE OF AUTOMATIC REVOLVING DOOR  
(20-FOOT DIAMETER)**

3. Each revolving door shall provide for egress in accordance with BHMA A156.27 with a *breakout* force of not more than 130 pounds (578 N).

❖ A revolving door can be incorporated, to a very limited extent, in a means of egress. Compliance with these three additional conditions is required.

Condition 1 limits the exit capacity that revolving doors can provide in a building. This is so that 50 percent of the capacity has conventional egress components and is not dependent on mechanical devices or fail-safe mechanisms.

Condition 2 limits the capacity of any one revolving door for the same reasons as stated in Condition 1. Each revolving door is therefore limited to a 50-person capacity.

Condition 3 limits the breakout force to 130 pounds (578 N), as opposed to the 180-pound (792 N) value listed in Section 1010.1.4.1.2. Revolving doors used as means of egress are not permitted to have the breakout force exceed 130 pounds (578 N) under any circumstances.

**1010.1.4.1.2 Other than egress component.** A revolving door used as other than a component of a *means of egress* shall comply with Section 1010.1.4.1. The *breakout* force of a revolving door not used as a component of a *means of egress* shall not be more than 180 pounds (801 N).

**Exception:** A *breakout* force in excess of 180 pounds (801 N) is permitted if the collapsing force is reduced to not more than 130 pounds (578 N) when not less than one of the following conditions is satisfied:

1. There is a power failure or power is removed to the device holding the door wings in position.
2. There is an actuation of the *automatic sprinkler system* where such system is provided.
3. There is an actuation of a smoke detection system that is installed in accordance with Section 907 to provide coverage in areas within the building that are within 75 feet (22 860 mm) of the revolving doors.
4. There is an actuation of a manual control switch, in an approved location and clearly identified, that reduces the *breakout* force to not more than 130 pounds (578 N).

❖ This section addresses revolving doors that are not used to serve any portion of the occupant egress capacity. For example, where adjacent side-hinged doors have more than the required egress capacity, the revolving door would not be part of the required means of egress.

The maximum breakout force of 180 pounds (792 N), applied within 3 inches (76 mm) of the outer edge of a wing, is based on industry standards to accommodate normal use conditions and other forces that may act on the leaves, such as those caused by wind or air pressure. An exception for revolving doors that are not a component of a required means of egress allows the breakout force to exceed 180 pounds (792

N) in normal operating conditions provided that a force of not more than 130 pounds (578 N) is required whenever any one of the listed conditions is satisfied.

**1010.1.4.2 Power-operated doors.** Where *means of egress* doors are operated or assisted by power, the design shall be such that in the event of power failure, the door is capable of being opened manually to permit *means of egress* travel or closed where necessary to safeguard *means of egress*. The forces required to open these doors manually shall not exceed those specified in Section 1010.1.3, except that the force to set the door in motion shall not exceed 50 pounds (220 N). The door shall be capable of swinging open from any position to the full width of the opening in which such door is installed when a force is applied to the door on the side from which egress is made. Power-operated swinging doors, power-operated sliding doors and power-operated folding doors shall comply with BHMA A156.10. Power-assisted swinging doors and low-energy power-operated swinging doors shall comply with BHMA A156.19.

**Exceptions:**

1. Occupancies in Group I-3.
2. Horizontal sliding doors complying with Section 1010.1.4.3.
3. For a biparting door in the emergency breakout mode, a door leaf located within a multiple-leaf opening shall be exempt from the minimum 32-inch (813 mm) single-leaf requirement of Section 1010.1.1, provided a minimum 32-inch (813 mm) clear opening is provided when the two biparting leaves meeting in the center are broken out.

❖ For convenience purposes, power-operated doors are intended to facilitate the normal nonemergency flow of persons through a doorway. Where a power-operated or power-assisted door is also required to be an egress door, the door must conform to the requirements of this section. The essential characteristic is that the door is to be manually openable from any position to its full open position at any time, with or without a power failure or a failure of a door mechanism. Hence, both swinging and horizontal sliding doors, complying with this section, may be used, provided the door can be operated manually from any position as a swinging door and that the minimum required clear width for egress capacity is not less than 32 inches (813 mm). Note that the opening forces of Section 1010.1.3 are applicable, except that the 30-pound (133 N) force needed to set the door in motion is increased to 50 pounds (220 N) as an operational tolerance in the design of the power-operated door.

Definitions for the different types of power-operated doors were added to the 2015 IBC to help clarify which standard (BHMA A156.10 or BHMA A156.19) is applicable to which type of power-operated door.

*Power-operated doors* are required to comply with BHMA A156.10. These doors open automatically when approached by a person or upon an action by a person, close automatically and include provisions

such as presence sensors to prevent entrapment. *Low-energy power-operated doors* are required to comply with BHMA A56.19. These doors are always swinging doors which open automatically upon an action by a person such as pressing a push plate or waving a hand in front of a sensor. Additionally, these doors close automatically and operate with decreased forces and decreased speeds (compared to *power-operated doors*). Least common are *power-assisted doors*, which are required to comply with BHMA A156.19. These doors are swinging doors which open by reduced pushing or pulling force on the door-operating hardware, close automatically after the pushing or pulling force is released and function with decreased forces.

In accordance with Exception 1, power-operated doors in detention and correctional occupancies (Group I-3) are not required to be manually operable by the occupants (inmates) for security reasons, but otherwise are required to conform to IBC Section 408.

Exception 2 states that power-operated, special-purpose horizontal sliding accordion or folding doors that meet the requirements of Section 1010.1.4.3 are not required to meet the requirements of Section 1010.1.4.2. This is consistent with the option offered in Section 1010.1.2 by Exception 6.

Exception 3 allows an individual leaf of a four-panel biparting door to be less than 32 inches (813 mm) wide, provided 32 inches (813 mm) of clear space is available when the two center biparting leaves are broken out as part of the emergency breakaway feature.

**1010.1.4.3 Special purpose horizontal sliding, accordion or folding doors.** In other than Group H occupancies, special purpose horizontal sliding, accordion or folding door assemblies permitted to be a component of a *means of egress* in accordance with Exception 6 to Section 1010.1.2 shall comply with all of the following criteria:

1. The doors shall be power operated and shall be capable of being operated manually in the event of power failure.
  2. The doors shall be openable by a simple method from both sides without special knowledge or effort.
  3. The force required to operate the door shall not exceed 30 pounds (133 N) to set the door in motion and 15 pounds (67 N) to close the door or open it to the minimum required width.
  4. The door shall be openable with a force not to exceed 15 pounds (67 N) when a force of 250 pounds (1100 N) is applied perpendicular to the door adjacent to the operating device.
  5. The door assembly shall comply with the applicable *fire protection rating* and, where rated, shall be self-closing or automatic closing by smoke detection in accordance with Section 716.5.9.3, shall be installed in accordance with NFPA 80 and shall comply with Section 716.
  6. The door assembly shall have an integrated standby power supply.
  7. The door assembly power supply shall be electrically supervised.
  8. The door shall open to the minimum required width within 10 seconds after activation of the operating device.
- ❖ Special purpose horizontal sliding, accordion or folding doors are permitted in the means of egress, in other than rooms or areas of Group H, under the conditions set forth in this section. Special purpose horizontal sliding, accordion or folding doors are not permitted to be used in Group H occupancies because of the potential for delaying or impeding egress from those areas and the additional risk to occupants in hazardous occupancies. Note that this section regulates doors that are part of the means of egress to meet a set of requirements different than Section 1010.1.4.2 (e.g., a power-operated horizontal sliding door that does not have “breakout” capabilities to allow the door panels to swing if power is lost). The doors addressed by Section 1010.1.4.3 are commonly in the normally open position (hidden in their enclosure).
- All eight of the criteria listed in this section must be met for a special purpose horizontal sliding, accordion or folding door since there is a concern that it must be able to be easily opened to the minimum required width under all conditions.
- Additionally, the door must be openable even if a force of 250 pounds (1100 N) is being applied perpendicular to it, as may occur if a group of people were pushing on it.
- Since the doors are manually operable, they need not automatically open or close during a loss of power; however, a standby power supply must be provided. The primary power supply must be supervised so that an alarm is received at a constantly attended location (such as a security desk) on loss of the primary power. If the doors are also serving as opening protective (i.e., fire doors), they must be automatic closing or self-closing in accordance with IBC Section 716.
- Since the maximum swinging door leaf width limitations of Section 1008.1.1 do not apply, a maximum opening time of 10 seconds is permitted. It should be noted, however, that the door need not open fully within the 10 seconds; rather, it must open to the minimum required width. For example, if the door is protecting an opening that is 10 feet (3048 mm) wide, but the minimum required width of the opening is 32 inches (813 mm) (as determined by Section 1008.1.1), the door need only open 32 inches (813 mm) within the 10-second criterion. In fact, the door may have controls such that the automatic opening feature only opens the door to a width of 32 inches (813 mm). If additional width is required, it can be accomplished by manual means and, possibly, by an additional activation of the operating device.

**1010.1.4.4 Security grilles.** In Groups B, F, M and S, horizontal sliding or vertical security grilles are permitted at the main *exit* and shall be openable from the inside without the use of a key or special knowledge or effort during periods that the space is occupied. The grilles shall remain secured in the full-open position during the period of occupancy by the general public. Where two or more *means of egress* are required, not more than one-half of the *exits* or *exit access doorways* shall be equipped with horizontal sliding or vertical security grilles.

❖ This section really functions as an exception to several sections, including Sections 1010.1.2 (Door swing) and 1010.1.9.3 (Locks and latches), and permits the use of these security grilles under conditions that are similar to those found in IBC Section 402 for covered mall buildings. These security grilles will be open when the space is occupied and will, therefore, not obstruct any egress path. Since the building may be partially used (e.g., team practice in a football stadium) when not fully occupied, no more than one-half of the exits from the building can be through security grilles.

**1010.1.5 Floor elevation.** There shall be a floor or landing on each side of a door. Such floor or landing shall be at the same elevation on each side of the door. Landings shall be level except for exterior landings, which are permitted to have a slope not to exceed 0.25 unit vertical in 12 units horizontal (2-percent slope).

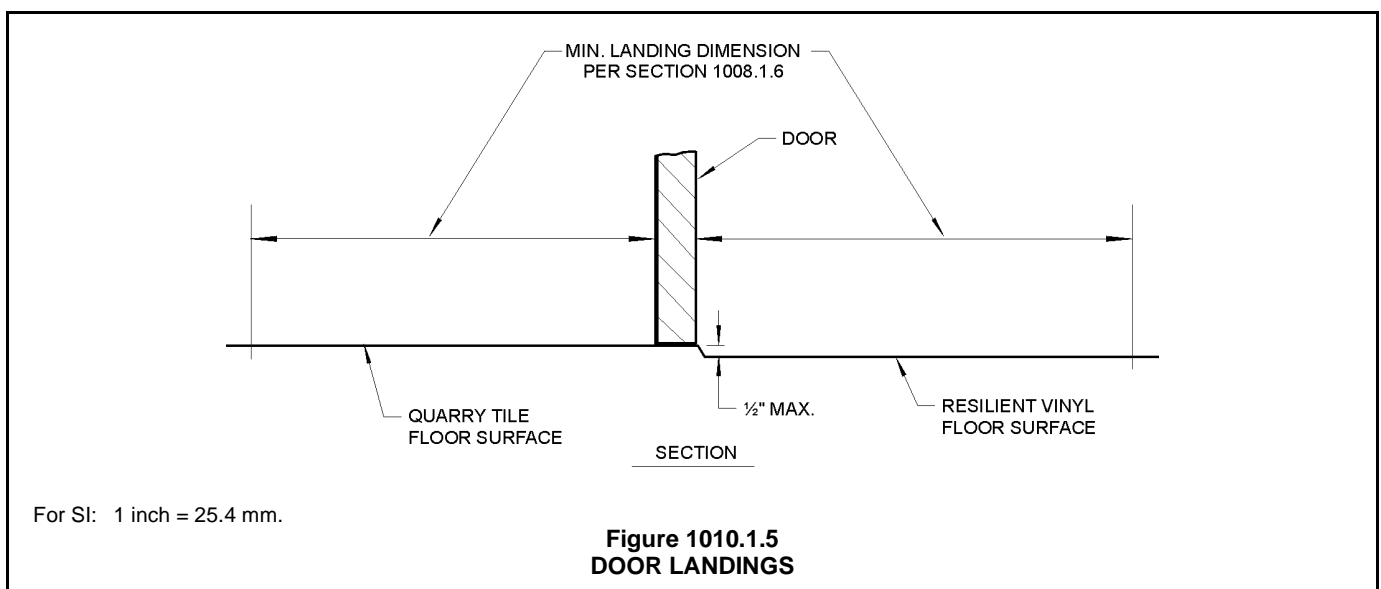
**Exceptions:**

1. Doors serving individual *dwelling units* in Groups R-2 and R-3 where the following apply:
  - 1.1. A door is permitted to open at the top step of an interior *flight of stairs*, provided the door does not swing over the top step.
  - 1.2. Screen doors and storm doors are permitted to swing over *stairs* or landings.

2. Exterior doors as provided for in Section 1003.5, Exception 1, and Section 1022.2, which are not on an *accessible route*.
3. In Group R-3 occupancies not required to be *Accessible units, Type A units* or *Type B units*, the landing at an exterior doorway shall be not more than 7<sup>3</sup>/<sub>4</sub> inches (197 mm) below the top of the threshold, provided the door, other than an exterior storm or screen door, does not swing over the landing.
4. Variations in elevation due to differences in finish materials, but not more than 1/2 inch (12.7 mm).
5. Exterior decks, patios or balconies that are part of *Type B dwelling units*, have impervious surfaces and that are not more than 4 inches (102 mm) below the finished floor level of the adjacent interior space of the dwelling unit.
6. Doors serving equipment spaces not required to be *accessible* in accordance with Section 1103.2.9 and serving an occupant load of five or less shall be permitted to have a landing on one side to be not more than 7 inches (178 mm) above or below the landing on the egress side of the door.

❖ Changes in floor surface elevation at a door, however small, often are slip or trip hazards. This is because persons passing through a door, including those who may have some mobility impairments, usually do not expect changes in floor surface elevation or are not able to recognize them because of the intervening door leaf. Under emergency conditions, a fall in a doorway could result not only in injury to the falling occupant but also interruption of orderly egress by other occupants. The exterior landing is allowed to slope to drain.

The size of this landing is set by Section 1010.1.6. In accordance with Exception 4, the floor surface elevation of the landing is to be at the same elevation plus or minus 1/2 inch (12.7 mm) (see Commentary Figure 1010.1.5).



Note that some of the exceptions indicate which direction the door swings to allow the exceptions while others do not limit the door swing direction.

Exception 1, which applies to nontransient residential occupancies, recognizes that occupants are familiar with the stair and landing arrangements. In Exception 1.1, an interior stairway can start immediately at the door, provided the door leaf does not swing over the stairway. Exception 1.2 clarifies that a screen door or storm door would not be considered the main door prohibited from swinging over the stairway by Exception 1.1.

Exception 2 references two other locations. Section 1003.5, Exception 1, permits a 7-inch (178 mm) change in elevation at exterior doors in Groups F, H, R-2, R-3, S and U if they are not on an accessible route. The door could swing in either direction for this exception and may actually be required to swing out in accordance with Section 1010.1.2. A reference to Section 1022.2 does not address a change in elevation but does address exterior exit doors.

In accordance with Exception 3, for a residential unit, the step-down is limited to  $7\frac{3}{4}$  inches (197 mm) measured from the top of the threshold rather than the interior floor surface. In addition, the exterior door cannot swing over the exterior landing. A screen door or storm door could swing over the exterior landing. This is consistent with the exception to Section 1010.1.7.

Exception 4 addresses a change in floor finish material (see Commentary Figure 1010.1.5).

In accordance with Exception 5, Type B dwelling or sleeping units are not required to have level landings on both sides of some of the exterior doors. Please note that this exception is not applicable for the primary entrance door to the unit (see Section 1105.1.7). Exterior doors that open out onto an exterior deck, patio or balcony are allowed a 4-inch (102 mm) step down. Type B units are established by Chapter 11 for residential occupancies containing four or more dwelling or sleeping units. In order to use this exception, the exterior decks, patios or balconies must be of solid and impervious construction, such as concrete or wood. A 4-inch (102 mm) step from inside the unit down to the exterior surfaces is allowed for weather purposes. This allowance is consistent with the provisions of ICC A117.1 and Fair Housing Accessibility Guidelines (FHAG).

While Exception 2 would allow for exterior doors of Group F or S to have a step down, it would not have this same allowance for small equipment spaces within a building. Sometimes these rooms have a step down to allow for spills within the space to not leak out under the door. This space is not required to be accessible (see IBC Section 1103.2.9) and the space is only accessed by maintenance and service personnel, so a step down would not be a barrier.

**1010.1.6 Landings at doors.** Landings shall have a width not less than the width of the *stairway* or the door, whichever is greater. Doors in the fully open position shall not reduce a

required dimension by more than 7 inches (178 mm). Where a landing serves an *occupant load* of 50 or more, doors in any position shall not reduce the landing to less than one-half its required width. Landings shall have a length measured in the direction of travel of not less than 44 inches (1118 mm).

**Exception:** Landing length in the direction of travel in Groups R-3 and U and within individual units of Group R-2 need not exceed 36 inches (914 mm).

❖ Door landings are at either side of the door. Landings can overlap floor surfaces within a room or corridor, overlap an exterior porch or balcony, or share the landings for stairways. The 7-inch (178 mm) encroachment and one-half required width limitations are consistent with Section 1005.7 for door encroachment. Section 1005.7 deals with egress width and capacity and is referenced from aisles (see Section 1018.1), corridors (see Section 1020.3), exit passageways (see Section 1024.2) and egress courts (see Section 1028.4.1).

This section also is intended to address landings at the entrance door to enclosed stairways (also see Section 1011.6 for stairway landings). The width of a landing at a door in a stairway is to be not less than the width of the stairway or the door, whichever is greater [see Commentary Figure 1011.6(4) for an example of these provisions].

No matter what size the door or stair landing is, door landings are to have the floor elevation requirements of Section 1010.1.5 extending at least 44 inches (1118 mm) in the direction of egress travel.

The reduction in landing length from 44 inches minimum to 36 inches minimum for certain residential occupancies allowed by the exception is in recognition of their low occupant load.

**1010.1.7 Thresholds.** Thresholds at doorways shall not exceed  $\frac{3}{4}$  inch (19.1 mm) in height above the finished floor or landing for sliding doors serving *dwelling units* or  $\frac{1}{2}$  inch (12.7 mm) above the finished floor or landing for other doors. Raised thresholds and floor level changes greater than  $\frac{1}{4}$  inch (6.4 mm) at doorways shall be beveled with a slope not greater than one unit vertical in two units horizontal (50-percent slope).

**Exceptions:**

1. In occupancy Group R-2 or R-3, threshold heights for sliding and side-hinged exterior doors shall be permitted to be up to  $7\frac{3}{4}$  inches (197 mm) in height if all of the following apply:
  - 1.1. The door is not part of the required *means of egress*.
  - 1.2. The door is not part of an *accessible route* as required by Chapter 11.
  - 1.3. The door is not part of an *Accessible unit, Type A unit* or *Type B unit*.
2. In *Type B units*, where Exception 5 to Section 1010.1.5 permits a 4-inch (102 mm) elevation change at the door, the threshold height on the exterior side of the door shall not exceed  $4\frac{3}{4}$  inches (120

mm) in height above the exterior deck, patio or balcony for sliding doors or 4 1/2 inches (114 mm) above the exterior deck, patio or balcony for other doors.

- ❖ A threshold is a potential tripping hazard and a barrier to accessibility by people with mobility impairments. For these reasons, thresholds for all doorways, except exterior sliding doors serving dwelling units, are to be a maximum of 1/2 inch (12.7 mm) high. Exterior sliding doors serving dwelling units, however, are permitted to be 3/4 inch (19.1 mm) high because of practical design considerations, concern for deterioration of the doorway because of snow and ice buildup and lack of adequate drainage in severe climates. Raised threshold and floor level changes at doorways without beveled edge treatment [see Commentary Figure 1010.1.7(1)] are limited to 1/4 inch (6.3 mm) high vertically.

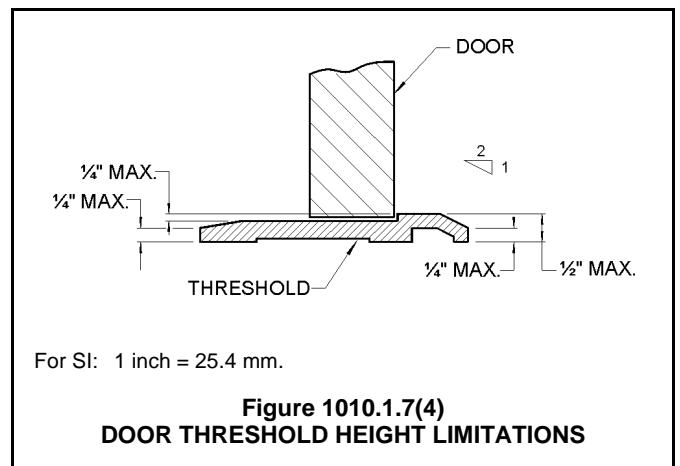
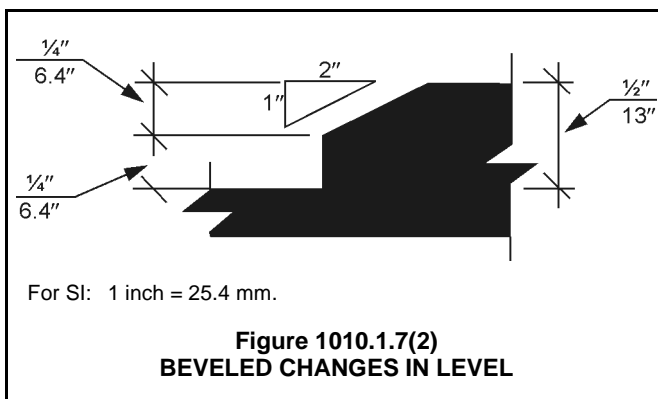
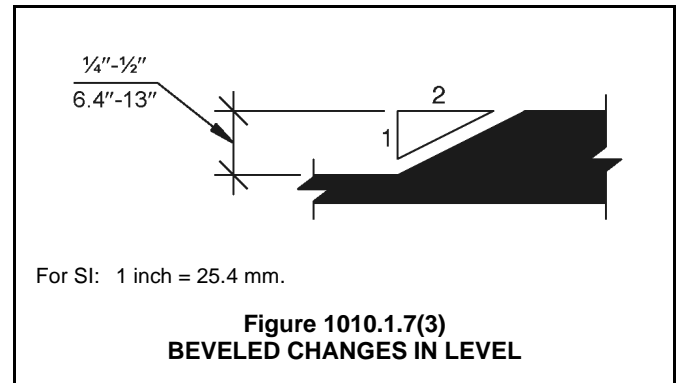
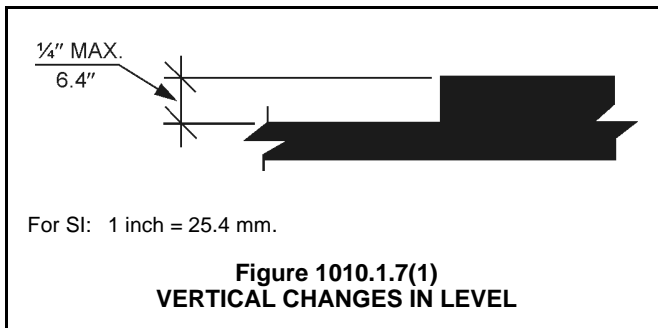
Commentary Figures 1010.1.7(2), 1010.1.7(3) and 1010.1.7(4) illustrate configurations where the change in elevation is between 1/4 inch (6.4 mm) and 1/2 inch (12.7 mm). The slope of required beveled edges cannot exceed one unit vertical in two units horizontal (1:2 or 50-percent slope) but lesser slopes are fully compliant. This kind of threshold treatment provides for minimum obstructions for wheelchair users and limits the trip hazard for those with other mobility disabilities.

The first exception permits a 7/4-inch (197 mm) threshold at both side-swinging and sliding exterior doors in Group R-2 and R-3 buildings. However, this door cannot be part of the required means of egress out of a building; cannot be part of an accessible route required into a building or unit (see IBC Sections 1104 and 1105) and cannot serve an Accessible, Type A or

Type B unit. The result would be that this exception would be permitted at the “back door,” stoop or patio in single-family homes (see IBC Section 1103.2.3) or upper floor balconies within individual apartments in buildings without elevators (see IBC Section 1107). This terminology is consistent with the 7 3/4-inch (197 mm) step down in Section 1010.1.5, Exception 3; however, this exception is to the threshold requirements, not the landing elevations.

The second exception is for doors where a 4-inch step down is permitted in Type B dwelling units between the interior finished floor surface and the exterior surface of exterior decks, patios and balconies (Section 1010.1.5 Exception 5). This section would permit the height of the threshold itself to exceed 1/2 or 3/4 inch in height, as long as the resultant profile from the interior floor to the exterior surface is maintained.

The threshold itself can be higher than 1/2 or 3/4 inch measured from the outside. The additional height, however, is contained within the 4-inch step down. The height of the threshold is limited to 1/2 inch or 3/4 inch above the interior floor and the total height must not be more than 4 1/2 or 4 3/4 inches above the exterior surface, depending upon the type of door. If the threshold is greater than 1/4 inch above the interior floor, it is to be beveled. See Commentary Figure 1010.1.7(5).



**MEANS OF EGRESS**

**1010.1.8 Door arrangement.** Space between two doors in a series shall be 48 inches (1219 mm) minimum plus the width of a door swinging into the space. Doors in a series shall swing either in the same direction or away from the space between the doors.

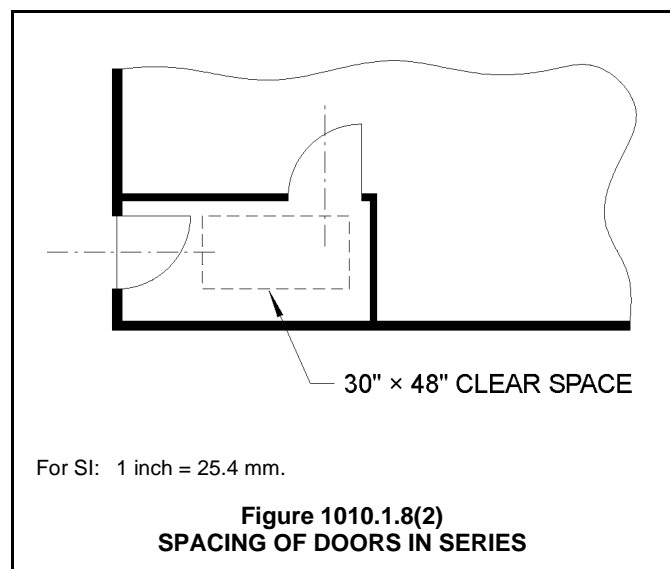
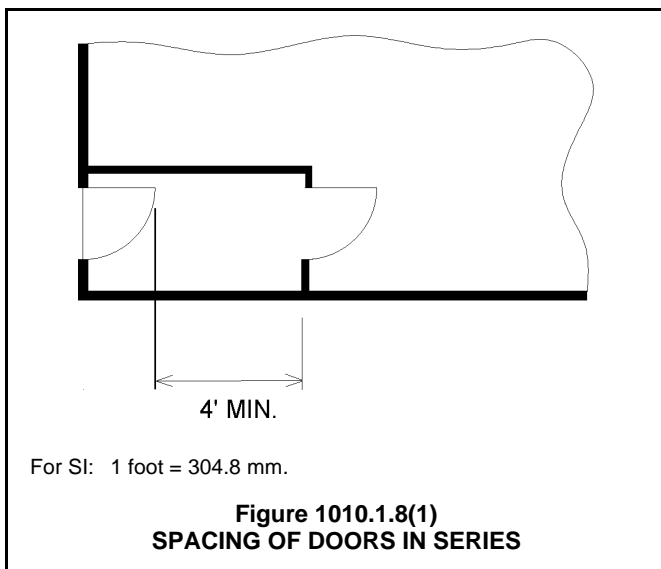
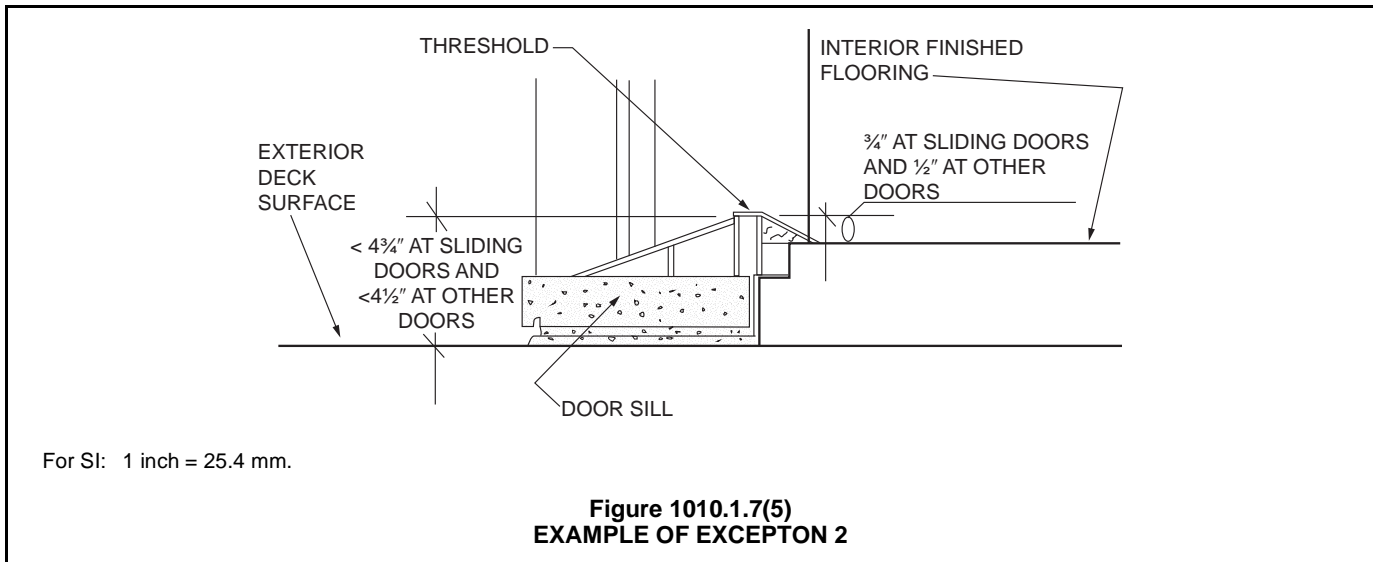
**Exceptions:**

1. The minimum distance between horizontal sliding power-operated doors in a series shall be 48 inches (1219 mm).
2. Storm and screen doors serving individual *dwelling units* in Groups R-2 and R-3 need not be spaced 48 inches (1219 mm) from the other door.
3. Doors within individual *dwelling units* in Groups R-2 and R-3 other than within *Type A dwelling units*.

❖ Door arrangement is required to be such that an occupant's use of a means of egress doorway is not hampered by the operation of a preceding door located in the same line of travel so that the occupant

flow can be smooth through the openings. Successive doors in a single egress path (i.e., in a series) can cause such interference. The 4-foot (1219 mm) clear distance between doors when the first door is open at 90 degrees allows an occupant, including a person using a wheelchair, to move past one door and its swing before beginning the operation of the next door [see Commentary Figure 1010.1.8(1)]. Note that where doors in a series are not arranged in a straight line, the intent of the code is to provide sufficient space to enable occupants to negotiate the second door without being encumbered by the first door's swing arc. To facilitate accessibility, the space between doors should provide sufficient clear space for a wheelchair [30 inches by 48 inches (762 mm by 1219 mm)] beyond the arc of the door swing [see Commentary Figure 1010.1.8(2)]. Additionally, the approach and access provisions of ICC A117.1 must be considered for all doors along an accessible route.

The exception is to permit horizontal sliding power-



operated doors (see Section 1010.1.4.2) to be designed with a lesser distance between them in a series arrangement because they are customarily designed to open simultaneously or in sequence such that movement through them is unhampered. Storm and screen doors on residential dwelling units need not be spaced at 48 inches (1219 mm) since it would be impractical, and they do not operate the same as doors in a series. Doors within dwelling units of Group R-2 or R-3 that are not Type A dwelling units (see IBC Section 1107) are also permitted to have a lesser distance between doors, because the accessibility provisions do not apply. There are requirements in Chapter 10 of the ICC A117.1 for door arrangements within Accessible and Type A dwelling and sleeping units.

**1010.1.9 Door operations.** Except as specifically permitted by this section, egress doors shall be readily openable from the egress side without the use of a key or special knowledge or effort.

❖ When installed for security purposes, locks and latches can intentionally prohibit the use of an egress door and thus interfere with or prevent the egress of occupants at the time of a fire. While the security of property is important, the life safety of occupants is essential. Where security and life safety objectives conflict, alternative measures, such as those permitted by each of the exceptions in Section 1010.1.9.3, may be applicable.

Egress doors are permitted to be locked, but must be capable of being unlocked and readily openable from the side from which egress is to be made. The outside of a door can be key locked as long as the inside—the side from which egress is to be made—can be unlocked without the use of tools, keys or special knowledge or effort. For example, an unlocking operation that is integral with an unlatching operation is acceptable.

Examples of special knowledge would be a combination lock or an unlocking device or deadbolt in an unknown, unexpected or hidden location. Special effort would dictate the need for unusual and unexpected physical ability to unlock or make the door fully available for egress.

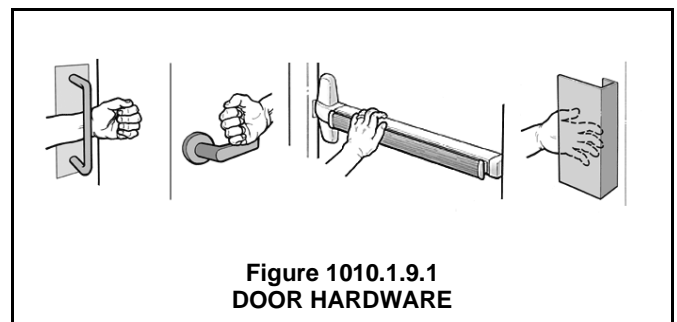
Where a pair of egress door leaves is installed, with or without a center mullion, the general requirement is that each leaf must be provided with its own releasing or unlatching device so as to be readily openable. Door arrangements or devices that depend on the release of one door before the other can be opened are not to be used except as permitted by Section 1010.1.9.4.

**1010.1.9.1 Hardware.** Door handles, pulls, latches, locks and other operating devices on doors required to be *accessible* by Chapter 11 shall not require tight grasping, tight pinching or twisting of the wrist to operate.

❖ Any doors that are located along an accessible route for ingress or egress must have door hardware that is easy to operate by a person with limited mobility or

dexterity. This would include all elements of the door hardware used in typical door operation, such as door levers, locks, security changes, etc. This requirement is also an advantage for persons with arthritis in their hands. Items such as small, full-twist thumb turns or smooth circular knobs are examples of hardware that is not acceptable. There are many types latching or locking devices can be operated without tight grasping, tight pinching, or twisting of the wrist what would comply with the requirements of this section.

Some people with disabilities are unable to grasp objects with their hands or twist their wrists. Such people are unable to operate, or have great difficulty operating, door hardware other than lever-operated mechanisms, push-type mechanisms and U-shaped door pulls. Door hardware that can be operated with a closed fist or a loose grip accommodates the greatest range of users. Hardware operated by simultaneous hand and finger movement requires greater dexterity and coordination and should be avoided for doors along an accessible route (see Commentary Figure 1010.1.9.1).



**Figure 1010.1.9.1  
DOOR HARDWARE**

**1010.1.9.2 Hardware height.** Door handles, pulls, latches, locks and other operating devices shall be installed 34 inches (864 mm) minimum and 48 inches (1219 mm) maximum above the finished floor. Locks used only for security purposes and not used for normal operation are permitted at any height.

**Exception:** Access doors or gates in barrier walls and fences protecting pools, spas and hot tubs shall be permitted to have operable parts of the release of latch on self-latching devices at 54 inches (1370 mm) maximum above the finished floor or ground, provided the self-latching devices are not also self-locking devices operated by means of a key, electronic opener or integral combination lock.

❖ The requirements in this section place the door hardware at a level that is usable by most people, including a person using a wheelchair. The exception allows security locks to be placed at any height. An example would be an unframed glass door at the front door of a tenant space in a mall that has the lock near the floor level. The lock is only used when the store is not open for business. Such locks are not required for the normal operation of the door.

The exception permits a special allowance for security latches at pools, spas and hot tubs. The con-

cern is that the 48-inch (1219 mm) maximum height would place the security latch within reach of children. The 54-inch (1372 mm) maximum height is intended to override the maximum 48-inch (1219 mm) reach range in ICC A117.1. This compromise addresses concerns for children's safety and still maintains accessibility to a reasonable level. Based on the last phrase in the exception, if the gate hardware also had a locking function and a key or other similar device would be needed to unlock the hardware to allow unlatching the latch, then the exception to allow the hardware to be 54-inches (1372 mm) above the floor is not applicable. A reference to this exception is found in IBC Section 1109.13, Exception 7, for the accessibility requirements for operable parts. This is consistent with the 2010 Standard and ANSI/NSPI-8 1996, *Model Barrier Code for Residential Swimming Pools, Spas, and Hot Tubs*.

**1010.1.9.3 Locks and latches.** Locks and latches shall be permitted to prevent operation of doors where any of the following exist:

1. Places of detention or restraint.
  2. In buildings in occupancy Group A having an *occupant load* of 300 or less, Groups B, F, M and S, and in *places of religious worship*, the main door or doors are permitted to be equipped with key-operated locking devices from the egress side provided:
    - 2.1. The locking device is readily distinguishable as locked.
    - 2.2. A readily visible durable sign is posted on the egress side on or adjacent to the door stating: THIS DOOR TO REMAIN UNLOCKED WHEN THIS SPACE IS OCCUPIED. The sign shall be in letters 1 inch (25 mm) high on a contrasting background.
    - 2.3. The use of the key-operated locking device is revokable by the *building official* for due cause.
  3. Where egress doors are used in pairs, *approved* automatic flush bolts shall be permitted to be used, provided that the door leaf having the automatic flush bolts does not have a doorknob or surface-mounted hardware.
  4. Doors from individual *dwelling* or *sleeping units* of Group R occupancies having an *occupant load* of 10 or less are permitted to be equipped with a night latch, dead bolt or security chain, provided such devices are operable from the inside without the use of a key or tool.
  5. *Fire doors* after the minimum elevated temperature has disabled the unlatching mechanism in accordance with *listed fire door* test procedures.
- ❖ Where security and life safety objectives conflict, alternative measures, such as those permitted by each of the listed situations, may be applicable.
- Item 1 is needed for jails and prisons or locations where someone must be kept inside for their own safety (i.e., dementia wards, psychiatric wards).
- Item 2 permits a locking device, such as a double-

cylinder dead bolt, on the main entrance door to a building or space. It must be immediately apparent that these doors are locked. For example, such locking devices may have an integral indicator that automatically reflects the "locked" or "unlocked" status of the device. In addition, a sign must be provided that clearly states that the door is to be unlocked when the building or space is occupied. The sign on or adjacent to the door not only reminds employees to unlock the door, but also advises the public that an unacceptable arrangement exists if one finds the door locked. Ideally, the individual who encounters the locked door will notify management and possibly the building official. Note that the use of the key-locking device is revocable by the building official. The locking arrangement is not permitted on any door other than the main exit and, therefore, the employees, security and cleaning crews will have access to other exits without requiring the use of a key. This allowance is not limited just to multiple-exit buildings but also to small buildings with one exit. This option is an alternative to the panic hardware required by Section 1010.1.10.

In Item 3, an automatic flush bolt device is one that is internal to the inactive leaf of a pair of doors. The device has a small "knuckle" that extends from the inactive leaf into an opening in the active leaf. When the active leaf is opened, the bolt is automatically retracted. When the active leaf is closed, the knuckle is pressed into the inactive leaf by the active leaf, extending the flush bolt(s), in the head or sill of the inactive leaf (see Commentary Figure 1010.1.9.3).

Automatic flush bolts on one leaf of a pair of egress doors are acceptable, provided the leaf with the automatic flush bolts is not equipped with a doorknob or other hardware that would imply to the user that the door leaf is unlatched independently of the companion leaf.

Item 4 addresses the need for security in residential dwelling and sleeping units such as hotel rooms, apartments, dormitory rooms or townhouses. The occupants are familiar with the operation of the indicated devices, which are intended to be relatively simple to operate without the use of a key or tool. Note that this item only applies to the door leading from individual dwelling or sleeping units in a building. This item would not be applicable for doors locked as part of a security system in a multiunit building.

Item 5 is in recognition of required test procedures (UL 10B or UL 10C) for listed fire doors, which include the disabling of the locking mechanism when a fire door is exposed to the elevated temperatures of a fire.

**1010.1.9.4 Bolt locks.** Manually operated flush bolts or surface bolts are not permitted.

**Exceptions:**

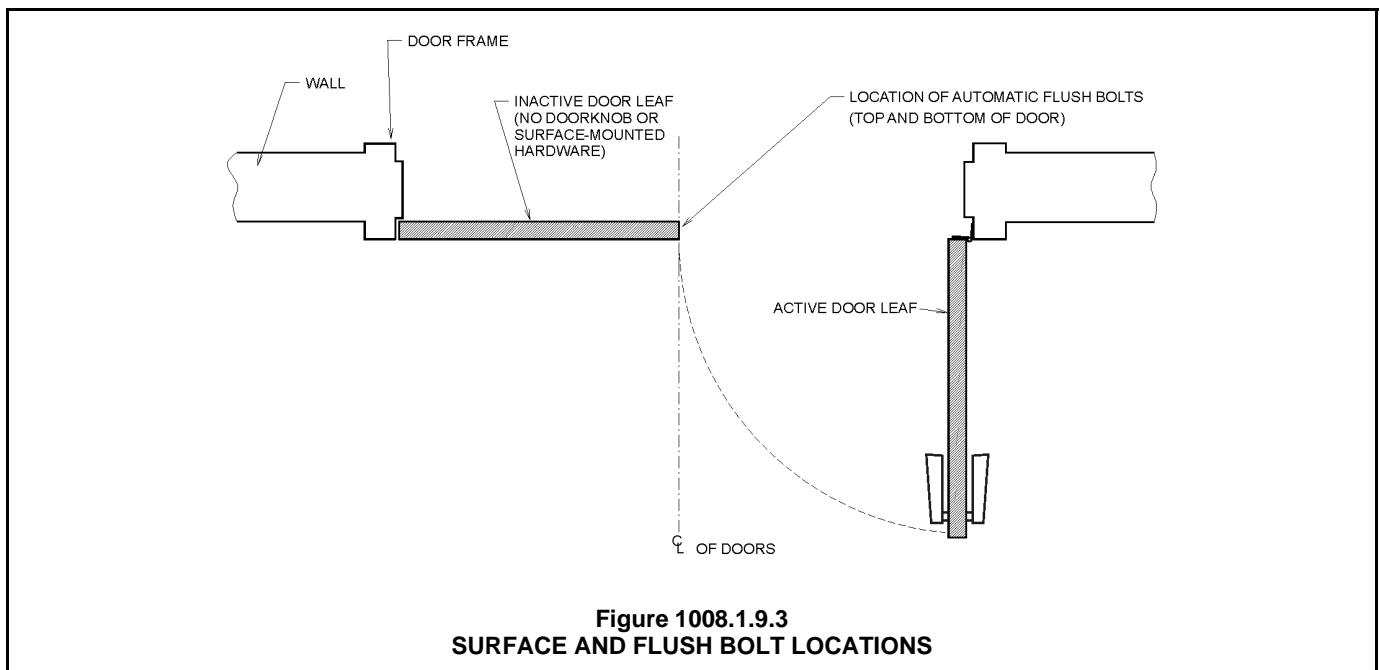
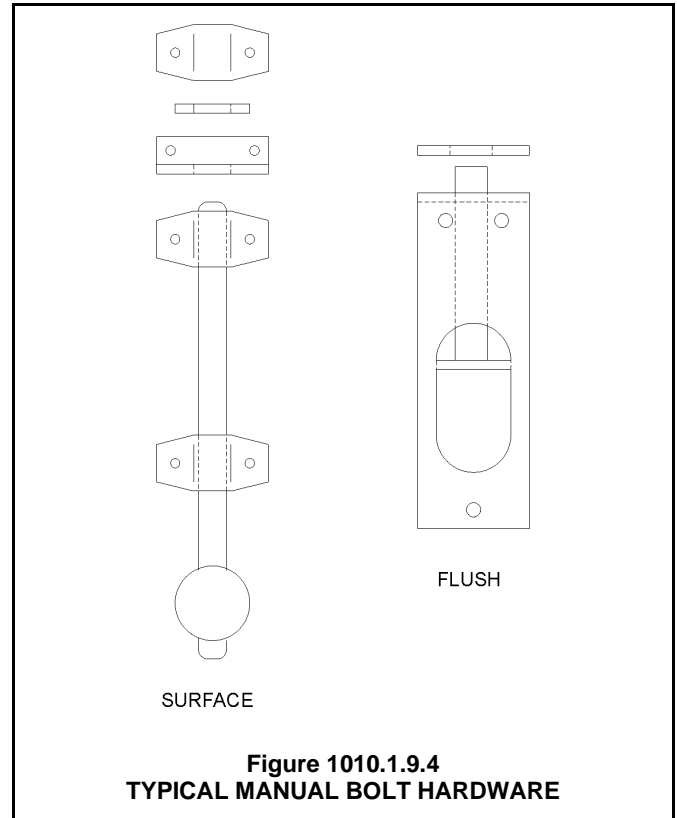
1. On doors not required for egress in individual *dwelling units* or *sleeping units*.
2. Where a pair of doors serves a storage or equipment room, manually operated edge- or surface-mounted bolts are permitted on the inactive leaf.

3. Where a pair of doors serves an *occupant load* of less than 50 persons in a Group B, F or S occupancy, manually operated edge- or surface-mounted bolts are permitted on the inactive leaf. The inactive leaf shall not contain doorknobs, panic bars or similar operating hardware.
4. Where a pair of doors serves a Group B, F or S occupancy, manually operated edge- or surface-mounted bolts are permitted on the inactive leaf provided such inactive leaf is not needed to meet egress capacity requirements and the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1. The inactive leaf shall not contain doorknobs, panic bars or similar operating hardware.
5. Where a pair of doors serves patient care rooms in Group I-2 occupancies, self-latching edge- or surface-mounted bolts are permitted on the inactive leaf provided that the inactive leaf is not needed to meet egress capacity requirements and the inactive leaf shall not contain doorknobs, panic bars or similar operating hardware.

❖ This section is applicable to doors that are required to be for means of egress purposes or are identified as a means of egress, such as by an “Exit” sign or other device. Doors, as well as a second leaf in a doorway that is provided for a purpose other than means of egress, such as for convenience or building operations, should be arranged or identified so as not to be mistaken as a means of egress. The use of manually operated flush bolts or surface bolts on means of egress doors have traditionally been prohibited because of the inability of users to quickly identify and operate such devices under emergency conditions.

This section prohibits installation of manually operated flush and surface bolts except in limited situa-

tions. The exceptions allowing the use of such hardware are intended to expand the use of manually operated edge- or surface-mounted bolts under specified conditions while maintaining an appropriate degree of safety for the building occupants. Flush and surface bolts represent locking devices that may be difficult to operate because of their location and operation (see Commentary Figure 1010.1.9.4).



Where edge-mounted or surface-mounted manually operated bolts are installed on the inactive leaf of a pair of doors, per the exceptions below, the manually operated bolts must have no effect on the egress operation of the active leaf.

Exception 1 allows manual flush bolts and surface bolts at some doors within an individual dwelling or sleeping unit. Even then, such bolts may only be used on doors not required for egress (see Section 1010.1.9.3, Item 4, for security of doors from individual dwelling and sleeping units).

Exception 2 provides for edge-mounted or surface-mounted bolts on the inactive leaf of a pair of doors from storage or equipment areas. Double doors are often provided to allow for the easy removal or replacement of large pieces of equipment or bulk movement of goods.

Exceptions 3 and 4 offer two options for limited doors in Group B, F and S occupancies. Again, the wider door is sometimes needed for the movement of equipment. Automatic flush bolts and removable center posts can be easily damaged and difficult to maintain in areas of frequent door usage. Revisions to the requirements for door hardware on such pairs of doors will increase building functionality while maintaining a very high degree of occupant safety.

In Exception 3, the number of occupants within the space must be less than 50, the active leaf must meet means of egress requirements and the inactive leaf must not have any operating hardware so that it could be mistaken for an egress door.

In accordance with Exception 4, if the Group B, F or S building is sprinklered throughout with an NFPA 13 system, the room served by the double door can have any occupant load if the inactive leaf is not required for egress capacity and has no operating hardware.

Exception 5 is in recognition of the need to move equipment into some patient sleeping and treatment rooms in hospital and nursing home environments. Again, the inactive leaf must not be needed for means of egress or have any operating hardware. This is consistent with IBC Section 407.1.1, which allows for staff to operate patient sleeping and treatment room doors during emergency events. The doors would still have to meet smoke barrier opening protective requirements. The clear width requirement of 41<sup>1</sup>/<sub>2</sub> inches (1054 mm) in Section 1010.1.1 would still have to be met with the active door leaf.

**1010.1.9.5 Unlatching.** The unlatching of any door or leaf shall not require more than one operation.

**Exceptions:**

1. Places of detention or restraint.
2. Where manually operated bolt locks are permitted by Section 1010.1.9.4.
3. Doors with automatic flush bolts as permitted by Section 1010.1.9.3, Item 3.

4. Doors from individual *dwelling units* and *sleeping units* of Group R occupancies as permitted by Section 1010.1.9.3, Item 4.

❖ The code prohibits the use of locks or latching devices that require more than one operation on any door required or used for egress, which could be a safety hazard in an emergency situation. The exceptions address locations where multiple locks or latching devices which require more than one operation are acceptable. See the referenced sections for additional commentary.

**1010.1.9.5.1 Closet and bathroom doors in Group R-4 occupancies.** In Group R-4 occupancies, closet doors that latch in the closed position shall be openable from inside the closet, and bathroom doors that latch in the closed position shall be capable of being unlocked from the ingress side.

❖ The intent of this provision is to address possible entrapment concerns in group homes. If a closet door has a door latch, the closet door must be openable from both inside and outside. This will ensure that someone cannot get stuck inside a closet by accident. If a closet does not latch, no interior hardware is required. In case a resident needs assistance in a bathroom, the bathroom door must have a type of hardware that would allow the door to be unlocked from the outside by staff. This requirement is unique to Group R-4. There are not similar requirements for other Group R occupancies, Group I-1 assisted living facilities or Group I-2 nursing homes; however, some assisted living or nursing home facilities install such devices to increase patient safety. Section 403.3.6 in the *International Plumbing Code*<sup>®</sup> (IPC<sup>®</sup>) prohibits the doors leading from multistall bathrooms from being lockable from the inside.

**1010.1.9.6 Controlled egress doors in Groups I-1 and I-2.** Electric locking systems, including electro-mechanical locking systems and electromagnetic locking systems, shall be permitted to be locked in the means of egress in Group I-1 or I-2 occupancies where the clinical needs of persons receiving care require their containment. Controlled egress doors shall be permitted in such occupancies where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or an *approved automatic smoke or heat detection system* installed in accordance with Section 907, provided that the doors are installed and operate in accordance with all of the following:

1. The door locks shall unlock on actuation of the *automatic sprinkler system* or *automatic fire detection system*.
2. The door locks shall unlock on loss of power controlling the lock or lock mechanism.
3. The door locking system shall be installed to have the capability of being unlocked by a switch located at the *fire command center*, a nursing station or other approved location. The switch shall directly break power to the lock.

4. A building occupant shall not be required to pass through more than one door equipped with a controlled egress locking system before entering an exit.
5. The procedures for unlocking the doors shall be described and approved as part of the emergency planning and preparedness required by Chapter 4 of the *International Fire Code*.
6. All clinical staff shall have the keys, codes or other means necessary to operate the locking systems.
7. Emergency lighting shall be provided at the door.
8. The door locking system units shall be listed in accordance with UL 294.

**Exceptions:**

1. Items 1 through 4 shall not apply to doors to areas occupied by persons who, because of clinical needs, require restraint or containment as part of the function of a psychiatric treatment area.
  2. Items 1 through 4 shall not apply to doors to areas where a *listed* egress control system is utilized to reduce the risk of child abduction from nursery and obstetric areas of a Group I-2 hospital.
- ❖ The intent of these provisions is to address the special safety needs for wards, units, or areas in assisted living facilities, nursing homes and hospitals where egress may need to be controlled for the safety of the occupants or where specialized protective measures are needed for patients. "Controlled egress" means simply that the ability of occupants, such as patients or residents, to leave a space is controlled by others, such as staff. The areas where controlled egress may be permitted include psychiatric areas, dementia units, Alzheimer's units, maternity units, and newborn nurseries. Code officials may also permit these provisions in other areas such as emergency departments or pediatric areas where the safety and/or security of the occupants are of primary concern. In all situations, there must be a balance between maintaining a safe and secure environment and providing for emergency egress.

The requirements of this section apply to locking systems controlling egress. The functions of an ingress control locking system are not addressed in the codes and are unrelated as long as egress is provided as required or permitted by this section and other applicable provisions of the code.

In areas where additional security may be a concern, a door hardware system may include an unlocking device, such as a keypad, card reader, eye scanner, thumbprint scanner or other credential device. Where these credential unlocking systems are only on the ingress side of a building or space, there are no limitations in the codes. Where these credential unlocking systems are on the egress side of a space (perhaps to monitor personnel movement), egress must be available through one of the locking systems addressed in Section 1010.1.9.7, 1010.1.9.8 or 1010.1.9.9. Such a credential unlocking device could

also be included in the controlled locking arrangements of IBC Section 408.4 and Section 1010.1.9.6, Item 6 of the code.

IBC Section 907.6 requires a fire alarm system to be installed in accordance with the requirements of that section and NFPA 72. NFPA 72 includes specific requirements for unlocking doors in the direction of egress that are consistent with the requirements in this section for controlled egress locking systems. Additionally, NFPA 72 includes specific requirements and guidance for backup power where the backup power is used to keep these doors in a locked condition in the direction of egress.

Items 1 through 3 address when the controlled egress locks would be required to automatically unlock allowing unrestricted egress.

Item 4 requires that no occupant shall have to pass through more than one controlled egress lock before entering an exit.

Item 5 requires the procedures for unlocking the doors to be described, approved by the code official, and included in the emergency planning and preparedness plan required by Chapter 4 of the *International Fire Code*.

Item 6 requires clinical staff to have the means necessary to operate the controlled egress locking system, such as keys, codes, etc.

Item 7 requires emergency lighting at the controlled egress door to ensure visibility for egress during a possible power outage.

Item 8 requires the units of the controlled egress locking system to be listed to UL 294. The UL 294 Access Control Systems standard applies to construction, performance, and operation of systems which control passage through a door, and electrical, electronic, or mechanical units of these systems.

The first exception allows for the automatic unlocking requirements to be omitted for doors in a psychiatric treatment area in hospitals or nursing homes due to additional safety concerns for the residents.

The second exception allows for automatic unlocking requirements to be omitted where a listed egress control system is installed for the specific purposes of reducing child abductions from nursery and obstetric areas of hospitals.

**1010.1.9.7 Delayed egress.** Delayed egress locking systems shall be permitted to be installed on doors serving any occupancy except Group A, E and H in buildings that are equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or an *approved automatic smoke or heat detection system* installed in accordance with Section 907. The locking system shall be installed and operated in accordance with all of the following:

1. The delay electronics of the delayed egress locking system shall deactivate upon actuation of the *automatic sprinkler system* or *automatic fire detection system*, allowing immediate, free egress.
2. The delay electronics of the delayed egress locking system shall deactivate upon loss of power controlling the

lock or lock mechanism, allowing immediate free egress.

3. The delayed egress locking system shall have the capability of being deactivated at the *fire command center* and other *approved* locations.
4. An attempt to egress shall initiate an irreversible process that shall allow such egress in not more than 15 seconds when a physical effort to exit is applied to the egress side door hardware for not more than 3 seconds. Initiation of the irreversible process shall activate an audible signal in the vicinity of the door. Once the delay electronics have been deactivated, rearming the delay electronics shall be by manual means only.

**Exception:** Where approved, a delay of not more than 30 seconds is permitted on a delayed egress door.

5. The egress path from any point shall not pass through more than one delayed egress locking system.

**Exception:** In Group I-2 or I-3 occupancies, the egress path from any point in the building shall pass through not more than two delayed egress locking systems provided the combined delay does not exceed 30 seconds.

6. A sign shall be provided on the door and shall be located above and within 12 inches (305 mm) of the door exit hardware:
  - 6.1. For doors that swing in the direction of egress, the sign shall read: PUSH UNTIL ALARM SOUNDS. DOOR CAN BE OPENED IN 15 [30] SECONDS.
  - 6.2. For doors that swing in the opposite direction of egress, the sign shall read: PULL UNTIL ALARM SOUNDS. DOOR CAN BE OPENED IN 15 [30] SECONDS.
  - 6.3. The sign shall comply with the visual character requirements in ICC A117.1.

**Exception:** Where approved, in Group I occupancies, the installation of a sign is not required where care recipients who because of clinical needs require restraint or containment as part of the function of the treatment area.

7. Emergency lighting shall be provided on the egress side of the door.
  8. The delayed egress locking system units shall be listed in accordance with UL 294.
- ❖ The intent of these provisions is to address special needs where there are concerns about internal security. Delays in egress, as allowed in this section, are not considered detrimental to occupant evacuation. The intent of these provisions is also to address special needs where occupants may need to be protected from harm because of their own actions. For example, residents or patients in some Group I-1 or Group I-2 occupancies may present a danger to themselves of elopement from the building into traffic, weather and other environmental hazards.

Delayed egress locking systems are permitted for doors in a means of egress serving occupancies other than those in Groups A, E and H. Delayed egress locking systems are not permitted in assembly or educational occupancies because the resulting delay in egress is not acceptable given the greater number of occupants who may be unfamiliar with the space or of a young age. Also, the delay from Group H would be unreasonable given the potential for rapid fire buildup in such areas.

This locking system is called “delayed egress” because of Item 4, which permits a fixed amount of time to pass prior to allowing egress.

The requirements of this section apply to locking systems which delay egress. The functions of an ingress control locking system are unrelated and are not addressed as long as egress is provided as required or permitted by this section and other applicable provisions of the code.

The requirements of this section apply to electromagnetic locking systems which open on hardware activation. The functions of an ingress control locking system are not addressed in the codes and are unrelated as long as egress is provided as required or permitted by this section and other applicable provisions of the code.

In areas where additional security may be a concern, a door hardware system may include an unlocking device, such as a keypad, card reader, eye scanner, thumbprint scanner or other credential device. Where these credential unlocking systems are only on the ingress side of a building or space, there are no limitations in the codes. Where these credential unlocking systems are on the egress side of a space (perhaps to monitor personnel movement), egress must be available through one of the locking systems addressed in Section 1010.1.9.7, 1010.1.9.8 or 1010.1.9.9. Such a credential unlocking device could also be included in the controlled locking arrangements of IBC Section 408.4 and Section 1010.1.9.6, Item 6 of the code.

IBC Section 907.6 requires a fire alarm system to be installed in accordance with the requirements of that section and NFPA 72. NFPA 72 includes specific requirements for unlocking doors in the direction of egress that are consistent with the requirements in this section for delayed egress locking systems. Additionally, NFPA 72 includes specific requirements and guidance for backup power where the backup power is used to keep these doors in a locked condition in the direction of egress.

Because of the egress delay caused by the system on the egress door, the building must be provided throughout with compensating fire protection features to promptly warn occupants of a fire condition. All listed conditions must be met in order to permit use of a delayed egress locking system.

Item 1 interconnects the locking system with an automatic sprinkler system in accordance with NFPA 13 or, alternatively, an automatic fire detection sys-

tem in accordance with Section 907, which is required to be installed throughout the building. Such systems are to provide occupants with an early warning of a fire event, and thus additional time for egress. Note that actuation of the automatic sprinkler system or actuation of the automatic fire detection system must eliminate the delay of the delayed egress locking system so the door immediately allows egress (without delay).

Item 2 specifies the delay is to be eliminated on loss of power. Since the operation of the delayed egress locking system is dependent on electrical power, in the event of electrical power loss to the lock or locking mechanism, the doors must immediately allow egress (without delay).

Item 3 specifies that the delay in the delayed egress locking system is capable of being eliminated by a signal sent from a fire command center or other approved locations. Personnel at the fire command center location would normally be the first alerted to an emergency event and would be expected to take appropriate action to allow immediate egress at all doors equipped with delayed egress locking systems. Other locations may be alternates to or back up the fire command center. Item 3 facilitates remotely eliminating the delay in the delayed egress locking system in the event of a fire or in the event of other nonfire emergencies.

Item 4 specifies the operational characteristics of the delayed egress locking system. The delay timer of the system and the audible signal (alarm) at the door may be configured one of two ways. In some occupancies, the delay timer is initiated and the alarm sounded immediately upon an attempt to open the door by pushing on the panic bar, or causing a slight movement of the door. In other occupancies, to prevent nuisance alarms from inadvertent bumps or accidental contact, the initiation of the delay timer and sounding of the alarm may be deferred by up to 3 seconds, requiring the occupant to attempt to operate the door hardware for up to, but not more than, 3 seconds.

Once the delay timer starts, the door is required to be openable from the egress side in not more than 15 seconds (or not more than 30 seconds where approved by the code official, per the exception). At the end of the delay, the door's locking system is required to allow the door to be opened by the occupant operating the egress side door hardware (i.e. pushing on the panic bar), allowing egress. The unlocking cycle is irreversible; once it is started, it does not stop. Once the door is openable from the egress side at the end of the delay, it remains openable allowing immediate egress until someone comes to the door and manually rearms the delay. The first user to the door may face a delay, but after that other users would be able to exit immediately. A method of automatically rearming the delayed egress locking system at the door from a remote location such as a central control station or security office is not permitted.

The exception to Item 4 permits the building official to allow the time delay prior to allowing egress to be increased beyond 15 seconds, but not in excess of 30 seconds. This exception is more often granted for the safety/security of occupants (e.g., to reduce or prevent elopement of patients) than for loss or theft prevention.

Item 5 limits the egress path to not more than one door with a delayed egress locking system. However, the exception to Item 5 allows not more than two doors with delayed egress locking systems in Groups I-2 and I-3 with the delay of the two systems to be not more than 30 seconds total.

Having multiple doors can help with preventing resident elopement and yet the overall delay does not exceed the previously accepted time period. An example of where the two-door arrangement may be helpful is a multistory facility where both the door from the story and the door from the building could be controlled.

Item 6 requires a sign to inform occupants how to operate the delayed egress locking system and when that door will become available for egress. An undesirable consequence of the door not unlocking immediately is if the user assumes it will never be available for egress and then proceeds to another exit door. In some occupancies, delayed egress locking systems may be utilized on doors not required to swing in the direction of egress travel. Options 6.1 and 6.2 allow for signs appropriate for the swing of the door. The required sign is typically supplied with the delayed egress locking system. The reference to ICC A117.1 visual requirements would not require raised letters or braille, but would require readable text, with good finish and contrast. The exception in Item 6 allows the sign to be omitted if the clinical needs of occupants require restraint or containment, as these patients may be capable of reading and following the sign's instructions then potentially putting themselves in harm's way. Based on the level of staff training within these facilities, the need to protect the patients by preventing elopement and the facts that these systems are required to be interconnected with the sprinkler or fire detection systems and unlock upon loss of power, it was determined that eliminating the sign in these facilities is reasonable.

Item 7 requires emergency lighting on the egress side of the door so that the user can read the sign required by Item 5.

Item 8 requires the units of the delayed egress locking system to be listed to UL 294. The UL 294 Access Control Systems standard applies to construction, performance and operation of systems which control passage through a door, and electrical, electronic or mechanical units of these systems.

**1010.1.9.8 Sensor release of electrically locked egress doors.** The electric locks on sensor released doors located in a *means of egress* in buildings with an occupancy in Group A,

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B, E, I-1, I-2, I-4, M, R-1 or R-2 and entrance doors to tenant spaces in occupancies in Group A, B, E, I-1, I-2, I-4, M, R-1 or R-2 are permitted where installed and operated in accordance with all of the following criteria:

1. The sensor shall be installed on the egress side, arranged to detect an occupant approaching the doors. The doors shall be arranged to unlock by a signal from or loss of power to the sensor.
  2. Loss of power to the lock or locking system shall automatically unlock the doors.
  3. The doors shall be arranged to unlock from a manual unlocking device located 40 inches to 48 inches (1016 mm to 1219 mm) vertically above the floor and within 5 feet (1524 mm) of the secured doors. Ready access shall be provided to the manual unlocking device and the device shall be clearly identified by a sign that reads "PUSH TO EXIT." When operated, the manual unlocking device shall result in direct interruption of power to the lock—*independent of other electronics*—and the doors shall remain unlocked for not less than 30 seconds.
  4. Activation of the building *fire alarm system*, where provided, shall automatically unlock the doors, and the doors shall remain unlocked until the fire alarm system has been reset.
  5. Activation of the building *automatic sprinkler system* or *fire detection system*, where provided, shall automatically unlock the doors. The doors shall remain unlocked until the *fire alarm system* has been reset.
  6. The door locking system units shall be listed in accordance with UL 294.
- ❖ The intent of this section is to provide consistent requirements where an electronically locked door is unlocked by activating devices mounted somewhere other than on the door itself. The unlocking activation is designed to be from a passive action by the occupant (e.g., walking to the door triggering a sensor), but the system includes a required nearby manual unlocking device (such as a push button) as a secondary electrical lock release device.

This section permits doors in a means of egress and entrance doors to tenant spaces in occupancies of Groups A, B, E, I-1, I-2, I-4, M, R-1 and R-2 to be electronically secured (locked) to control ingress while maintaining the doors as a means of egress. Typically these systems are used in high-security areas where a record of who has entered and left a space is desired. Or this system may be used where there is a concern for elopement or child abduction (Group I-1, I-2 or I-4).

This section of the IBC does not limit the number of doors in a means of egress that may be equipped with sensor-released electrically locked doors.

IBC Section 907.6 requires that a fire alarm system, where provided, is installed in accordance with the requirements of that section and NFPA 72. NFPA 72 includes specific requirements for unlocking doors

in the direction of egress, which are consistent with the requirements in this section for sensor release of electrically locked egress doors. Additionally, NFPA 72 includes specific requirements and guidance for backup power where the backup power is used to keep these doors in a locked condition.

The requirements of this section apply to locking systems with a sensor release. The functions of an ingress control locking system are not addressed in the codes and are unrelated as long as egress is provided as required or permitted by this section and other applicable provisions of the code.

In areas where additional security may be a concern, a door hardware system may include an unlocking device, such as a keypad, card reader, eye scanner, thumbprint scanner or other credential device. Where these credential unlocking systems are only on the ingress side of a building or space, there are no limitations in the codes. Where these credential unlocking systems are on the egress side of a space (perhaps to monitor personnel movement), egress must be available through one of the locking systems addressed in Section 1010.1.9.7, 1010.1.9.8 or 1010.1.9.9. Such a credential unlocking device could also be included in the controlled locking arrangements of IBC Section 408.4 and Section 1010.1.9.6, Item 6 of the code.

In areas where additional security may be a concern, a door hardware system may include a remote unlocking device, such as a keypad, card reader, eye scanner or thumbprint scanner. Where these systems are only on the ingress side of a building or space, there are no limitations in the codes. Where these systems are on the egress side of a space, free egress must still be available through one of the electromagnetic systems addressed in Section 11010.1.9.7, 1010.1.9.8 or 1010.1.9.9. Such a remote unlocking device could also be included in the controlled locking arrangements for IBC Section 408.4 and Section 1010.9.6 of the code.

Items 1 through 6 provide operational criteria to ensure egress during normal and emergency situations. Occupancies in Groups F, S and H are not included here because of their increased hazard caused by fuel load and other potentially life-threatening factors.

Item 1 requires that such doors be provided with an occupant sensor on the egress side of the door. These sensors typically operate on an infrared, microwave or sonic principle, but other technologies may be available. This sensor is required to automatically release the electrical lock on approach of an occupant from the egress side or when there is a loss of power to the sensor. This provision is written as "performance-based," where any means of sensor design can be utilized to cause the doors to unlock, allowing immediate egress. This section does not indicate at what distance the sensor should be set to operate. The sensor may be set to detect an approaching occupant in time to unlock the electrical

locks prior to the occupant reaching the door, to permit egress without the occupant realizing the doors were electrically locked. In other applications, the sensor may be set to require the occupant to be closer to the door prior to unlocking the electrical lock to allow egress.

Item 2 states that if there is a loss of power to the electrical lock or to the locking system, the electrical lock on the door must unlock. These doors are commonly secured with fail-safe devices which prioritize life safety over security (such as electromagnetic locks or fail-safe power bolts) so that the electrical locks on these doors will automatically unlock when power to the electrical locking device or locking system is interrupted. In some instances, the locking system controller may be powered from a different source than the electrical locking device itself. In these cases, a loss of power to the locking system controller (while power remains applied to the locking device) must also cause the electrical locking device on the egress door to automatically unlock.

Item 3 requires that there be a manual unlocking device (push button), within 5 feet of the door, mounted 40 to 48 inches above the floor, unobstructed and with a clearly identifiable sign that says "PUSH TO EXIT." When operated, the manual unlocking device is to directly interrupt, independent of other electronics, the power to the electrical lock and cause the doors to remain electrically unlocked for a minimum of 30 seconds. To achieve a minimum 30-second delay independent of other electronics, the push button unlocking device should be designed and installed to provide this delay. The 30-second minimum is to allow adequate time for an individual to operate the manual unlocking device and then to egress through the door.

Items 4 and 5 require the building fire alarm system, automatic fire detection system or sprinkler system, if provided, to be interfaced with the door's electric locking system to unlock automatically on activation. The electrical locks on the doors are to remain unlocked until the fire alarm system is reset, ensuring egress is not impeded by the electric locking system.

Item 6 requires the units of the locking system to be listed to UL 294. The UL 294 Access Control System standard applies to construction, performance, and operation of systems which control passage through a door, and electrical, electronic, or mechanical units of these systems.

To summarize, it is important to keep in mind that an egress door equipped with a sensor release system must always allow egress whether power is present or not. The egress door must be "fail-safe" and must assume this "fail-safe" condition when power is removed from any part of the sensor release system. In other words, if the sensor release system loses power, the egress door must be capable of being opened. People must be kept from being involuntarily locked inside buildings.

**1010.1.9.9 Electromagnetically locked egress doors.** Doors in the *means of egress* in buildings with an occupancy in Group A, B, E, I-1, I-2, I-4, M, R-1 or R-2 and doors to tenant spaces in Group A, B, E, I-1, I-2, I-4, M, R-1 or R-2 shall be permitted to be locked with an electromagnetic locking system where equipped with hardware that incorporates a built-in switch and where installed and operated in accordance with all of the following:

1. The hardware that is affixed to the door leaf has an obvious method of operation that is readily operated under all lighting conditions.
2. The hardware is capable of being operated with one hand.
3. Operation of the hardware directly interrupts the power to the electromagnetic lock and unlocks the door immediately.
4. Loss of power to the locking system automatically unlocks the door.
5. Where *panic or fire exit hardware* is required by Section 1010.1.10, operation of the *panic or fire exit hardware* also releases the electromagnetic lock.
6. The locking system units shall be listed in accordance with UL 294.

❖ The intent of this section is to provide consistent requirements where an electromagnetic lock is released by door-mounted hardware such as a panic bar, lockset/latchset, or touch-sense bar, all of which would be equipped with an integral switch that, when actuated by the normal actions of opening the door, causes the electromagnetic lock to release allowing immediate egress. In the identified occupancy groups, doors in the means of egress are permitted to be locked with an electromagnetic locking system where equipped with door hardware that incorporates a built-in switch, provided all the specified conditions are met. Additionally, doors to tenant spaces of the identified occupancy groups may be equipped with electromagnetic locks, provided all of the specified conditions are met. The use of this type of locking system may provide for a greater degree of security preventing or controlling access or ingress than that offered by a door with mechanical locking devices alone. The allowance for electromagnetically locked egress doors is limited to low- and moderate-hazard occupancies where security may be a concern.

It may be important to note other "shall be permitted" locking arrangements in the code may also use electromagnetic locks as part of their system. Controlled egress locking systems (Section 1010.1.9.6), delayed egress locking systems (Section 1010.1.9.7), and sensor release of electrically locked door systems (Section 1010.1.9.8) all frequently use electromagnetic locks.

The requirements of this section apply to electromagnetic locking systems which open on hardware activation. The functions of an ingress control locking system are not addressed in the codes and are unre-

lated as long as egress is provided as required or permitted by this section and other applicable provisions of the code.

In areas where additional security may be a concern, a door hardware system may include an unlocking device, such as a keypad, card reader, eye scanner, thumbprint scanner or other credential device. Where these credential unlocking systems are only on the ingress side of a building or space, there are no limitations in the codes. Where these credential unlocking systems are on the egress side of a space (perhaps to monitor personnel movement), egress must be available through one of the locking systems addressed in Section 1010.1.9.7, 1010.1.9.8 or 1010.1.9.9. Such a credential unlocking device could also be included in the controlled locking arrangements of IBC Section 408.4 and Section 1010.1.9.6, Item 6 of the code.

When the occupant prepares to egress through the door, the method of operating the door hardware must be obvious, even under poor lighting conditions. The operation shall be accomplished through the use of a single motion and meet the general requirement that the door be readily openable without the use of special knowledge or effort. The release of the electromagnetic lock on the door must occur immediately on the operation of the door hardware by interrupting the power supply to the electromagnetic lock. This requirement is the same regardless of the type of door hardware: panic hardware, fire exit hardware, a latchset/lockset, or a touch-sense bar. As an additional safeguard, the loss of power to the locking system is required to automatically release the electromagnetic lock on the door.

A properly designed and installed electromagnetic locking system complying with the requirements of this section of the IBC may not be obvious to the occupants, as the door unlatches/unlocks (electromagnetically and mechanically) allowing egress through the normal operation of the door hardware (panic or fire exit hardware, latchset/lockset, or touch-sense bar). Considering these performance requirements, this section of the IBC does not include a requirement that the electromagnetic lock be unlocked (released) on activation of the building fire alarm system. Also, this section of the IBC does not limit the number of doors in the means of egress which may be equipped with electromagnetic locking systems.

The units of the electromagnetic locking system are required to be listed in accordance with UL 294. The UL 294 Access Control Systems standard applies to construction, performance, and operation of systems which control passage through a door, and electrical, electronic, or mechanical units of these systems. Where these special provisions are utilized, the requirements of Section 1010.1.10 regarding panic hardware remain applicable. In Group A and E occupancies having occupant loads of 50 or

more, the door hardware must also comply with the requirements for panic hardware.

**1010.1.9.10 Locking arrangements in correctional facilities.** In occupancies in Groups A-2, A-3, A-4, B, E, F, I-2, I-3, M and S within correctional and detention facilities, doors in *means of egress* serving rooms or spaces occupied by persons whose movements are controlled for security reasons shall be permitted to be locked where equipped with egress control devices that shall unlock manually and by not less than one of the following means:

1. Activation of an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.
2. Activation of an *approved manual fire alarm box*.
3. A signal from a *constantly attended location*.

❖ Correctional facilities can include a variety of uses where detainees may be gathered for eating, recreational activities, education, technical training, job training, etc. Correctional facilities can also contain types of support services, such as a store, storage areas or hospital area. Security is still a concern within these areas. This provision will allow the correctional facility to maintain security on all areas. Most commonly the doors would be opened by staff from a central control point under Item 3, but Items 1 and 2 allow for other alternatives in lower security facilities. This provision is not intended to apply to these groups when located outside of a detention or correctional facility.

**1010.1.9.11 Stairway doors.** Interior *stairway means of egress* doors shall be openable from both sides without the use of a key or special knowledge or effort.

**Exceptions:**

1. *Stairway* discharge doors shall be openable from the egress side and shall only be locked from the opposite side.
2. This section shall not apply to doors arranged in accordance with Section 403.5.3.
3. In *stairways* serving not more than four stories, doors are permitted to be locked from the side opposite the egress side, provided they are openable from the egress side and capable of being unlocked simultaneously without unlatching upon a signal from the *fire command center*, if present, or a signal by emergency personnel from a single location inside the main entrance to the building.
4. *Stairway exit* doors shall be openable from the egress side and shall only be locked from the opposite side in Group B, F, M and S occupancies where the only interior access to the tenant space is from a single *exit stairway* where permitted in Section 1006.3.2.
5. *Stairway exit* doors shall be openable from the egress side and shall only be locked from the opposite side in Group R-2 occupancies where the only

interior access to the *dwelling unit* is from a single *exit stairway* where permitted in Section 1006.3.2.

- ❖ Based on adverse fire experience where occupants have become trapped in smoke-filled stairway enclosures, stairway doors generally must be arranged to permit reentry into the building without the use of any tools, keys or special knowledge or effort. For security reasons, this restriction does not apply to the discharge door from the stairway enclosure to the outside or into an exit passageway (Exception 1). Section 403 for high-rise buildings permits locking doors from the stairway side, provided the doors are capable of being unlocked from a fire command station and there is a communication system within the stairway enclosure that allows contact with the fire command station (Exception 2).

Exception 3 addresses the need for security. The exception is limited to four-story buildings to provide a short travel distance to the stairway discharge door for the building occupants. In addition, to allow quick entrance for fire fighters and emergency responders, a means of simultaneously unlocking all of the doors by emergency personnel must be provided. This provision further requires that the stairway doors be unlocked without unlatching. Stairway doors will typically be fire door assemblies, and their continued latching is necessary to maintain the integrity of the fire-resistive separation for the exit enclosure. The remote unlocking signal shall be initiated from the fire command station, if provided, or a single point of signal initiation at an approved location inside the building's main entrance.

Exceptions 4 and 5 allow for stairways in single-exit buildings to have doorways that lead to multiple tenants and dwelling units. For security reasons, those doors can remain locked from the stairway side so no one can enter another tenant space or dwelling unit from the exit stairway.

**1010.1.10 Panic and fire exit hardware.** Doors serving a Group H occupancy and doors serving rooms or spaces with an *occupant load* of 50 or more in a Group A or E occupancy shall not be provided with a latch or lock other than *panic hardware* or *fire exit hardware*.

**Exceptions:**

1. A main *exit* of a Group A occupancy shall be permitted to be locking in accordance with Section 1010.1.9.3, Item 2.
2. Doors serving a Group A or E occupancy shall be permitted to be electromagnetically locked in accordance with Section 1010.1.9.9.

Electrical rooms with equipment rated 1,200 amperes or more and over 6 feet (1829 mm) wide, and that contain over-current devices, switching devices or control devices with *exit* or *exit access doors*, shall be equipped with *panic hardware* or *fire exit hardware*. The doors shall swing in the direction of egress travel.

- ❖ Doors that are part of a means of egress from the locations listed in this section shall not be provided

with a latch or lock other than panic hardware or fire exit hardware unless one of the two exceptions is met. Fire exit hardware is essentially panic hardware with internal modifications for use on fire-rated doors. Also see the commentaries to the definitions for "Fire exit hardware" or "Panic hardware" and Sections 1010.1.10.1 and 1010.1.10.2.

For all Group H occupancies, regardless of the occupant load, if latching (or locking) hardware is installed, it must be panic hardware or fire exit hardware because of the physical hazards of these spaces.

For all doors that provide means of egress for rooms and spaces of assembly and educational (Group A and E) occupancies with an occupant load of 50 or more, if latching (or locking) hardware is installed, it must be panic hardware or fire exit hardware. This would include large assembly spaces in mixed-use buildings. These uses are characterized by higher occupant load densities. Whereas doors from an assembly or educational room with an occupant load of less than 50 do not require panic hardware or fire exit hardware, a door that provides means of egress for two or more such rooms would require panic hardware or fire exit hardware when the combination of spaces has a total occupant load of 50 or more.

The first exception clarifies that the provisions for key-locking hardware at the main exit in Group A occupancies are permitted instead of panic hardware at those specific locations. (For the Group A exception, see the commentary to Section 1010.1.9.3, Item 2.)

The second exception resolves a potential conflict with Section 1010.1.9.9, and specifically Item 5, which allows an electromagnetic lock to be installed in addition to panic or fire exit hardware where panic or fire exit hardware would be required as long as the operation of the panic hardware or fire exit hardware releases the electromagnetic lock.

Certain electrical rooms are required to have panic hardware. Refer to IBC Chapter 27 and *NFPA 70: National Electrical Code*® (NEC) for specific requirements for when panic hardware or fire exit hardware is required. This requirement is applicable only where multiple conditions are present. The type of room regulated creates a potentially hazardous environment. In the event of an electrical accident, the more immediate egress provided by the panic hardware is desirable.

**1010.1.10.1 Installation.** Where *panic* or *fire exit hardware* is installed, it shall comply with the following:

1. *Panic hardware* shall be *listed* in accordance with UL 305.
2. *Fire exit hardware* shall be *listed* in accordance with UL 10C and UL 305.
3. The actuating portion of the releasing device shall extend not less than one-half of the door leaf width.

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4. The maximum unlatching force shall not exceed 15 pounds (67 N).
- ❖ As its name implies, panic hardware is special unlatching and unlocking hardware that is intended to simplify the unlatching and unlocking operation to a single, no more than 15-pound (67 N), force applied in the direction of egress [see Commentary Figures 1010.1.10.1(1) and (2)]. In a panic situation with a rush of persons trying to utilize a door, devices such as doorknobs or thumb turns may cause sufficient delay so as to create a crush at the door and prevent or slow the opening operation.

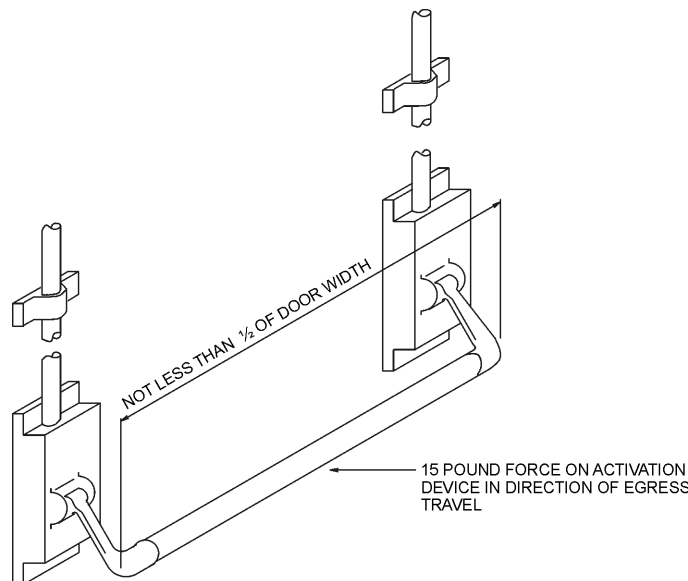
The locational specifications for the activating panel or bar are based on ready availability and access to the unlatching device. Note that the section requires the width of the actuating portion of the panic hardware or fire exit hardware to measure at least one-half the width of the door leaf. For example, on a 3-0 door (nominal 36 inches wide), the activating portion of the panic or fire hardware would measure at least 18 inches. Panic and fire exit hardware must be listed. UL 305, *Standard for Safety Panic Hardware*, includes construction and performance requirements dealing with endurance, emergency operation, elevated ambient exposure and low-temperature impact tests to ensure that the panic device operates properly (for panic hardware on a balanced door, see Section 1010.1.10.2). The activation device must be mounted between 34 inches and 48 inches (864 mm and 1219 mm) above the floor in accordance with Section 1010.1.9.2. Section 1010.1.1.1 allows the panic hardware to extend the full width of the door as long as it does not protrude more than 4 inches (102 mm) into the door's required minimum clear width.

Standard panic hardware or "listed panic hardware" is not approved for use on fire door assemblies. Panic hardware and fire exit hardware can be similar in appearance.

Where a fire door, such as to an exit stairway, is required to be equipped with panic hardware, the hardware must accomplish the dual objectives of panic hardware and continuity of the enclosure in which it is located—thus the reference to UL 10C, *Standard for Safety Positive Pressure Fire Tests of Door Assemblies*. In this case, fire exit hardware is to be provided that meets both objectives and requirements, since panic hardware is not tested for use on fire doors. There are standard test procedures designed to evaluate the performance of panic and fire exit hardware from the panic standpoint as well as from a fire protection standpoint. "Fire door assemblies" are defined in Section 716.5 as a combination of doors, frame, hardware and other accessories required to provide a specific degree of fire and smoke barrier protection to the opening in a fire wall, fire barrier, fire partition, smoke barrier or exterior wall required to have a fire-resistance rating.

Fire doors must close and positively latch in order to protect exit stairways, corridors and other areas of the building from the spread of smoke and fire. Additionally, fire doors are required to self-close and automatically latch after each use. Positive latching of fire doors is not related to the locking of the door and should never be confused with locking or security issues.

The requirement for positive latching means that dogging devices are not permitted on fire exit hardware. A dogging device is an option on the hardware



For SI: 1 pound = 4.4 N.

**Figure 1010.1.10.1(1)**  
**EXAMPLES OF TYPICAL PANIC HARDWARE**

that allows for the panic hardware to be locked in the fully depressed position. A dogging device mechanically defeats the latching feature of panic hardware preventing the door from positively latching when in the closed position. The dogging device is typically manually activated with a small wrench or tool and is activated through a hole adjacent to the activation bar. Dogging capability is often provided on exterior doors that are intended as building entrances.

Fire exit hardware must be labeled. Typical locations are on either end of the hardware. Information on the label must include the words “listed” and “fire exit hardware” and indicate a control or serial number. The label on the fire door itself should indicate that it is a fire door suitable for use with fire exit hardware.

**1010.1.10.2 Balanced doors.** If *balanced doors* are used and *panic hardware* is required, the *panic hardware* shall be the push-pad type and the pad shall not extend more than one-half the width of the door measured from the latch side.

- ❖ The provisions for balanced doors ensure that the occupants push only on the latch side of the door since the hinge side of a balanced door pivots “against” the direction of egress (see the commentary for the definition of “Door, balanced” in Chapter 2).

**1010.2 Gates.** Gates serving the *means of egress* system shall comply with the requirements of this section. Gates used as a

component in a *means of egress* shall conform to the applicable requirements for doors.

**Exception:** Horizontal sliding or swinging gates exceeding the 4-foot (1219 mm) maximum leaf width limitation are permitted in fences and walls surrounding a stadium.

- ❖ This section specifies that all requirements for doors also apply to gates, except that gates surrounding a stadium are allowed to exceed 4 feet (1219 mm) in width. Usually a large gate is required to adequately serve a stadium crowd for egress purposes.

**1010.2.1 Stadiums.** *Panic hardware* is not required on gates surrounding stadiums where such gates are under constant immediate supervision while the public is present, and where safe dispersal areas based on 3 square feet (0.28 m<sup>2</sup>) per occupant are located between the fence and enclosed space. Such required safe dispersal areas shall not be located less than 50 feet (15 240 mm) from the enclosed space. See Section 1028.5 for *means of egress* from safe dispersal areas.

- ❖ Panic hardware is impractical for large gates that surround stadiums. Normally, these gates are opened and closed by the stadium’s grounds crew, which is constantly in attendance during the use of such gates. The safe dispersal area requirement provides for the safety of the crowd if for some reason the gate is not open. The safe dispersal area is to be between the stadium enclosure and the surrounding fence and



Figure 1010.1.10.1(2)  
EXAMPLES OF TYPICAL PANIC HARDWARE

the area to be occupied is not to be closer than 50 feet (15 240 mm) to the stadium enclosure.

See the commentary for Section 1028.5 for access to a safe dispersal area when access to a public way is not available.

**1010.3 Turnstiles.** Turnstiles or similar devices that restrict travel to one direction shall not be placed so as to obstruct any required *means of egress*.

**Exception:** Each turnstile or similar device shall be credited with a capacity based on not more than a 50-person *occupant load* where all of the following provisions are met:

1. Each device shall turn free in the direction of egress travel when primary power is lost and on the manual release by an employee in the area.
2. Such devices are not given credit for more than 50 percent of the required egress capacity or width.
3. Each device is not more than 39 inches (991 mm) high.
4. Each device has not less than 16½ inches (419 mm) clear width at and below a height of 39 inches (991 mm) and not less than 22 inches (559 mm) clear width at heights above 39 inches (991 mm).

Where located as part of an *accessible route*, turnstiles shall have not less than 36 inches (914 mm) clear at and below a height of 34 inches (864 mm), not less than 32 inches (813 mm) clear width between 34 inches (864 mm) and 80 inches (2032 mm) and shall consist of a mechanism other than a revolving device.

❖ This section provides for a limited use of turnstiles to serve as a means of egress component. The exception to this section limits each turnstile to a maximum egress capacity of 50 persons. The turnstile must comply with all four listed items to be considered as serving any part of the occupant load for means of egress. The turnstiles must rotate freely both when there is a loss of power and when they are manually released. Note that the 50-person limit applies to each individual turnstile. These provisions are similar to the revolving door provisions in Section 1010.1.4.1.

If turnstiles are located along an accessible route, the route for persons using mobility devices must be something other than a revolving device, such as a swinging gate. A common example would be the turnstiles for automatic ticket taking, such as at the entrance to a mass transit platform.

**1010.3.1 High turnstile.** Turnstiles more than 39 inches (991 mm) high shall meet the requirements for revolving doors.

❖ Where a turnstile is higher than 39 inches (991 mm), the restriction to egress is much like a revolving door. Thus, the egress limitations for revolving doors in Section 1010.1.4.1 apply to this type of turnstile. If a high turnstile does not meet the revolving door requirements for doors that are an egress component, it is not to be included as serving a portion of the means of egress. It would be necessary to pro-

vide doors in these areas for egress. High turnstiles may not be part of an accessible route for ingress or egress.

**1010.3.2 Additional door.** Where serving an *occupant load* greater than 300, each turnstile that is not portable shall have a side-hinged swinging door that conforms to Section 1010.1 within 50 feet (15 240 mm).

❖ This section addresses a common egress condition for sports arenas where a number of turnstiles are installed for ticket taking. Portable turnstiles are moved from the egress path for proper exiting capacity. Permanent turnstiles are not considered as providing any of the required egress capacity when serving an occupant load greater than 300, no matter how many turnstiles are installed. Doors are required to provide occupants with a path of egress other than through the turnstiles. The doors are to be located within 50 feet (15 240 mm) of the turnstiles.

## SECTION 1011 STAIRWAYS

**1011.1 General.** *Stairways* serving occupied portions of a building shall comply with the requirements of Sections 1011.2 through 1011.13. *Alternating tread devices* shall comply with Section 1011.14. Ship's ladders shall comply with Section 1011.15. Ladders shall comply with Section 1011.16.

**Exception:** Within rooms or spaces used for assembly purposes, stepped aisles shall comply with Section 1029.

❖ It is important for stairway safety that all stairways meet the provisions in this section. This would include all elevation changes using stairways; everything from one riser to multiple flights and landings between stories (see the definitions for "Stair" and "Stairway" in Chapter 2). These provisions will be applicable for interior exit access stairways, interior exit stairways and exterior exit stairways, as well as any steps along the paths for exit access or exit discharge. It is intended that this section be applicable to required stairways as well as what can be called "convenience" stairways.

It is important to understand the terminology. Exit stairways are stairways that provide a protected path of travel between the exit access and the exit discharge. Interior exit stairways are required to be enclosed in accordance with Section 1022. Exterior exit stairways are protected by the exterior wall of the building and must comply with Section 1027. Exit access stairways are typically unenclosed interior stairways and comply with Section 1019 when they provide access between stories. Exit access travel distance stops at an exit stairway enclosure, but includes any travel down an exit access stairway. Stairways that are outside and provide a route from the level of exit discharge to grade are considered part of the exit discharge. See the commentary in Chapter 2 for the defined term, "Exit discharge, level of."

Sections 1011.2 through 1011.13 provide criteria for the typical stairway. Special provisions are pro-

vided for curved stairways (Section 1011.9), spiral stairways (Section 1011.10), and stairways to the roof for fire department access and for elevator equipment service (Sections 1011.12 and 1011.13).

Items that provide vertical access similar to stairways are also addressed in this section: alternating tread devices (Section 1011.14), ship's ladders (Section 1011.15) and ladders (Section 1011.16). These devices are only permitted to provide access to very limited spaces.

The exception indicates that stepped aisles (previously called aisle stairs) are addressed in Section 1029. Having this exception at the beginning of the stairway section negated the need for repeated exceptions throughout the stairway provisions. While both stairways and stepped aisles are a series of treads and risers, how occupants move on and off and configurations are very different. Occupants leave and join stepped aisles along the entire run, while occupants only enter the stairways at the top and bottom. Stepped aisles have center handrails with breaks to allow for access into the seating, while most stairways have handrails on both sides. Stepped aisles can be nonuniform in some locations to allow for parabolic seating bowls, while with stairways, uniform tread and riser configurations are required. Section 1029 should be used for stepped aisles between and immediately adjacent to seating or where the steps are a direct continuation of the stepped aisles and lead to a level cross aisle or floor. Section 1011 is used for stairways that lead from the balcony, concourse or cross aisle to a floor level above or below the seating areas (see Sections 1011.5.2, 1011.5.4 and 1011.6).

**1011.2 Width and capacity.** The required capacity of stairways shall be determined as specified in Section 1005.1, but the minimum width shall be not less than 44 inches (1118 mm). See Section 1009.3 for accessible means of egress stairways.

**Exceptions:**

1. Stairways serving an occupant load of less than 50 shall have a width of not less than 36 inches (914 mm).
2. Spiral stairways as provided for in Section 1011.10.
3. Where an incline platform lift or stairway chairlift is installed on stairways serving occupancies in Group R-3, or within dwelling units in occupancies in Group R-2, a clear passage width not less than 20 inches (508 mm) shall be provided. Where the seat and platform can be folded when not in use, the distance shall be measured from the folded position.

❖ To provide adequate space for occupants traveling in opposite directions and to permit the intended full egress capacity to be developed, minimum dimensions are dictated for means of egress stairways. A minimum width of 44 inches (1118 mm) is required for stairway construction to permit two columns of

users to travel in the same or opposite directions. The reference to Section 1005.1 is for the determination of stairway width based on the occupant load it will serve (i.e., capacity). The larger of the two widths is to be used.

Exception 1 recognizes the relatively small occupant loads of less than 50 that permit a staggered file of users when traveling in the same direction. When traveling in opposite directions, one column of users must stop their ascent (or descent) to permit the opposite column to continue. Again, considering the relatively small occupant loads, any disruption of orderly flow will be infrequent. The use of this exception is limited to buildings where the entire occupant load of each upper story and/or basement is less than 50.

Exception 2 permits a spiral stairway to have a minimum width of 26 inches (660 mm) when it conforms to Section 1011.10, on the basis that the configuration of a spiral stairway will allow nothing other than single-file travel.

Exception 3 addresses the use of inclined platform lifts or stairway chairlifts for individual dwelling units. For clarification on the types of lifts, see the commentary to IBC Section 1109.8. Both types of lifts may be installed to aid persons with mobility impairments in their homes. The code and ASME A18.1 allow for a reduction in the width of the stair to a minimum of 20 inches (508 mm) of clear passageway to be maintained on a stairway where a lift is located. If a portion of the lift, such as a platform or seat, can be folded, the minimum clear dimension is to be measured from the folded position. If the lift cannot be folded, then the 20 inches (508 mm) is measured from the fixed position. The track for these lifts typically extends 9 to 12 inches (229 to 305 mm) from the wall, making the 20-inch (508 mm) clear measurement actually 24 to 27 inches (610 to 686 mm) from the edge of the track.

The code does not have any specific provisions for where incline platform lifts are utilized along stairways in locations other than within dwelling units. IBC Section 1109.8 limits the use of platform lifts in new construction to mainly areas with minimal occupant loads or where elevators and ramps are impracticable. IEBC Section 410.8.3 and IBC Section 705.1.3 allow for platform lifts anywhere in existing buildings in order to gain accessibility for persons with mobility impairments. When in the closed and off position, the platform lifts should not block the clear width required for the stairway, or use of the handrails. The industry is currently working on different options to address the concern that the lift may be in operation during an event that requires evacuation.

**1011.3 Headroom.** Stairways shall have a headroom clearance of not less than 80 inches (2032 mm) measured vertically from a line connecting the edge of the nosings. Such headroom shall be continuous above the stairway to the point where the line intersects the landing below, one tread depth

## MEANS OF EGRESS

beyond the bottom riser. The minimum clearance shall be maintained the full width of the *stairway* and landing.

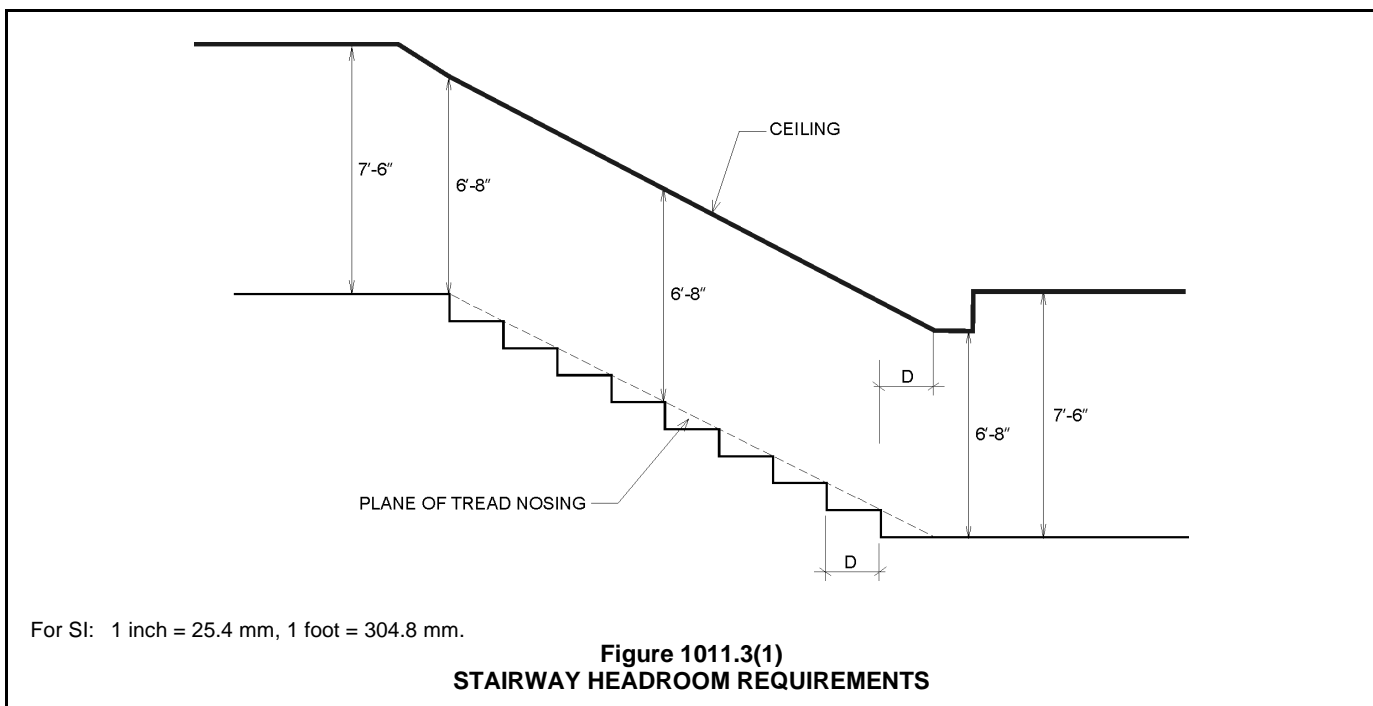
### Exceptions:

1. *Spiral stairways* complying with Section 1011.10 are permitted a 78-inch (1981 mm) headroom clearance.
  2. In Group R-3 occupancies; within *dwelling units* in Group R-2 occupancies; and in Group U occupancies that are accessory to a Group R-3 occupancy or accessory to individual *dwelling units* in Group R-2 occupancies; where the *nosings* of treads at the side of a *flight* extend under the edge of a floor opening through which the *stair* passes, the floor opening shall be allowed to project horizontally into the required headroom not more than 4<sup>3</sup>/<sub>4</sub> inches (121 mm).
- ❖ This headroom requirement is necessary to avoid an obstruction to orderly flow and to provide visibility to the users so that the desired path of travel can be planned and negotiated. Height is a vertical measurement above every point along the stairway stepping and walking surfaces, with minimum height measured vertically from the tread nosing or from the surface of a landing or platform up to the ceiling [see Commentary Figure 1011.3(1)].
- Section 1003.2 and IBC Section 1208.2 require a minimum ceiling height within a room of 7 feet, 6 inches (2307 mm). A bulkhead or doorway at the bottom of the stairway would be allowed to meet the minimum headroom height of 80 inches (2032 mm), as permitted in Section 1003.3.
- Exception 1, allowing for a clear headroom of 6 feet, 6 inches (1981 mm) for spiral stairs, correlates with the provisions of Section 1011.10.

Exception 2 recognizes a common method of stairwell construction in which the stringer on the open side of a stair is supported by the same floor joists or wall that supports the edge of the opening through which the stairway passes to the floor above, thus resulting in the stairway being wider at the lower portion than at the top portion. In this case, headroom is not required for a distance of up to 4<sup>3</sup>/<sub>4</sub> inches (121 mm) measured horizontally from the edge of the opening above to the handrail or guard system, which limits the clear width on the lower open sides of the stairway. The 4<sup>3</sup>/<sub>4</sub> inches (121 mm) maximum is derived from the finished width of a typical 2 by 4 supporting wall and is not critical to obstructing orderly flow or visibility in the desired path of travel [see Commentary Figure 1011.3(2)].

**1011.4 Walkline.** The walkline across *winder* treads shall be concentric to the direction of travel through the turn and located 12 inches (305 mm) from the side where the *winders* are narrower. The 12-inch (305 mm) dimension shall be measured from the widest point of the clear *stair* width at the walking surface of the *winder*. Where *winders* are adjacent within the *flight*, the point of the widest clear *stair* width of the adjacent *winders* shall be used.

❖ This requirement is essential for smooth, consistent travel on stairs that turn with winder treads. It provides a standard location for the regulation of the uniform tread depth of winders. Because of the wide range of anthropometrics of stairway users, there is no one line that all persons will travel on stairs; however, the code recognizes a standard location of a walkline is essential to design and enforcement. Each footfall of the user through the turn can be associated with an arc to describe the path traveled. As a user ascends or descends the flight, the turning at each

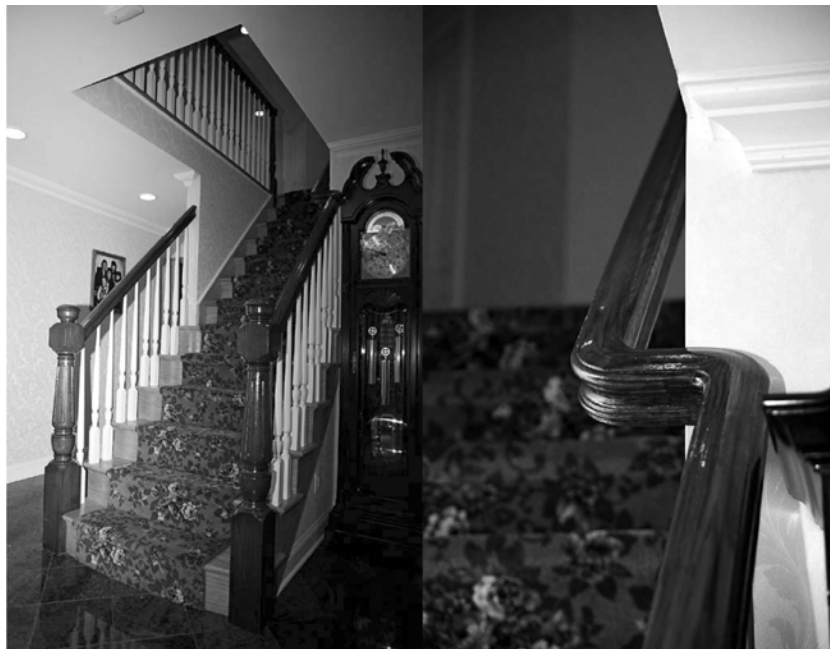


step should be consistent through the turn. The walkline is established concentric to, or having the same center (approximately parallel) as, the arc of travel of the user. The tread depth dimension at the walkline is one of two tread depths across the width of the stair at which winder tread depth is regulated, cited in Section 1011.5.2. The second is the minimum tread depth. Regulation at these two points controls the angularity of the turn and the configuration of the flight. In order to establish consistently shaped winders, tread depths must always be measured concentric to the arc of travel. The walkline is unique as the only line or path of travel where winder tread depth is controlled by the same minimum tread depth as rectangular treads. However, Exception 2 of Section 1011.5.4 recognizes that winder tread depth need not be compared to rectangular tread depths for dimensional uniformity in the same flight because the location of the walkline is chosen for the purpose of providing a standard and cannot be specific to the variety of actual paths followed by all users. This specific line location is determined by measuring along each nosing edge 12 inches (305 mm) from the extreme of the clear width of the stair at the surface of the winder tread or the limit of where the foot might be placed in use of the stair. If adjacent winders are present, the point of the widest clear stair width at the surface of the tread in the group of adjacent consecutive winders is used to provide the reference from which the 12-inch (305 mm) dimension will be measured along each nosing. The tread depth may be determined by measuring between adjacent nosings at these determined intersections of the nosings with

the walkline. It is important to note that the clear stair width is only that portion of the stair width that is clear for passage. Portions of the stair beyond the clear width are not consequential to use of the stair, consistent travel or location of the walkline.

**1011.5 Stair treads and risers.** *Stair* treads and risers shall comply with Sections 1011.5.1 through 1011.5.3.

❖ The provisions for treads and risers contribute to the efficient use of the stairway, facilitating smooth and consistent travel. This section provides dimensional ranges and tolerances for the component elements to allow the flexibility required to design and construct a stair or a flight of stairs that are elements of a stairway. The allowed proportion of maximum riser height and minimum tread depth provide for a maximum angle of ascent but there is no maximum tread depth to consider with the minimum riser height that would define a minimum angle for a stairway. Nor is the proportion of riser height to tread depth compared with the limitations of the length of the user's stride on stairways, which is significantly foreshortened from the user's stride on the level. For this reason, care should be taken when incorporating larger tread depths and controlling the point at which a tread might be wide enough to require more than one step to cross, which can vary significantly when considering ascent and descent movement patterns. Especially in areas where all segments of the public might use the stairs, those persons requiring two smaller sequential steps to cross the tread would progress at significantly different rates than those who might be able to stretch or jump and lead to dangerous compli-



**Figure 1011.3(2)**  
**EXAMPLE OF SECTION 1011.3, EXCEPTION 2**

cations, especially in egress. Of equal significance is the use of shorter risers without increasing tread depth resulting in a proportion that could cause overstepping. With these same limitations for proportion in mind, however, by controlling the minimum depth of rectangular treads and the minimum depth and angularity of winder treads, these components can control the configuration of the plan of a flight of stairs to provide for smooth and consistent travel.

Section 1011.5.1 provides for consistent identification of the surfaces that are to be measured. This is as critical to the users' experience throughout the built environment as it is to determining all the dimensions in this section as they must relate to each other and the ultimate design and construction of a safe stairway.

The remaining sections address the uniformity and essential attributes of the tread and riser. Of particular note is the nosing or leading edge of the tread. The nosing shape and projection affect the determination of the tread depth and the riser height and are regulated at all steps throughout the stairway, including the nosings at landings to provide for smooth and consistent travel. Furthermore, the line connecting the nosings is used to determine handrail height, guard height and headroom, causing consistent nosings to be a dependent integral of every element of the stairway design, construction and regulation.

**1011.5.1 Dimension reference surfaces.** For the purpose of this section, all dimensions are exclusive of carpets, rugs or runners.

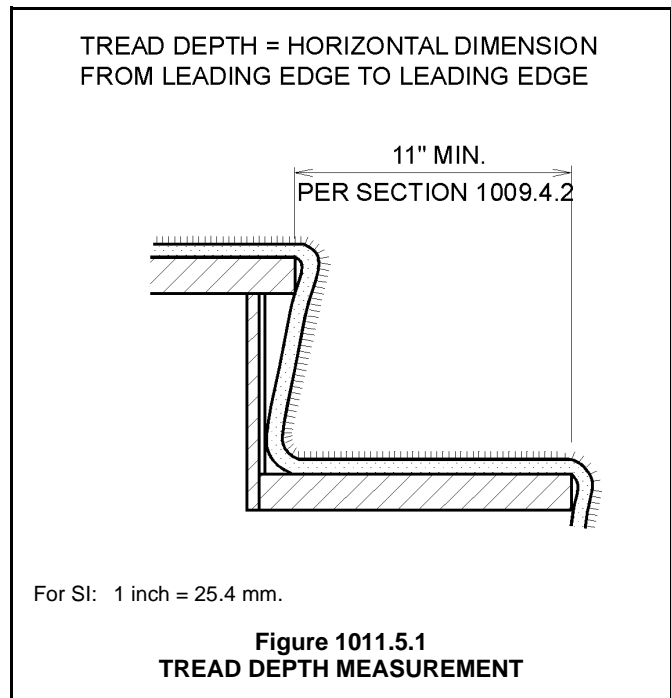
❖ Carpets, rugs and runners, like furniture, are frequently changed by the occupants and are not regulated by the code. For this reason it is essential that the riser height and tread depth be regulated exclusive of these transitory surfaces to provide an enforceable standard. This practice minimizes the possible variation because of the removal of nonpermanent carpeting throughout the life of a structure and provides a standard enforcement methodology that will provide consistency across the build environment for all users. When owners or occupants add carpeting, rugs or runners, they need to add it to all tread and landing surfaces in the stairway. It is important that the tread and landing surfaces are consistent and comply with the code prior to the addition of carpet. This methodology of enforcement makes it unnecessary to reconstruct floor and stair elevations in the stairway when nonpermanent carpet surfaces are changed that do not require a building permit and eliminates the resulting variations in the built environment that will not comply with the tolerance in Section 1011.5.4 (see Commentary Figure 1011.5.1).

**1011.5.2 Riser height and tread depth.** *Stair* riser heights shall be 7 inches (178 mm) maximum and 4 inches (102 mm) minimum. The riser height shall be measured vertically between the *nosings* of adjacent treads. Rectangular tread depths shall be 11 inches (279 mm) minimum measured horizontally between the vertical planes of the foremost projec-

tion of adjacent treads and at a right angle to the tread's *nosing*. *Winder* treads shall have a minimum tread depth of 11 inches (279 mm) between the vertical planes of the foremost projection of adjacent treads at the intersections with the walkline and a minimum tread depth of 10 inches (254 mm) within the clear width of the *stair*.

**Exceptions:**

1. *Spiral stairways* in accordance with Section 1011.10.
2. *Stairways* connecting stepped *aisles* to cross *aisles* or concourses shall be permitted to use the riser/tread dimension in Section 1029.13.2.
3. In Group R-3 occupancies; within *dwelling units* in Group R-2 occupancies; and in Group U occupancies that are accessory to a Group R-3 occupancy or accessory to individual *dwelling units* in Group R-2 occupancies; the maximum riser height shall be 7<sup>3</sup>/<sub>4</sub> inches (197 mm); the minimum tread depth shall be 10 inches (254 mm); the minimum *winder* tread depth at the walkline shall be 10 inches (254 mm); and the minimum *winder* tread depth shall be 6 inches (152 mm). A *nosing* projection not less than <sup>3</sup>/<sub>4</sub> inch (19.1 mm) but not more than 1<sup>1</sup>/<sub>4</sub> inches (32 mm) shall be provided on *stairways* with solid risers where the tread depth is less than 11 inches (279 mm).
4. See Section 403.1 of the *International Existing Building Code* for the replacement of existing *stairways*.
5. In Group I-3 facilities, *stairways* providing access to guard towers, observation stations and control rooms, not more than 250 square feet (23 m<sup>2</sup>) in area, shall be permitted to have a maximum riser



height of 8 inches (203 mm) and a minimum tread depth of 9 inches (229 mm).

- ❖ The riser height—the vertical dimension from tread surface to tread surface or tread surface to landing surface—is typically limited to not more than 7 inches (178 mm) or less than 4 inches (102 mm). The minimum tread depth—the horizontal distance from the leading edge (nosing) of one tread to the leading edge (nosing) of the next adjacent tread or landing—is typically limited to not less than 11 inches (279 mm) [see Commentary Figure 1011.5.2]. The minimum tread depth of 11 inches (279 mm) is intended to accommodate the largest shoe size found in 95 percent of the adult population, allowing for an appropriate overhang of the foot beyond the tread nosing while descending a stairway. Tread depths under 11 inches (279 mm) could cause a larger overhang (depending on the size of the foot) and could force users with larger feet to increase the angle of their foot to the line of travel while descending a stairway. Based on the probability of adequate foot placement, the rate of misstep with various step sizes and consideration for the user’s comfort and energy expenditure, it was agreed that the 11-inch (279 mm) minimum tread depth and maximum 7-inch (178 mm) riser height resulted in the reasonable proportion of riser height and tread depth for stairway construction. A minimum riser height of 4 inches (102 mm) is considered to allow the visual identification of the presence of the riser in ascent or descent.

The precise location of rectangular tread depth and riser measurements is to be perpendicular to the tread’s nosing or leading edge. This is to duplicate the user’s anticipated foot placement in traveling the stairway.

The size for a winder tread is also considered for

proper foot placement along the walkline [see Commentary Figure 1011.9 and the commentary for Section 1011.4]. The dimensional requirements are consistent with the straight tread.

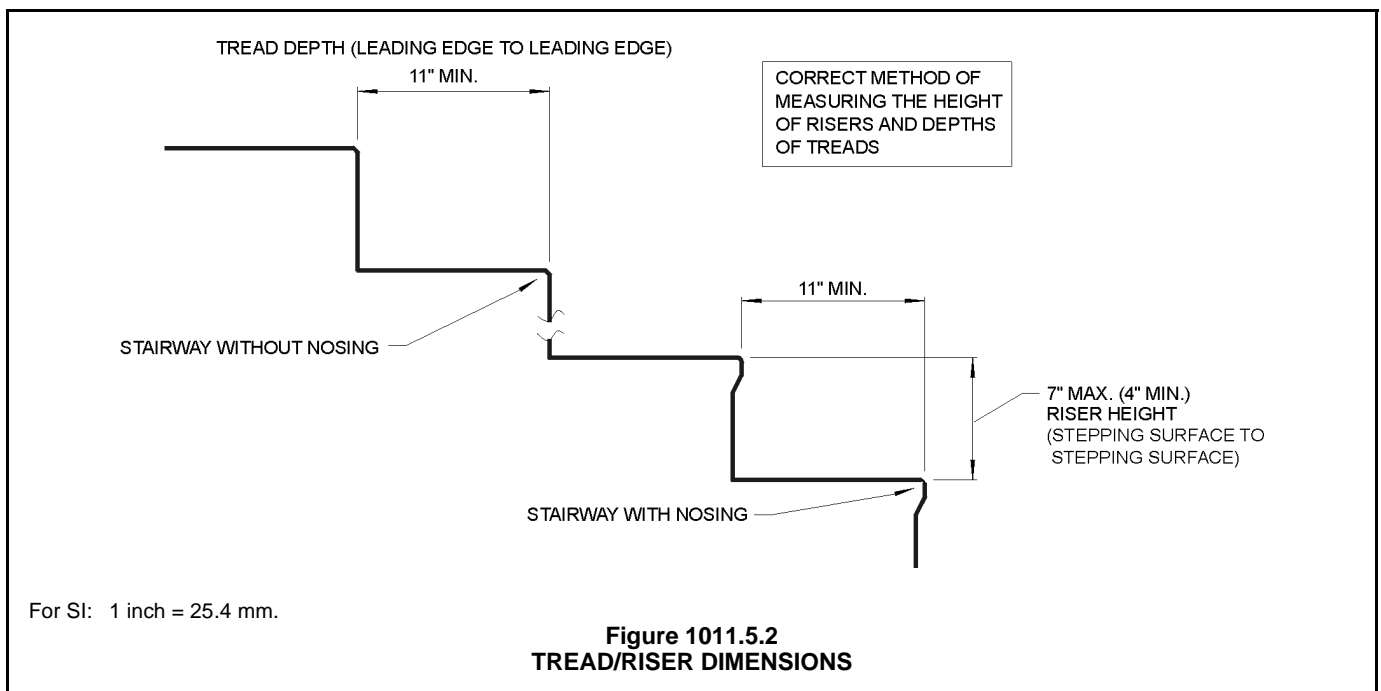
The exceptions apply only to the extent of the text of each exception. For example, the entire text of Section 1011.5.2 is set aside for spiral stairways conforming to Section 1011.10 (see Exception 3). However, Exception 3 allows a different maximum riser and minimum tread under limited conditions, but retains the minimum riser height and measurement method of Section 1011.5.2.

The requirements for dimensional uniformity are found in Sections 1011.5.4 and 1011.5.4.1.

Exception 1 is for spiral staircases, a unique type of stairway. Section 1011.5.2 is not applicable to this stair type, again because of construction issues and limited applications. For a discussion on spiral staircases, see Section 1011.10.

Exception 2 provides a practical exception where assembly facilities are designed for viewing. See Sections 1029.13 through 1029.13.2.4 for assembly stepped aisle-walking surfaces. This exception is limited to when stairways are a direct continuation of the path of travel from the level cross aisle to the stepped aisles. It is not permitted for other stairways within the assembly space.

Exception 3 allows revisions to the 7 inches/11 inches (178 mm/279 mm) riser/tread requirements for Group R-3 and any associated utility (such as barns, connected garages or detached garages) and within individual units of Group R-2 and their associated utility areas (such as attached garages). This change is allowed because of the low occupant load and the high degree of occupant familiarity with the stairways. When this exception is taken for stairways that have



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solid risers, each tread is required to have a nosing projection with a minimum dimension of  $\frac{3}{4}$  inch (19.1 mm) and maximum dimension of  $1\frac{1}{4}$  inches (32 mm) where the tread depth is less than 11 inches (279 mm). Nosing projections are created where the nosing of the tread above extends beyond the trailing edge of the tread below or when a solid riser is angled under the tread above and connected to the trailing edge of the tread below. Nosing projections are not required for residential stairs with open risers and 10-inch (254 mm) treads. A nosing projection provides a greater stepping surface for those ascending the stairway. For users descending the stairway, the nosing projection allows the toe of the foot to be placed further away from the riser above, providing the necessary clearance for the heel of the foot as it swings down in an arc to its position on the tread (see Commentary Figure 1011.5.3).

Exception 4 allows for the replacement of an existing stair. Where a change of occupancy would require compliance with current standards, this exception allows a stairway that may be steeper than that permitted, provided it does not constitute a hazard [see *International Existing Building Code*<sup>®</sup> (IEBC<sup>®</sup>) Section 403.1].

Exception 5 allows steeper stairs in spaces of not more than 250 square feet (23 m<sup>2</sup>) in correctional facilities (Group I-3) with a maximum riser height of 8 inches (203 mm) and a minimum tread depth of 9 inches (229 mm) because of the minimal occupant load and the familiarity of the users with the stairway. Although not stated in this exception, utilizing a nosing projection to provide effective tread depth, as

stated in Exception 3 for tread depths less than 11 inches (279 mm), is a good design practice.

**1011.5.3 Winder treads.** *Winder* treads are not permitted in *means of egress stairways* except within a *dwelling unit*.

### Exceptions:

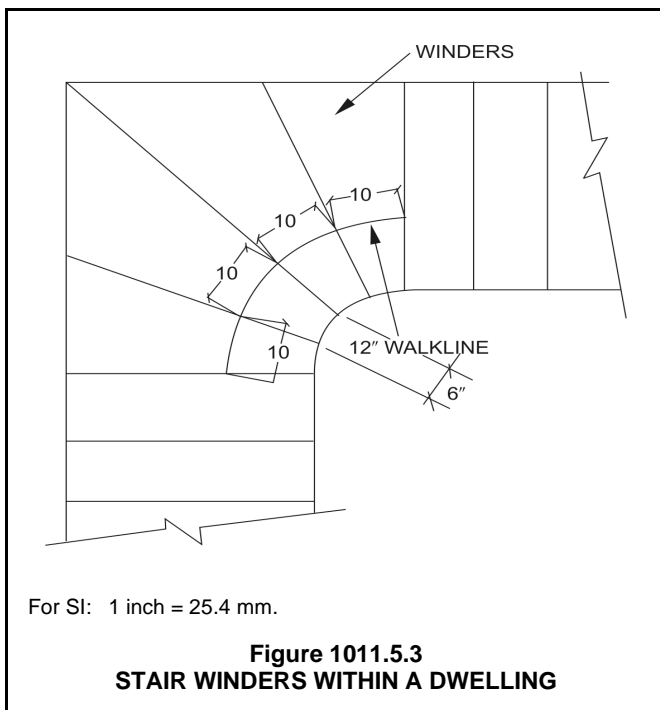
1. Curved *stairways* in accordance with Section 1011.9.
2. *Spiral stairways* in accordance with Section 1011.10.

❖ The intent of this section is to coordinate the general provisions for stairway tread and riser dimensions in Section 1011.5.2 with the provisions for winder treads permitted in curved and spiral stairways (see Sections 1011.9 and 1011.10). Winders are permitted in *means of egress stairways* within *dwelling units* where occupant loads are smaller and occupants have increased familiarity (see Commentary Figure 1011.5.3 and Section 1011.5.2, Exception 3). This is consistent with provisions in the *International Residential Code*<sup>®</sup> (IRC<sup>®</sup>).

Winders are used to change the direction of a flight by introducing a consistent incremental turn associated with each tread. The risk of injury in the use of stairways constructed with winders is considered to be greater than for stairways constructed as straight runs where users may be restricted by the presence of other users limiting visual clues or influencing the rate of travel. Additional user attention in the turn and the aid of the turn in arresting falls similar to turns at landings is also understood to negate this.

The employment of winders in stairway construction may necessitate the change of the user's gait in both ascent and descent where the tread depth of the winder is not equal to the tread depth of any rectangular treads in the same flight. For example, a person descending a straight flight of stairs will develop a particular gait conforming to the proportion of the riser height and tread depth that will be consistent throughout the flight. However, in a flight that includes winders and rectangular treads, the user must accommodate a change in the proportion of the riser height and tread depth as determined by the path of travel chosen. Visual clues are important to the users' instinctive responses to alter the path of travel, the length of the stride, or a combination of both that may result in nonconcentric movement. To ensure users of the visual clues necessary to alter their gait and limit the need to alter the path of travel in conditions of higher occupant loading, flights with winders must meet the specific safety provisions listed for curved or spiral stairways unless they are within a dwelling unit.

**1011.5.4 Dimensional uniformity.** *Stair* treads and risers shall be of uniform size and shape. The tolerance between the largest and smallest riser height or between the largest and smallest tread depth shall not exceed  $\frac{3}{8}$  inch (9.5 mm) in any *flight of stairs*. The greatest *winder* tread depth at the



walkline within any *flight of stairs* shall not exceed the smallest by more than  $\frac{3}{8}$  inch (9.5 mm).

**Exceptions:**

1. *Stairways* connecting stepped *aisles* to cross *aisles* or concourses shall be permitted to comply with the dimensional nonuniformity in Section 1029.13.2.
2. Consistently shaped *winders*, complying with Section 1011.5, differing from rectangular treads in the same *flight of stairs*.
3. Nonuniform riser dimension complying with Section 1011.5.4.1.

❖ Dimensional uniformity in the design and construction of stairways contributes to safe stairway use. When ascending or descending a stair, users establish a gait based on the instinctive expectation or “feel” that each step taken will be at the same height and will land in approximately the same position on the tread as the previous steps in the pattern. A change in tread or riser dimensions in a stairway flight in excess of the allowed dimensional tolerance can break the rhythm and cause a misstep, stumbling or physical strain that may result in a fall or serious injury. Therefore, this section limits the dimensional variations to a tolerance of  $\frac{3}{8}$  inch (9.5 mm) between the largest and smallest riser or tread dimension in a flight of stairs. A “flight” of stairs is defined as a run of stairs between landings.

For special conditions of construction and as a practical matter, this section allows some greater variations in stairway tread and riser dimensions than the general limitations specified above.

Exception 1 provides a practical exception where

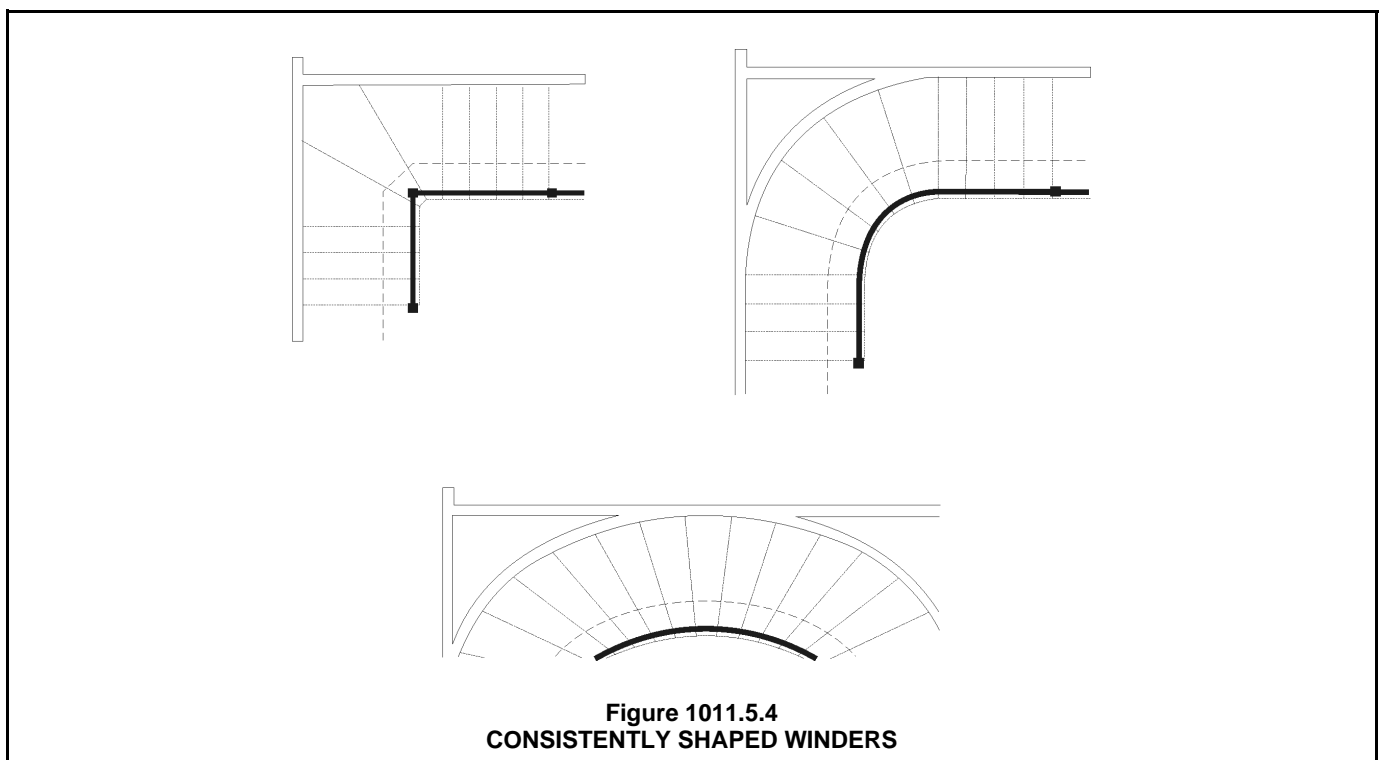
assembly facilities are designed for viewing. See Sections 1029.13 through 1029.13.2.4 for assembly stepped aisle walking surfaces. This exception is limited to when stairways are a direct continuation of the path of travel from the level cross aisle to the stepped aisles. It is not permitted for other stairways within the assembly space.

Exception 2 addresses winder treads, which must be consistent along the walkline (see Commentary Figure 1011.5.4) when compared to other winder treads in the same flight but are not required to meet the tolerance when compared to the uniform dimension of rectangular treads in the same flight.

Exception 3 is in recognition of the situation where a stairway moves down to a surface that slopes up or down perpendicular to the stairway. See the commentary to Section 1105.4.1.

**1011.5.4.1 Nonuniform height risers.** Where the bottom or top riser adjoins a sloping *public way*, walkway or driveway having an established grade and serving as a landing, the bottom or top riser is permitted to be reduced along the slope to less than 4 inches (102 mm) in height, with the variation in height of the bottom or top riser not to exceed one unit vertical in 12 units horizontal (8-percent slope) of *stair width*. The *nosings* or leading edges of treads at such nonuniform height risers shall have a distinctive marking stripe, different from any other *nosing* marking provided on the *stair flight*. The distinctive marking stripe shall be visible in descent of the *stair* and shall have a slip-resistant surface. Marking stripes shall have a width of not less than 1 inch (25 mm) but not more than 2 inches (51 mm).

❖ This section addresses the situation where the bottom riser of a flight of stairways meets a sloped land-



**Figure 1011.5.4**  
**CONSISTENTLY SHAPED WINDERS**

ing, such as a public way, walk or driveway (see Commentary Figure 1011.5.4.1). Because the sidewalk landing is sloped perpendicular to the stairway run, stepping off the bottom tread on one side will result in a higher riser than stepping off the bottom tread on the other side. This is permitted provided the bottom riser is marked so that someone using the stairs will be aware of the hazard of a nonuniform riser.

**1011.5.5 Nosing and riser profile.** *Nosings* shall have a curvature or bevel of not less than  $\frac{1}{16}$  inch (1.6 mm) but not more than  $\frac{9}{16}$  inch (14.3 mm) from the foremost projection of the tread. Risers shall be solid and vertical or sloped under the tread above from the underside of the *nosing* above at an angle not more than 30 degrees (0.52 rad) from the vertical.

❖ The profiles of treads and risers contribute to stairway safety. The radius or bevel of the nosing eases the otherwise square edge of the tread and prevents irregular chipping and wear that can become a maintenance issue and seriously affect the safe use of the stair. The minimum curvature or bevel of  $\frac{1}{16}$  inch (1.6 mm) eliminates a sharp square edge that will cause greater injury in falls and provides a certain contrast from the other surfaces of the stair for easier visual location of the start of the tread surface. The  $\frac{9}{16}$ -inch (14.3 mm) limit of beveling and maximum radius of curvature at the leading edge of the tread is intended to allow descending foot placement on a surface that does not pitch the foot forward or allow the ball of the foot to slide off the treads and ascending foot placement to slide onto the tread without catching on a square edge. This section also states that risers shall be solid; however, Section 1011.5.5.3 specifically states exceptions to this requirement that are to be applied. The sloping of risers allows the step profile to have a nosing projection without a lip that might cause a foot to catch when dragged up the face of the riser. Such designs are subject to the maximum nosing projection stated in Section 1011.5.5.1 that must

be considered when choosing the angle to slope the riser.

**1011.5.5.1 Nosing projection size.** The leading edge (*nosings*) of treads shall project not more than  $1\frac{1}{4}$  inches (32 mm) beyond the tread below.

❖ A nosing projection allows the descending foot to be placed further forward on the tread and the heel to then clear the nosing of the tread above as it swings down in an arc, landing on a tread that is effectively deeper than if no nosing projection is used. Nosing projections are so common in stair design that they are usually only noticed by users when they are absent since the lack of nose projection can affect one's gait. Treads with vertical risers are allowed with or without a nosing projection. A nosing projection may also be accommodated by slanting the riser under the tread above. The nosing projection is limited to  $1\frac{1}{4}$  inch (32 mm) maximum. Treads designed with rounding or bevel on the underside would reduce the chance that a user's toe might catch while ascending the stairway (see Commentary Figure 1011.5.5.1).

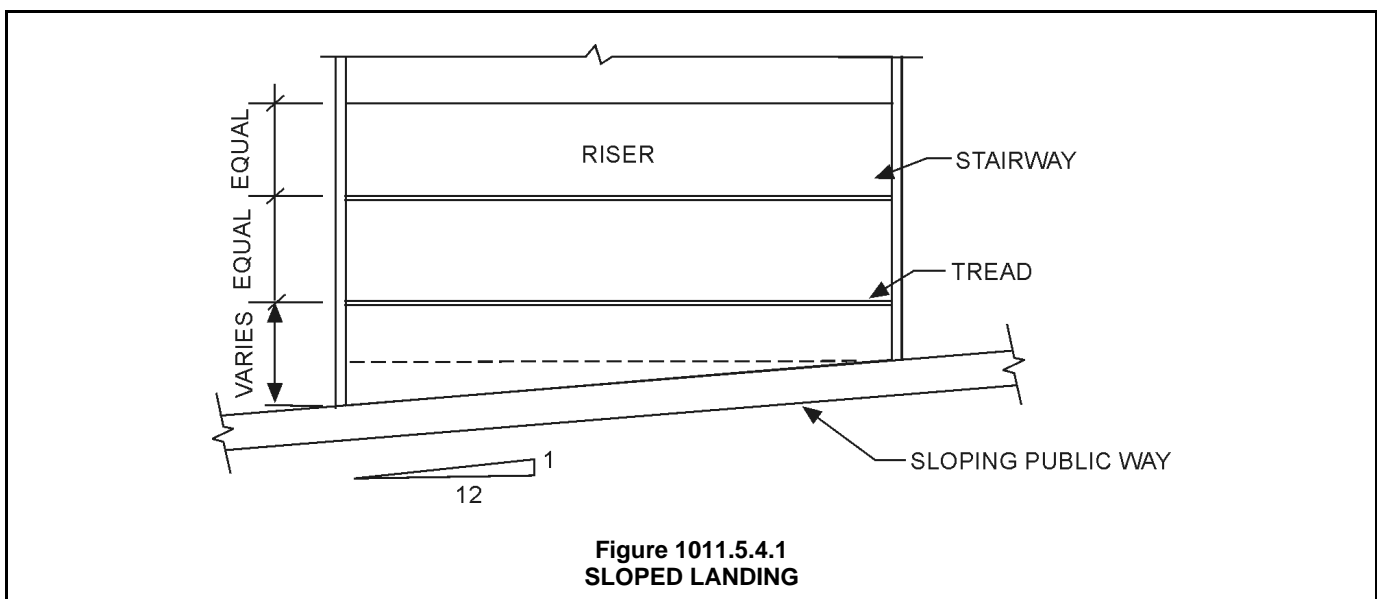
**1011.5.5.2 Nosing projection uniformity.** *Nosing* projections of the leading edges shall be of uniform size, including the projections of the *nosing's* leading edge of the floor at the top of a *flight*.

❖ See the commentary to Section 1011.5.5.1.

**1011.5.5.3 Solid risers.** Risers shall be solid.

**Exceptions:**

1. Solid risers are not required for *stairways* that are not required to comply with Section 1009.3, provided that the opening between treads does not permit the passage of a sphere with a diameter of 4 inches (102 mm).
2. Solid risers are not required for occupancies in Group I-3 or in Group F, H and S occupancies other



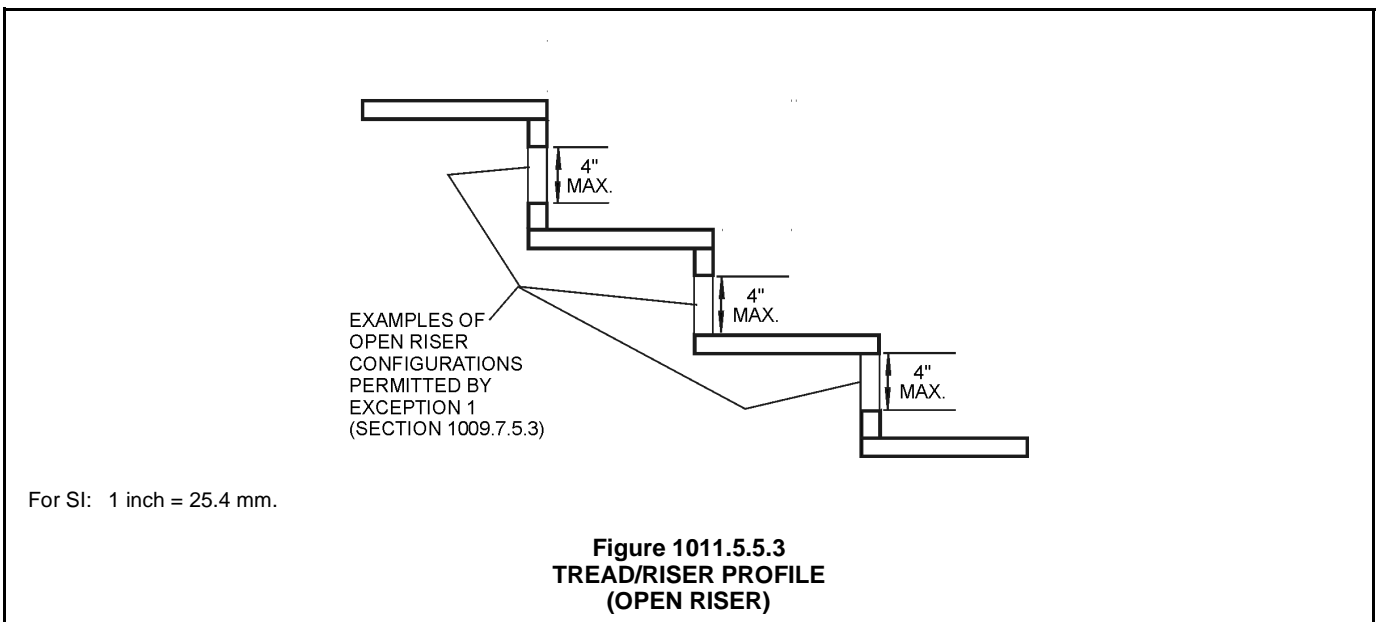
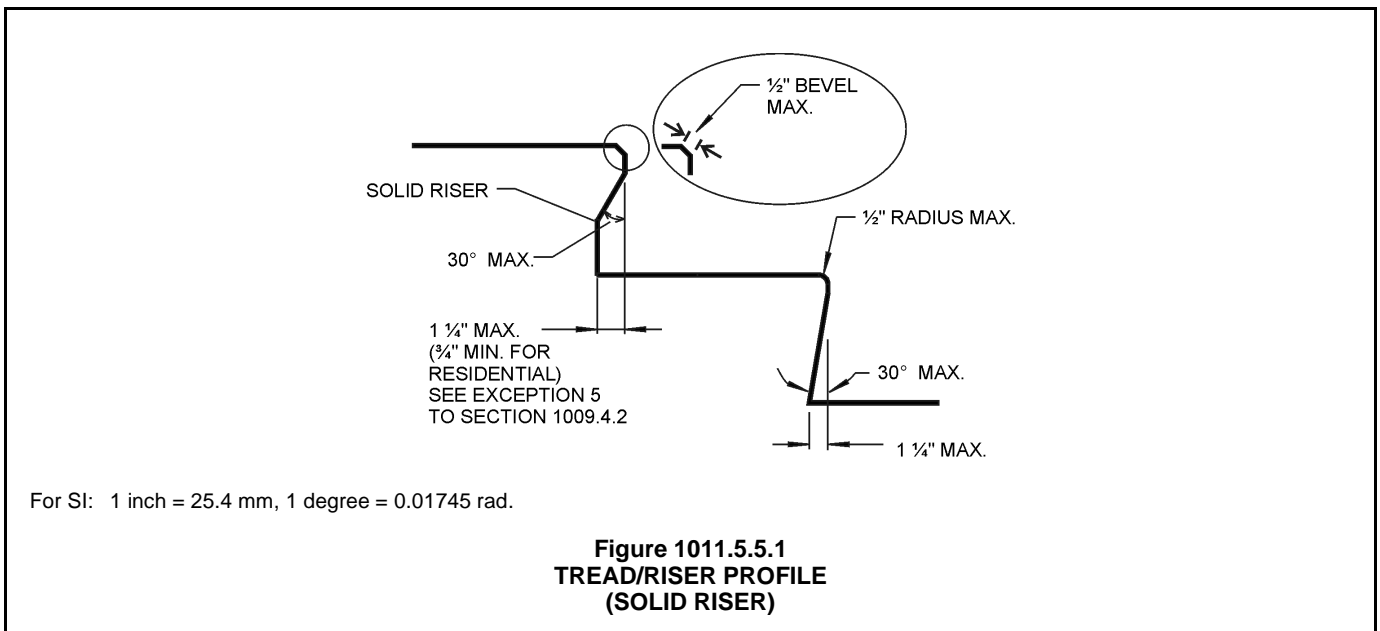
**Figure 1011.5.4.1 SLOPED LANDING**

than areas accessible to the public. There are no restrictions on the size of the opening in the riser.

3. Solid risers are not required for *spiral stairways* constructed in accordance with Section 1011.10.

❖ The code does not address when a riser could contain openings and still be considered “solid.” However, the intent is so that someone would not catch their toe as they moved up the stairway (see the commentary for nosing projections in Section 1011.5.5). It is not the intent to prohibit risers made of grills or other designs where a toe would not catch. Grill stairways are often used in exterior locations to allow for the passage of snow or rain and decrease the chance of accumulation and possible slips and falls on the stairways.

Exception 1 allows the use of open risers on all stairs that are not part of an accessible means of egress. Where the riser is allowed to be open, the opening is limited to be consistent with the requirements for guards (see Commentary Figure 1011.5.5.3). While not required, the second option shown in Commentary Figure 1011.5.5.3 would limit the possibility of a toe catch as someone moved up the stairways and would be a safer design. The code does not reference ICC A117.1 for stairways, because stairways are not part of an accessible route; however, the code and standard provide opening limitations in tread surfaces. Section 1011.7.1 does allow for treads to have a maximum opening that allows for a 1/2-inch (12.7 mm) sphere.



Exception 2 recognizes that open risers are commonly used for stairs in occupancies such as detention facilities, storage, industrial and high-hazard areas for practical reasons. In detention facilities, open risers provide a greater degree of security and supervision because people cannot effectively conceal themselves behind the stair. Factories, high-hazard buildings and storage facilities have areas where workers may need the open risers to decrease the chance of spillage, water or snow accumulating on the stairs. See Section 1011.7.1 for permitted openings in the treads.

Exception 3 recognizes open risers as necessary for adequate foot placement in spiral stairways. The 4-inch (102 mm) opening limitations of Exception 1 are not applicable to spiral stairways.

**1011.6 Stairway landings.** There shall be a floor or landing at the top and bottom of each *stairway*. The width of landings shall be not less than the width of *stairways* served. Every landing shall have a minimum width measured perpendicular to the direction of travel equal to the width of the *stairway*. Where the *stairway* has a straight run the depth need not exceed 48 inches (1219 mm). Doors opening onto a landing shall not reduce the landing to less than one-half the required width. When fully open, the door shall not project more than 7 inches (178 mm) into a landing. Where *wheelchair spaces* are required on the *stairway* landing in accordance with Section 1009.6.3, the *wheelchair space* shall not be located in the required width of the landing and doors shall not swing over the *wheelchair spaces*.

**Exception:** Where *stairways* connect stepped *aisles* to cross *aisles* or concourses, *stairway* landings are not required at the transition between *stairways* and stepped *aisles* constructed in accordance with Section 1029.

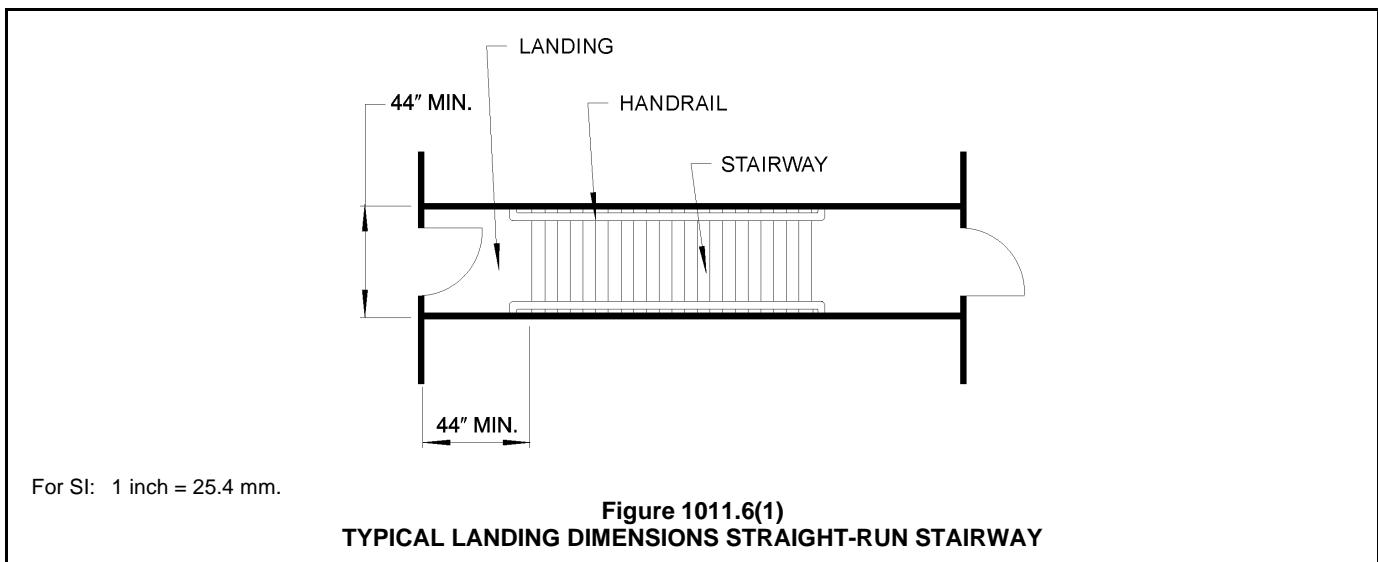
- ❖ A level portion of a stairway provides users with a place to rest in their ascent or descent, to enter a stairway and to adjust their gait before continuing. Landings also break up the run of a stairway, especially at a turn, to aid in the arrest of falls that may occur (see Section 1011.8).

The minimum size (width and depth) of all landings in a stairway is determined by the actual width of the stairway. If Section 1011.2 requires a stairway to have a width of at least 44 inches (1118 mm) and the stairway is constructed with that minimum width, then all landings serving that stairway must be at least 44 inches (1118 mm) wide and 44 inches (1118 mm) deep [see Commentary Figure 1011.6(1)]. If a stairway is constructed wider than required, landings must increase accordingly so as to not create a bottleneck situation in the egress travel. However, when a stairway is configured so that it has a straight run, the depth of the landing between flights in the direction of egress travel is not required to exceed 48 inches (1219 mm), even though the actual width of the stair may exceed 48 inches (1219 mm) [see Commentary Figure 1011.6(2)].

It is not the intent of this section to require that a stairway landing be shaped as a square or rectangle. A landing turning the stairway 90 degrees (1.57 rad) or more with a curved or segmented outside periphery would be permitted, as long as the landing provides an area described by an arc with a radius equal to the actual stairway width [see Commentary Figure 1011.6(3)]. In this case, the space necessary for means of egress will be available.

The last portion of the requirement limits the extent to which doors that swing onto landings may interfere or encroach upon the required landing space. This limits the arc of the door swing on a landing, so that the effect on the means of egress is minimized [see Commentary Figure 1011.6(4)]. This is consistent with a door opening into an exit access corridor in Section 1005.7. For safety reasons and to ensure the means of egress is continually available for everyone, where an area of refuge/wheelchair space must be located on a landing, the wheelchair spaces must not be within the required landing width and the entrance door to the stair enclosure may not swing over the wheelchair spaces [see Commentary Figure 1009.3(1)].

Exception 1 provides a practical exception where



assembly facilities are designed for viewing. See Sections 1029.13 through 1029.13.2.4 for assembly stepped aisle walking surfaces. This exception is limited to when stairways are a direct continuation of the path of travel from the level cross aisle to the stepped aisles. It is not permitted for other stairways within the assembly space.

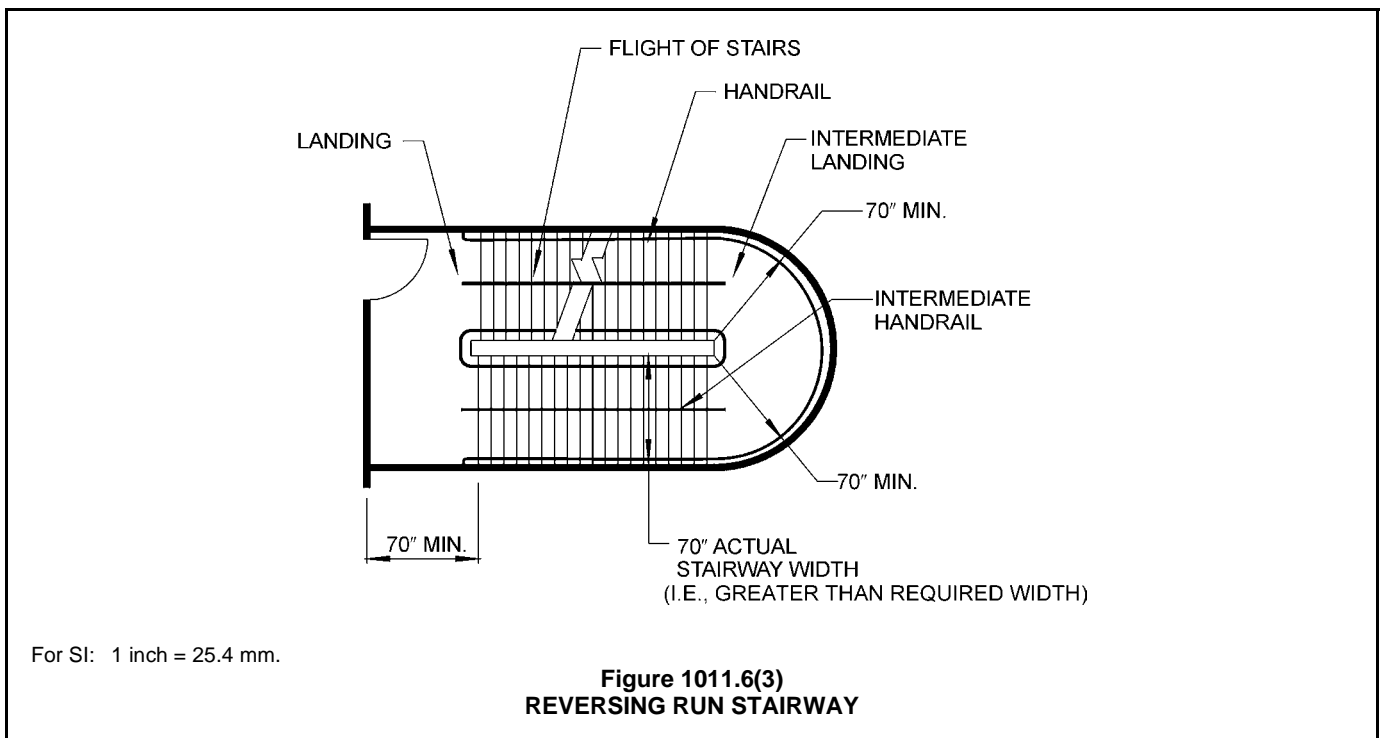
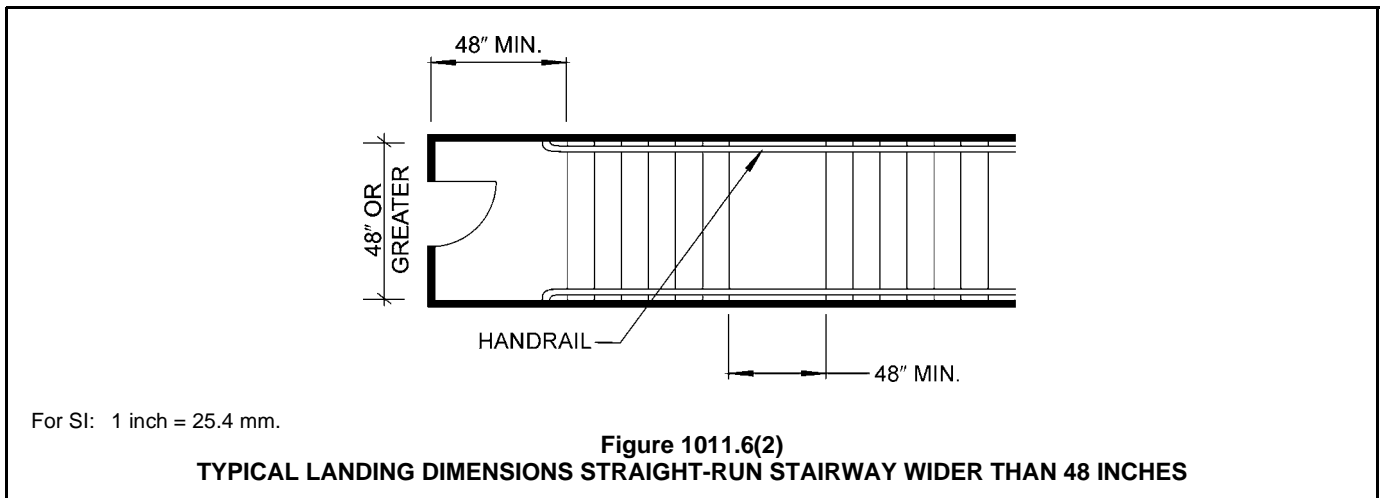
**1011.7 Stairway construction.** *Stairways* shall be built of materials consistent with the types permitted for the type of construction of the building, except that wood *handrails* shall be permitted for all types of construction.

❖ In keeping with the different levels of fire protection provided by each of the five basic types of construction designated in Chapter 6, the materials used for stairway construction must meet the appropriate combustibility/noncombustibility requirements indicated in

Section 602 for the particular type of construction of the building in which the stairway is located. This is required whether or not the stair is part of the required means of egress. Any structure supporting the stairway and the stairway enclosure must be fire-resistance rated consistent with the construction type; however, the stairway components inside the enclosure need only comply with the material limits for the type of construction.

If desired, wood handrails may be used on the basis that the fuel load contributed by this combustible component of stairway construction is insignificant and will not pose a fire hazard.

**1011.7.1 Stairway walking surface.** The walking surface of treads and landings of a *stairway* shall not be sloped steeper than one unit vertical in 48 units horizontal (2-percent slope)



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in any direction. *Stairway* treads and landings shall have a solid surface. Finish floor surfaces shall be securely attached.

### Exceptions:

1. Openings in *stair* walking surfaces shall be a size that does not permit the passage of  $\frac{1}{2}$ -inch-diameter (12.7 mm) sphere. Elongated openings shall be placed so that the long dimension is perpendicular to the direction of travel.
  2. In Group F, H and S occupancies, other than areas of parking structures accessible to the public, openings in treads and landings shall not be prohibited provided a sphere with a diameter of  $1\frac{1}{8}$  inches (29 mm) cannot pass through the opening.
- ❖ It is the intent of this section that both landing and stair treads be solid and level with firmly attached surface materials; however, the 1:48 slope should be adequate to allow for drainage to limit the chance for an accumulation of water where someone might slip.

The exceptions permit the use of open grate-type material or slotted grill for stairway treads and landings in two different situations.

Exception 1 allows for a maximum  $\frac{1}{2}$ -inch (12.7 mm) opening on stairway treads in public areas and serving any use (see Commentary Figure 1011.7.1). This is very beneficial on exterior stairways where snow, ice or water may accumulate. The  $\frac{1}{2}$ -inch (12.7 mm) limitation is based on the size of a crutch or cane tip and is consistent with ICC A117.1 and federal accessibility requirements. The opening limitation is also small enough that most shoe heels will not get stuck. If a slotted grill pattern is used, the slots must run side to side on the stairway tread, not nosing to back.

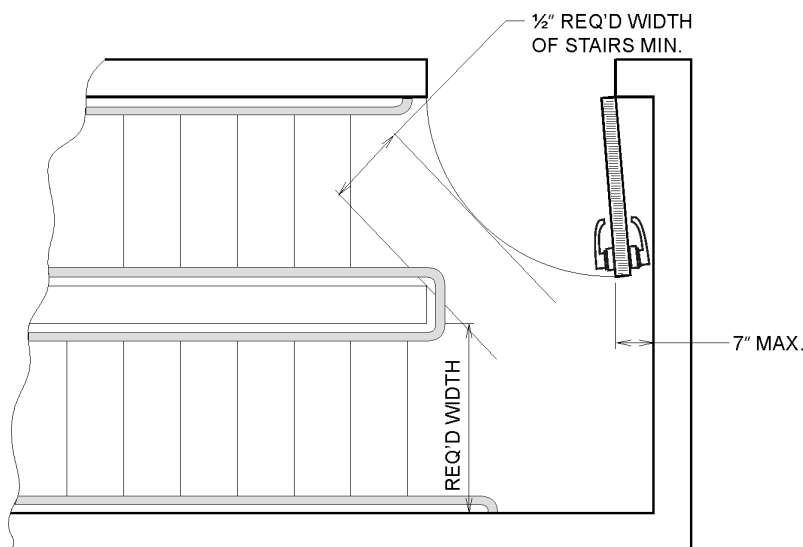
Exception 2 is applicable in factory, industrial, storage and high-hazard occupancies. This provision is

intended to apply primarily to stairs that provide access to areas not required to be accessible, such as pits, catwalks, tanks, equipment platforms, roofs or mezzanines. Walking surfaces with limited-size openings are typically used because open grate-type material is less susceptible to accumulation of dirt, debris or moisture, as well as being more resistant to corrosion. Most commercially available grate material is manufactured with a maximum nominal 1-inch (25 mm) opening; therefore, the limitation that the openings not allow the passage of a sphere of  $1\frac{1}{8}$  inches (29 mm) diameter allows the use of most material as well as accounting for manufacturing tolerances.

The allowances for openings in risers is addressed in Section 1011.5.5.3.



Figure 1011.7.1  
OPEN TREAD IN ACCORDANCE WITH EXCEPTION 1



For SI: 1 inch = 25.4 mm.

Figure 1011.6(4)  
DOOR CLEARANCE REQUIREMENTS IN STAIRWAY

**1011.7.2 Outdoor conditions.** Outdoor *stairways* and outdoor approaches to *stairways* shall be designed so that water will not accumulate on walking surfaces.

- ❖ Outdoor stairways and approaches to stairways are to be constructed with a slope that complies with Section 1011.7.1 or are required to be protected such that walking surfaces do not accumulate water. While not specifically stated, any interior locations, such as near a pool, should also have the stair designed to limit the accumulation of water in order to maintain slip resistance (see Section 1003.4).

Where exterior stairways are used in moderate or severe climates, there may also be a concern to protect the stairway from accumulations of snow and ice to provide a safe path of egress travel at all times. Maintenance of the means of egress requires an unobstructed path to allow for full instant use in case of a fire or emergency (see Section 1031.3). Typical methods for protecting these egress elements include roof overhangs or canopies; heated slabs; grated treads and landings; or, when approved by the building official, a reliable snow removal maintenance program.

**1011.7.3 Enclosures under interior stairways.** The walls and soffits within enclosed usable spaces under enclosed and unenclosed stairways shall be protected by 1-hour fire-resistance-rated construction or the fire-resistance rating of the stairway enclosure, whichever is greater. Access to the enclosed space shall not be directly from within the stairway enclosure.

**Exception:** Spaces under *stairways* serving and contained within a single residential dwelling unit in Group R-2 or R-3 shall be permitted to be protected on the enclosed side with 1/2-inch (12.7 mm) gypsum board.

- ❖ This section addresses the fire hazard of storage under an interior stairway, whether it is an exit access stairway or exit stairway. The stairway must be protected from a storage area under it, even if the stair is not required to be enclosed. The section also requires that the storage area not open into a stairway enclosure. This limits the potential of a fire that starts in the storage area from affecting the means of egress. The exception provides specific criteria for separation for storage areas under an interior stairway for the indicated residential occupancies.

**1011.7.4 Enclosures under exterior stairways.** There shall not be enclosed usable space under *exterior exit stairways* unless the space is completely enclosed in 1-hour fire-resistance-rated construction. The open space under *exterior stairways* shall not be used for any purpose.

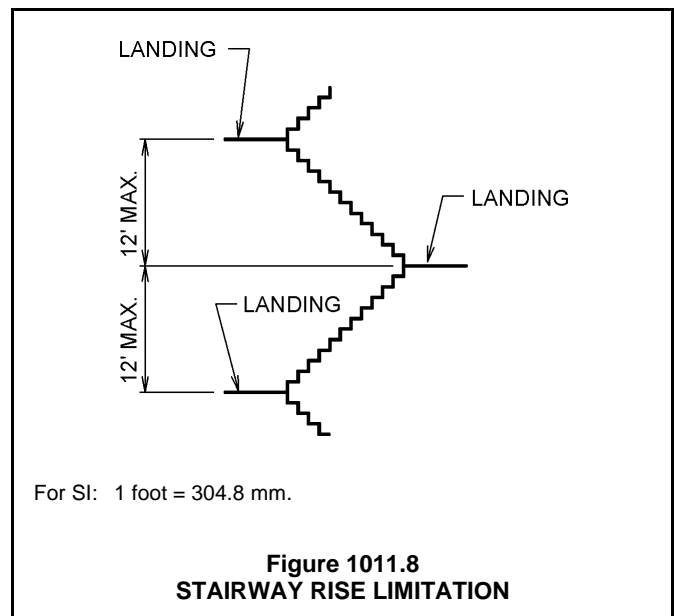
- ❖ If the space under an exterior stairway is to be used, such as for storage, the area below the stairway must be separated from the stairway with walls and a ceiling with a fire-resistance rating of at least 1 hour. If the space under the exterior stairway is open, it must remain free and clear. A fire occurring in this space would jeopardize the use of the stairway for exiting during an emergency.

**1011.8 Vertical rise.** A flight of stairs shall not have a vertical rise greater than 12 feet (3658 mm) between floor levels or landings.

**Exception:** Spiral stairways used as a means of egress from technical production areas.

- ❖ Between landings and platforms, the vertical rise is to be measured from one landing walking surface to another (see Commentary Figure 1011.8). The limited height provides a reasonable interval for users with physical limitations to rest on a level surface and also serves to alleviate potential negative psychological effects of long and uninterrupted stairway flights.

The exception allows for spiral stairways that only serve technical production areas to eliminate intermediate landings regardless of height. These stairways typically have limited use and serve areas such as catwalks or lighting booths in stadiums and theaters. In addition, there is the technical difficulty of maintaining proper headroom in a spiral stairway with an intermediate landing.



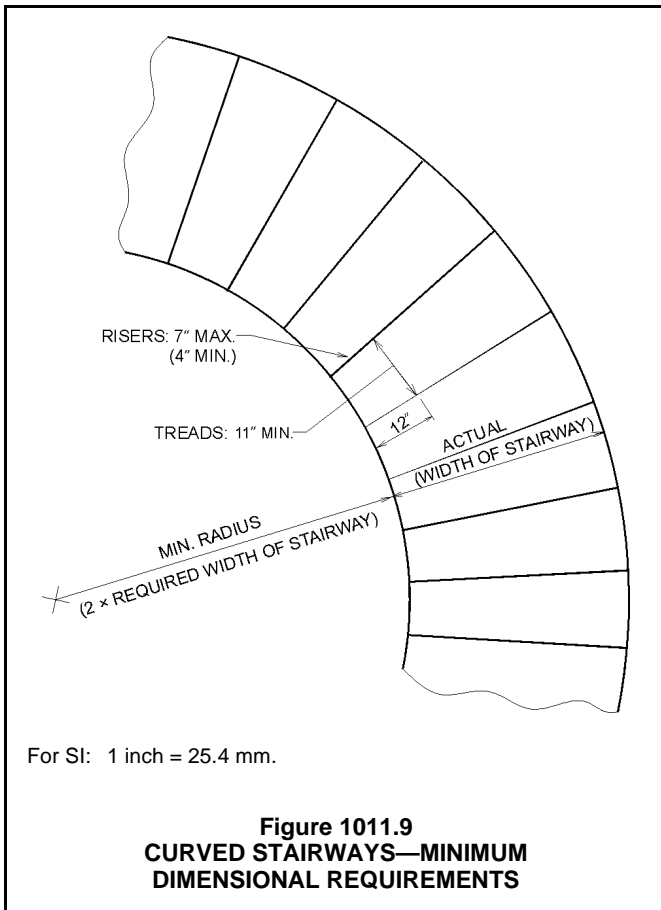
**1011.9 Curved stairways.** Curved stairways with winder treads shall have treads and risers in accordance with Section 1011.5 and the smallest radius shall be not less than twice the minimum width or required capacity of the stairway.

**Exception:** The radius restriction shall not apply to curved stairways in Group R-3 and within individual dwelling units in Group R-2.

- ❖ Curved stairway construction consists of a series of winder treads that form a stairway configuration. Options are many, including circular, S-shaped, oval, elliptical, hourglass, etc. The commentary to Section 1011.5.3 regarding the possible event of nonconcentric movement on stairways with winders also applies to curved stairways. This type of stairway is allowed to be used as a component of a means of egress when tread and riser dimensions meet the require-

ments or exceptions of Section 1011.5. This section also requires that the shorter radius must be equal to or greater than twice the required width (see Section 1011.2) of the stairway to limit the degree of turning thereby expediting egress from higher occupancies (see Commentary Figure 1011.9).

The exception for residential units eliminates the minimum radius requirement where the occupants are familiar with the extent of the turning of the stair through the curve.



**1011.10 Spiral stairways.** *Spiral stairways* are permitted to be used as a component in the *means of egress* only within *dwelling units* or from a space not more than 250 square feet (23 m<sup>2</sup>) in area and serving not more than five occupants, or from *technical production areas* in accordance with Section 410.6.

A *spiral stairway* shall have a 7½-inch (191 mm) minimum clear tread depth at a point 12 inches (305 mm) from the narrow edge. The risers shall be sufficient to provide a headroom of 78 inches (1981 mm) minimum, but riser height shall not be more than 9½ inches (241 mm). The minimum *stairway* clear width at and below the *handrail* shall be 26 inches (660 mm).

❖ Spiral stairways can be used within an individual dwelling unit, from small spaces in other occupancies

and from technical production areas in spaces such as theaters. Spiral stairways are permitted to provide access between the levels within a live/work unit (see Section 419.3.2).

Spiral stairways are generally constructed with a fixed center pole that serves as either the primary or the only means of support from which pie-shaped treads radiate to form a winding stairway. The term “spiral” in the geometrical sense describes a curve that diminishes in radius and relates to the form of the stair as viewed in perspective from above or below; however, “spiral” does not describe the actual geometry of the stair. The unique turning of spiral stairs allows the center pole to act as the guard at the inside of the stair and the typically narrow width requires users to choose a walkline along the outer perimeter near the only required handrail. On spiral stairways of larger widths, where two users can pass and restrict access to the single handrail, the provision of a handrail at both sides should be considered.

The commentary to Section 1011.5.3 regarding the possible event of nonconcentric movement on stairways with winders also applies to spiral stairways. The nature of stairway construction is such that it does not serve well when used in emergencies that require immediate evacuation, nor does a spiral stairway configuration permit the handling of a large occupant load in an efficient and safe manner. Furthermore, it is impossible for fire service personnel to use a spiral stairway at the same time and in a direction opposite that being used by occupants to exit the premises, possibly causing a serious delay in fire-fighting operations. Therefore, this section allows only very limited use of spiral stairways when used as part of a required means of egress. Spiral stairways may be used in any occupancy as long as such stairways are not a component of a required means of egress.

Spiral stairways are required to have dimensional uniformity. The stairway must have a clear width of at least 26 inches (660 mm) at and below the handrail. The depth of the treads must not be less than 7½ inches (191 mm) measured at a point that is 12 inches (305 mm) out from the narrow edge (see Commentary Figure 1011.10). Riser heights are required to be the same throughout the stairway, but are not to exceed 9½ inches (241 mm). Minimum headroom of 6 feet, 6 inches (1981 mm) is required.

**1011.11 Handrails.** Stairways shall have handrails on each side and shall comply with Section 1014. Where glass is used to provide the handrail, the handrail shall comply with Section 2407.

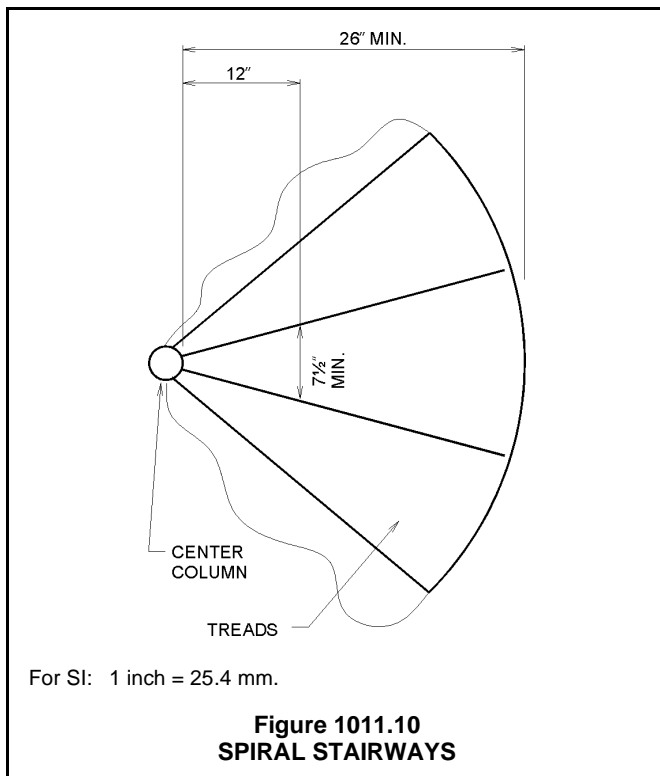
Exceptions:

1. Stairways within dwelling units and spiral stairways are permitted to have a handrail on one side only.
2. Decks, patios and walkways that have a single change in elevation where the landing depth on each side of the change of elevation is greater than what is required for a landing do not require handrails.

- 3. In Group R-3 occupancies, a change in elevation consisting of a single riser at an entrance or egress door does not require handrails.
- 4. Changes in room elevations of three or fewer risers within dwelling units and sleeping units in Group R-2 and R-3 do not require handrails.

❖ Handrails are required along each side of a flight of stairs; however, handrails are not required along stairway landings. Handrail continuity and extensions that will overlap the landings are addressed in Sections 1014.4 and 1014.6.

Handrails have four recognized functions in stairway use. First, they serve to guide persons in ascent and descent along the path of egress travel, especially important for those with low vision, and in cases of fire where vision might be obscured by smoke. Second, they provide a tool for the user to exert stabilizing forces longitudinally (along the length of the rail), vertically and, most importantly, transversely (perpendicular) to the rail as the body transfers weight from side to side with each leg swing of the unique gait used on stairs. Third, they provide for pulling when arms are used to augment legs in ascent of steeper angles or when such climbing strategies result in more efficient use of the strengths of the user. Fourth, they are a tool that can be utilized to help in the arrest of a fall. In these capacities handrails serve to aid in the use of the stairway and are required on both sides of stairways in compliance with Section 1014 to allow passing users unencumbered access to a handrail. Finally, when glass is the material used to provide the handrail, it must comply with IBC Section 2407.



Note that if the handrail extension is at a location that could be considered a protruding object, the handrail must return to the post at a height of less than 27 inches (686 mm) above the floor. Handrails along the stair runs are not considered protruding objects.

The exceptions state conditions where handrails are only required on one side or are not needed at all. By the nature of their construction, spiral stairways can only have a single handrail (see Exception 1). In accordance with Exceptions 1 and 4, within dwelling units, all stairways can have a handrail on one side only, and stairs with three or fewer risers are not required to have any handrails. Since “Stair” is defined as one or more risers, Exceptions 2 and 3 are necessary. Exception 3 exempts the single step at the front or back door of a Group R-3 dwelling unit (i.e., townhouse). Decks, patios and walkways often move down with the grade. When there are single steps, either off a patio or deck to grade, or along the surface, a handrail is not required (Exception 2, see Commentary Figure 1011.11). Many of these exceptions dealing with residential units are consistent with the IRC.

For guard requirements at stairways, see Section 1011.13.

**1011.12 Stairway to roof.** In buildings four or more stories above *grade plane*, one *stairway* shall extend to the roof surface unless the roof has a slope steeper than four units vertical in 12 units horizontal (33-percent slope).

**Exception:** Other than where required by Section 1011.12.1, in buildings without an occupied roof access to the roof from the top story shall be permitted to be by an *alternating tread device*, a ship’s ladder or a permanent ladder.

❖ Because of safety considerations, roofs used for habitable purposes such as roof gardens, observation decks, sporting facilities (including jogging or walking



**Figure 1011.11  
EXAMPLE OF SECTION 1011.11, EXCEPTION 2**

tracks and tennis courts) or similar uses, must be provided with conventional stairways that will serve as required means of egress. Access by ladders or an alternating tread device for such uses is not permitted.

In buildings four or more stories high, roofs that are not used for habitable purposes must be provided with ready access by conventional stairways or by an alternating tread device (see Section 1011.14). If this stair is also to provide access to an elevator penthouse on the roof, see additional requirements in Section 1011.12.1. Two reasons for this are access for roof or rooftop equipment repair and fire department access during a fire event. Sloping roofs with a rise greater than 4 inches (102 mm) for every 12 inches (305 mm) in horizontal measurement (4:12) are exempt from the requirements of this section because of the steepness of the construction and the inherent dangers to life safety.

While it is not specifically required that roof access be through an exit stairway enclosure, since part of the intent is for fire department access to the roof, it is strongly advised. Section 1023.9 requires signage at the level of exit discharge indicating whether the stairway has roof access.

**1011.12.1 Stairway to elevator equipment.** Roofs and penthouses containing elevator equipment that must be accessed for maintenance are required to be accessed by a stairway.

❖ The requirement for a stair to the roof for maintaining elevator equipment correlates the code with ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*. This referenced standard (see IBC Section 3001.2) has required stairs and a door to access elevator equipment since 1955. More specifically, Section 2.27.3.2.1 of ASME A17.1/CSA B44 states the following: “a stairway with a swinging door and platform at the top level, conforming to 2.7.3.3 shall be provided from the top floor of the building to the roof level. Hatch covers as a means of access to the roofs shall not be permitted.” Alternating tread devices or ladders are not permitted as an alternative to the stairway for access to the elevator penthouse. This provision is more specific; therefore, while not prohibiting using the same stairway for access to the roof and the elevator penthouse (see Sections 1011.12 and 1011.12.2), access to that elevator penthouse must be via a stairway with door access, not an alternating tread device and hatch.

**1011.12.2 Roof access.** Where a stairway is provided to a roof, access to the roof shall be provided through a penthouse complying with Section 1510.2.

**Exception:** In buildings without an occupied roof, access to the roof shall be permitted to be a roof hatch or trap door not less than 16 square feet (1.5 m<sup>2</sup>) in area and having a minimum dimension of 2 feet (610 mm).

❖ The purpose of the penthouse or stairway bulkhead requirement in this section is to protect the walking surface of the stairway to the roof. The exception pro-

vides for situations when roof access is only needed for service or maintenance purposes, and where the access may be permitted by alternatives such as alternating tread devices, ship’s ladders or ladders.

**1011.13 Guards.** Guards shall be provided along stairways and landings where required by Section 1015 and shall be constructed in accordance with Section 1015. Where the roof hatch opening providing the required access is located within 10 feet (3049 mm) of the roof edge, such roof access or roof edge shall be protected by guards installed in accordance with Section 1015.

❖ While guards are required at the edge of a normally occupied roof by Section 1015, there is also a safety concern for roof areas that need to be accessed by service personnel, inspectors and emergency responders. This requirement for guards provides a minimum measure of safety when the roof access is close to the roof edge. This is consistent with the requirements at mechanical equipment in Section 1015.6 and 1015.7.

**1011.14 Alternating tread devices.** *Alternating tread devices* are limited to an element of a *means of egress* in buildings of Groups F, H and S from a mezzanine not more than 250 square feet (23 m<sup>2</sup>) in area and that serves not more than five occupants; in buildings of Group I-3 from a guard tower, observation station or control room not more than 250 square feet (23 m<sup>2</sup>) in area and for access to unoccupied roofs. *Alternating tread devices* used as a means of egress shall not have a rise greater than 20 feet (6096 mm) between floor levels or landings.

❖ This type of device is constructed in such a way that each tread alternates with each adjacent tread so that the device consists of a system of right-footed and left-footed treads (see Commentary Figure 1011.14).

The use of center stringer construction, half-treads and an incline that is considerably steeper than allowed for ordinary stairway construction makes the alternating tread device unique. However, because of its structural feature, only single-file use of the device (between handrails) is possible, thus preventing the occupants from passing one another. The pace of occupant travel is set by the slowest user, a condition that could become critical in an emergency situation. Furthermore, it is impossible for fire service personnel to use an alternating tread device at the same time and in a direction opposite that being used by occupants to exit the premises, possibly causing a serious delay in fire-fighting operations. For these reasons, this section greatly restricts the use of alternating tread devices as a means of egress. Alternating tread devices may be used in any occupancy as long as such stairways are not a component of a required means of egress.

Alternating tread devices are considered a modest improvement to ladder construction and, therefore, can be used as an unoccupied roof access in accordance with the requirements of Section 1011.12.

Alternating tread devices are permitted 20 feet (6096 mm) between landings given their limited appli-

ation and low occupant loads. In addition, it is recognized a vertical rise higher than the typical stairway is needed for these steeper devices which are used where space is often too restrictive for a regular stairway.

**1011.14.1 Handrails of alternating tread devices.** Handrails shall be provided on both sides of alternating tread devices and shall comply with Section 1014.

❖ For the safety of occupants, this section references the dimensional requirements for handrail locations to be used in conjunction with the special construction features of alternating tread devices provided in Section 1011.14. Because of the steepness of these devices, handrails on both sides are essential for safe functional use and additional clearances are required so that hand movement will not be encumbered by obstructions. Section 1015.3, Exception 5, permits the handrails along alternating tread devices to also serve as guards.

**1011.14.2 Treads of alternating tread devices.** *Alternating tread devices* shall have a minimum tread depth of 5 inches (127 mm), a minimum projected tread depth of 8½ inches (216 mm), a minimum tread width of 7 inches (178 mm) and a maximum riser height of 9½ inches (241 mm). The tread depth shall be measured horizontally between the vertical planes of the foremost projections of adjacent treads. The riser height shall be measured vertically between the leading edges of adjacent treads. The riser height and tread depth provided shall result in an angle of ascent from the horizontal of between 50 and 70 degrees (0.87 and 1.22 rad). The initial

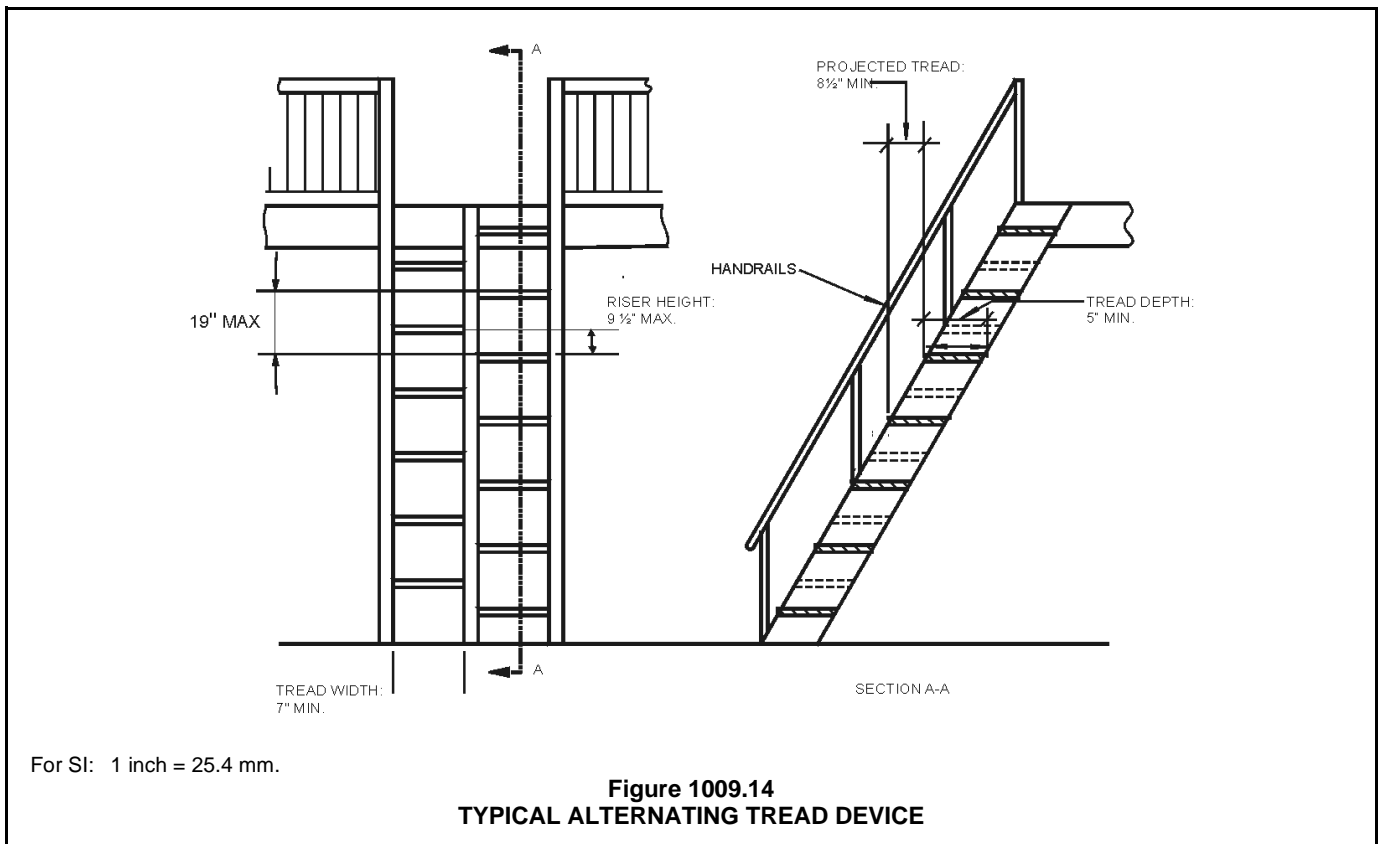
tread of the device shall begin at the same elevation as the platform, landing or floor surface.

**Exception:** *Alternating tread devices* used as an element of a *means of egress* in buildings from a mezzanine area not more than 250 square feet (23 m<sup>2</sup>) in area that serves not more than five occupants shall have a minimum tread depth of 3 inches (76 mm) with a minimum projected tread depth of 10½ inches (267 mm). The rise to the next alternating tread surface shall not exceed 8 inches (203 mm).

❖ Alternating tread stairways (see Section 1009.13) are required to have tread depths of at least 5 inches (127 mm). Tread projections are not to be less than 3½ inches (89 mm) when measured from tread nosing to tread nosing [next adjacent tread to the left or right to provide a minimum projected tread depth of 8½ inches (216 mm)] (see Commentary Figure 1011.14).

The risers are to be not more than 9½ inches (241 mm) when measured from tread to alternating tread (next adjacent tread to the left or right). The rise between treads on the same side would be 19 inches (482 mm) maximum. Applying the limiting dimensions stated above results in a device with a very steep incline that is common to ladders; however, because the device may be walked facing down in descent, it is considered a type of stairway in the code.

Tread widths are required to be a minimum of 7 inches (178 mm) or more. With a center support, the total width will be more than 15 inches (381 mm).



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Although no maximum width of the tread is stated, the device must be of a width to provide for functional use of both handrails at the same time in ascent and descent. For this same reason, handrail heights for alternating tread devices are modified from those stairways in Section 1014.2.

Just using the dimensions could result in an alternating tread device with an angle greater than 75 degrees (1.3 rad). In any case, the overall angle of the device must be between 50 and 70 degrees (0.87 and 1.22 rad).

For alternating tread devices used as a means of egress from small-area mezzanines as prescribed in the exception, the treads must project at least  $7\frac{1}{2}$  inches (191 mm) as compared to the  $3\frac{1}{2}$  inches (89 mm) stated above; treads are to be at least 3 inches (76 mm) in depth [compared to 5 inches (127 mm)] and risers are not to exceed 8 inches (203 mm) in height [compared to  $9\frac{1}{2}$  inches (341 mm)].

**1011.15 Ship's ladders.** Ship's ladders are permitted to be used in Group I-3 as a component of a *means of egress* to and from control rooms or elevated facility observation stations not more than 250 square feet (23 m<sup>2</sup>) with not more than three occupants and for access to unoccupied roofs. The minimum clear width at and below the *handrails* shall be 20 inches (508 mm).

❖ Ship's ladders can be used in correctional facilities for access to small control rooms, observation stations and unoccupied roofs. Where approved by the code

official, ship's ladders could be used for access to unoccupied roofs in other occupancies. Ship's ladders are of similar gradient or pitch to alternating tread devices; however, the treads span the full width like that of a ladder rather than being staggered to either side (see Commentary Figure 1011.15).

**1011.15.1 Handrails of ship's ladders.** *Handrails* shall be provided on both sides of ship's ladders.

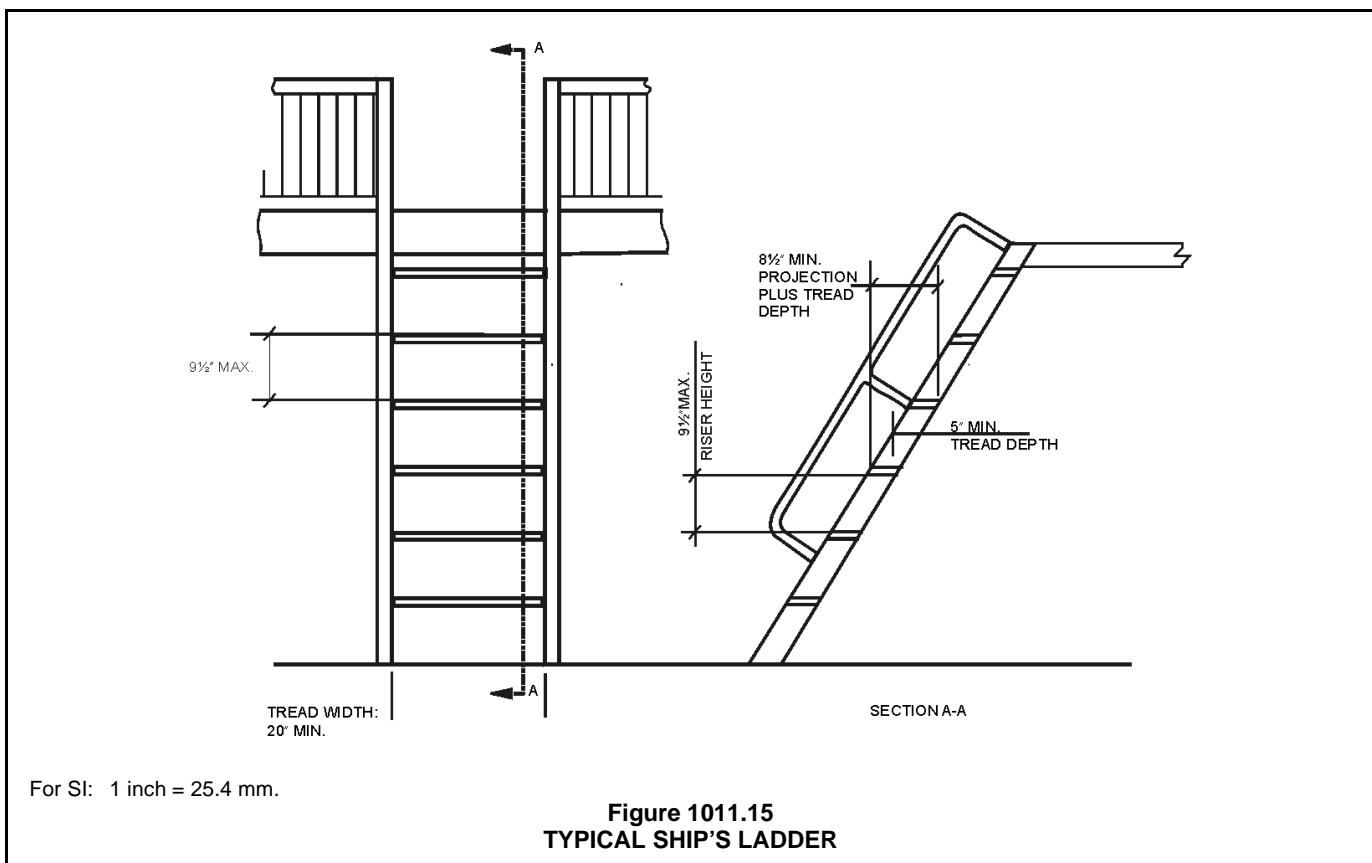
❖ Handrails are needed on both sides to assist in ascent and descent and the absence of a maximum width. Section 1015.3, Exception 5, permits the handrails along ship's ladders to also serve as guards.

**1011.15.2 Treads of ship's ladders.** Ship's ladders shall have a minimum tread depth of 5 inches (127 mm). The tread shall be projected such that the total of the tread depth plus the *nosing* projection is not less than  $8\frac{1}{2}$  inches (216 mm). The maximum riser height shall be  $9\frac{1}{2}$  inches (241 mm).

❖ See Commentary Figure 1011.5 for an example of this configuration.

**1011.16 Ladders.** Permanent ladders shall not serve as a part of the *means of egress* from occupied spaces within a building. Permanent ladders shall be permitted to provide access to the following areas:

1. Spaces frequented only by personnel for maintenance, repair or monitoring of equipment.
2. Nonoccupiable spaces accessed only by catwalks, crawl spaces, freight elevators or very narrow passageways.



3. Raised areas used primarily for purposes of security, life safety or fire safety including, but not limited to, observation galleries, prison guard towers, fire towers or lifeguard stands.
  4. Elevated levels in Group U not open to the general public.
  5. Nonoccupied roofs that are not required to have *stairway* access in accordance with Section 1011.12.1.
  6. Ladders shall be constructed in accordance with Section 306.5 of the *International Mechanical Code*.
- ❖ Permanent ladders are permitted as a means of ingress and egress to very limited spaces. Typically, these spaces are not considered occupied and, as such, are not required to have a means of egress. While the term “technical production areas” is not used in this section, IBC Section 410.6.3.4, Item 6, allows for ladders to be used to access technical production areas. Item 6 of this section references the IMC for when ladders can be used to access mechanical equipment that is located in an elevated space or in a room. The details and construction requirements for a permanent ladder are also found in that section. This will help make sure that permanent ladders are safe and useable, while providing consistency for both the designer and the building official.

## SECTION 1012 RAMPS

**1012.1 Scope.** The provisions of this section shall apply to ramps used as a component of a *means of egress*.

### Exceptions:

1. Ramped *aisles* within assembly rooms or spaces shall comply with the provisions in Section 1029.
  2. Curb ramps shall comply with ICC A117.1.
  3. Vehicle ramps in parking garages for pedestrian *exit access* shall not be required to comply with Sections 1012.3 through 1012.10 where they are not an *accessible route* serving *accessible* parking spaces, other required *accessible* elements or part of an *accessible means of egress*.
- ❖ Ramps provide an alternative method of vertical means of access to or egress from a building. Ramps are required for access to building areas for persons who are mobility impaired (see Chapter 11) and for small changes in floor elevations that are a safety hazard in themselves (see Section 1003.5). All ramps intended for pedestrian usage, whether required or otherwise provided, must comply with the requirements of this section. The code considers any walking surface that has a slope steeper than one unit vertical in 20 units horizontal (5-percent slope) to be a ramp (see the definition for “Ramp” in Chapter 2).
- As with stairways, it is important to understand the terminology. Exit ramps are ramps that provide a protected path of travel between the exit access and the

exit discharge. Interior exit ramps are required to be enclosed in accordance with Section 1022. Exterior exit ramps are protected by the exterior wall of the building and must comply with Section 1027. Exit access ramps are typically unenclosed interior ramps and comply with Section 1019 when they provide access between stories. Exit access travel distance stops at an exit ramp enclosure, but includes any travel down an exit access ramp. Ramps that are outside and provide a route from the level of exit discharge to grade are considered part of the exit discharge. See the commentary in Chapter 2 for the defined term, “Exit discharge, level of.”

Exception 1 indicates that ramped aisles are addressed in Section 1029. Having this exception at the beginning of the ramp section negated the need for repeated exceptions throughout the ramp provisions. While ramps and ramped aisles may look similar, configurations and how occupants move on and off those walking surfaces are very different. Occupants leave and join ramped aisles along the entire run, while occupants only enter the ramp at the top and bottom. Ramped aisles may have no or only one handrail in order to allow for access to the seats, while most ramps have handrails on both sides. Ramped aisles can have steeper slopes to allow for seating bowls to address line of sight. Section 1029 should be used for ramped aisles between and immediately adjacent to seating or where the ramps are a direct continuation of the ramped aisles and lead to a level cross aisle or floor. Section 1012 is used for ramps that lead from the balcony, concourse or cross aisle to a floor level above or below the seating areas.

Exception 2 references specific curb cut requirements found in Section 406 of ICC A117.1. It is important to realize there are different provisions for curb ramps and ramps. For example, a curb ramp can have a rise of any height and not require handrails. Ramps require handrails when the rise is more than 6 inches.

Exception 3 addresses parking garages. An accessible route is required to and from any accessible parking space, and all ramp provisions must be followed. However, ramps that provide access to and from nonaccessible spaces in the remainder of the parking garage need only comply with the provisions for slope and guard requirements. This permits non-accessible portions of garages to be constructed as a continuous slope. Ramps that are strictly for vehicles, such as jump ramps, are not required to meet any of the ramp provisions.

**1012.2 Slope.** *Ramps* used as part of a *means of egress* shall have a running slope not steeper than one unit vertical in 12 units horizontal (8-percent slope). The slope of other pedestrian *ramps* shall not be steeper than one unit vertical in eight units horizontal (12.5-percent slope).

- ❖ Maximum slope is limited to facilitate the ease of ascent and to control the descent of persons with or without a mobility impairment. The maximum slope of a ramp in the direction of travel is limited to one unit

## MEANS OF EGRESS

vertical in 12 units horizontal (1:12) (see Commentary Figure 1012.2). Ramps in existing buildings may be permitted to have a steeper slope at small changes in elevation (see Sections 410.8.5 and 705.1.4 of the IEBC). An example of a ramp that is not part of a means of egress and, therefore, allowed to be a maximum slope of 1:8, is a loading dock or delivery ramp where the ramp is not part of any required exit discharge.

**1012.3 Cross slope.** The slope measured perpendicular to the direction of travel of a ramp shall not be steeper than one unit vertical in 48 units horizontal (2-percent slope).

❖ The limitation of one unit vertical in 48 units horizontal on the slope across the direction of travel is to prevent a severe cross slope that would pitch a user to one side (see Commentary Figure 1012.2).

**1012.4 Vertical rise.** The rise for any ramp run shall be 30 inches (762 mm) maximum.

Because pushing a wheelchair up a ramp requires a great deal of energy, landings must be situated so that a person can rest after each 30-inch (762 mm) elevation change (see Commentary Figure 1012.2).

**1012.5 Minimum dimensions.** The minimum dimensions of means of egress ramps shall comply with Sections 1012.5.1 through 1012.5.3.

❖ These minimum dimension requirements allow the ramp to function as a means of egress and an accessible route.

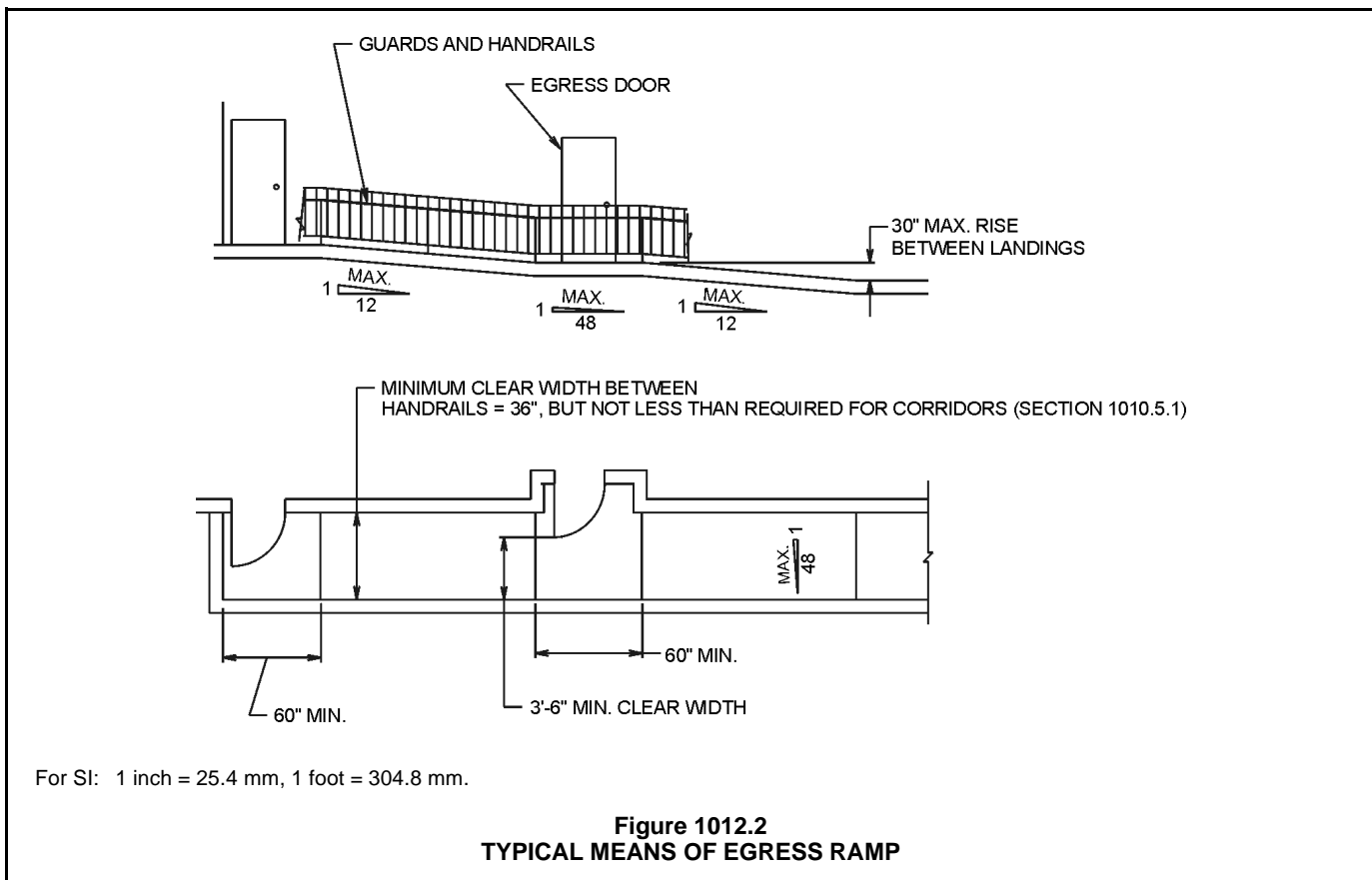
**1012.5.1 Width and capacity.** The minimum width and required capacity of a means of egress ramp shall be not less than that required for corridors by Section 1020.2. The clear width of a ramp between handrails, if provided, or other permissible projections shall be 36 inches (914 mm) minimum.

❖ The requirements for the width of a means of egress ramp is based on the width required for minimum width [typically 36 inches (941 mm)] and the capacity based on the occupant load to be served (see Section 1005.3.2). Note that the clear width of 36 inches (914 mm) is required between the handrails and any other obstructions (e.g., handrail supports, curbs) for proper clearance for a person in a wheelchair. This is different from stairways where handrails are permitted to project into the required width. The 36-inch (914 mm) minimum clear width between handrails is consistent with ICC A117.1 and the federal 2010 ADA Standard.

**1012.5.2 Headroom.** The minimum headroom in all parts of the means of egress ramp shall be not less than 80 inches (2032 mm).

❖ The requirement for headroom on any part of an egress ramp is identical to the requirement of a conventional (nonspiral) stairway (see Section 1011.3). General headroom heights along the means of egress are addressed in Section 1003.2.

**1012.5.3 Restrictions.** Means of egress ramps shall not reduce in width in the direction of egress travel. Projections



into the required *ramp* and landing width are prohibited. Doors opening onto a landing shall not reduce the clear width to less than 42 inches (1067 mm).

- ❖ The purpose of not allowing ramps to reduce in width in the direction of egress travel is to prevent a restriction that would interfere with the flow of occupants out of a facility. This would include ramp landings in accordance with Section 1012.6.2. Handrails are the only exception in accordance with Sections 1012.5.1 and 1014.8.

Doors that open onto a ramp landing, including those at the top and bottom landings, must not reduce the clear width to less than 42 inches (1067 mm). This is a more restrictive provision than for corridors that would permit the reduction to one-half the required width (see Section 1005.7). Since one of the purposes of a ramp is to accommodate persons with physical disabilities, it must provide the additional clear width for access by those confined to wheelchairs without the interference or potential blockage caused by the swing of a door (see Commentary Figures 1012.2 and 1012.5.3).

**1012.6 Landings.** *Ramps* shall have landings at the bottom and top of each *ramp*, points of turning, entrance, exits and at doors. Landings shall comply with Sections 1012.6.1 through 1012.6.5.

- ❖ Landings must be provided to allow users of a ramp to rest on a level floor surface and to adjust to the change in floor surface pitch.  
Landings are required at the top and bottom of

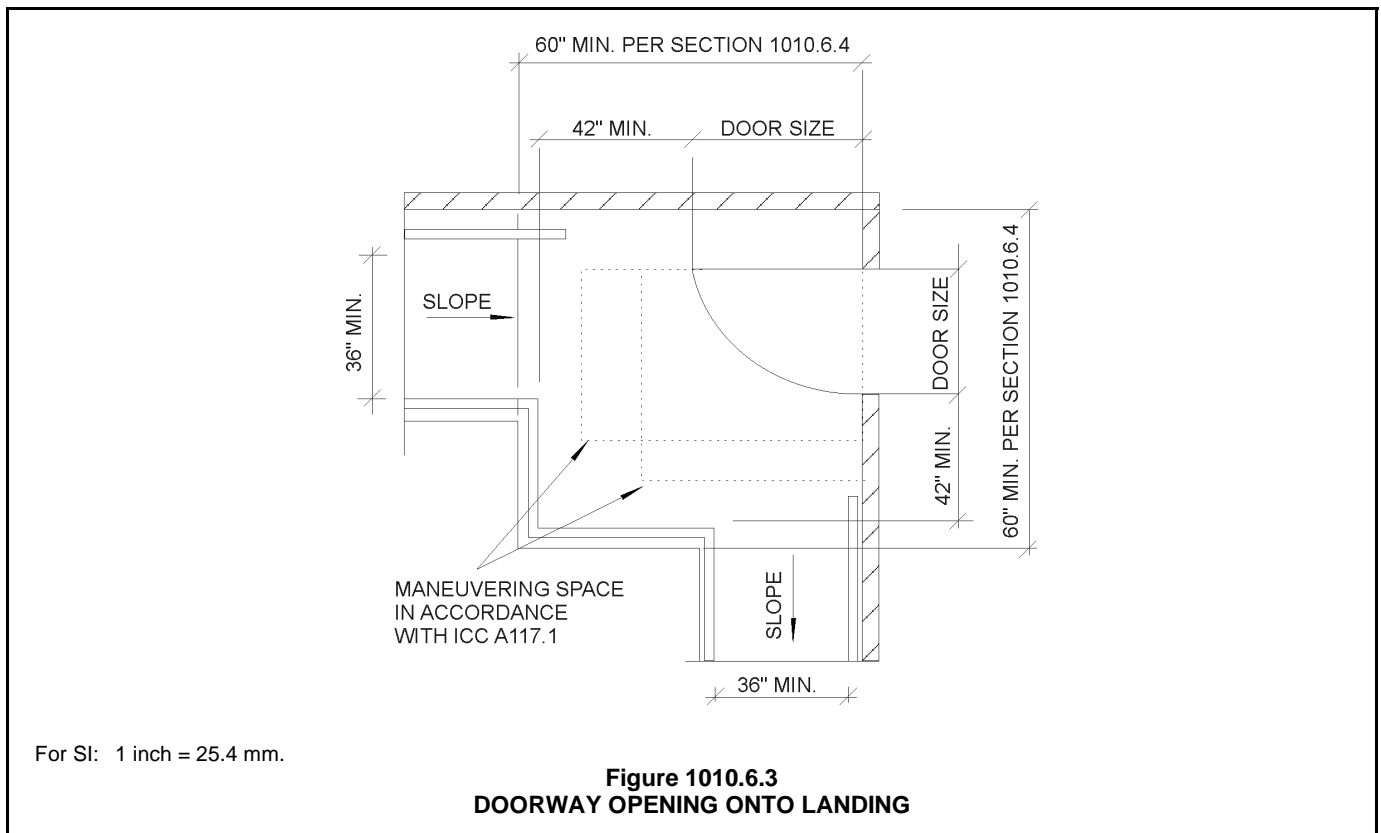
each ramp run (see Commentary Figure 1012.6). In addition, Section 1012.4 requires a landing every 30 inches (762 mm) of vertical rise of the ramp. The requirements for landings allow those occupants of the structure the ability to negotiate all changes in direction, and prepare themselves to either ascend or descend the ramp and to rest. If there is a door at the top or the bottom of the ramp, there are additional requirements in Section 1012.5.3 for door swing over the landing and Section 405 of ICC A117.1 for maneuvering space and turning space at the door.

**1012.6.1 Slope.** Landings shall have a slope not steeper than one unit vertical in 48 units horizontal (2-percent slope) in any direction. Changes in level are not permitted.

- ❖ Landings must be almost flat. This allows persons confined to a wheelchair to come to a complete stop without having to activate the brake or hold themselves stationary at the landing. The maximum slope or cross slope of the landing in any direction is 1:48 (see Commentary Figure 1012.2). This minimum slope is to allow for drainage to limit the accumulation of water on the landing surface.

**1012.6.2 Width.** The landing width shall be not less than the width of the widest *ramp* run adjoining the landing.

- ❖ The width of all landings must be consistently as wide as the widths of the ramp runs leading to them. Means of egress ramps cannot be reduced in width in the direction of egress travel. This is also applicable to the landings connecting the ramp runs (see Commentary Figure 1012.6).



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**1012.6.3 Length.** The landing length shall be 60 inches (1525 mm) minimum.

### Exceptions:

1. In Group R-2 and R-3 individual *dwelling* and *sleeping units* that are not required to be *Accessible units*, *Type A units* or *Type B units* in accordance with Section 1107, landings are permitted to be 36 inches (914 mm) minimum.
  2. Where the *ramp* is not a part of an *accessible route*, the length of the landing shall not be required to be more than 48 inches (1220 mm) in the direction of travel.
- ❖ The landings for ramps must be at least 60 inches (1524 mm) long (see Commentary Figure 1012.6). This allows persons confined to wheelchairs a sufficient distance to stop and rest along with any persons who may be assisting them. This requirement is directly applicable to straight-run ramps that may require an intermediate landing at every 30 inches (762 mm) of vertical rise (see Commentary Figure 1012.2). If the landing is also to be used to negotiate a change in the ramp's direction, Section 1012.6.4 is applicable. If a door overlaps the landing, Section 1012.5.3 is applicable.

The exceptions provide for smaller landings in dwelling and sleeping units and other locations where the ramp is not part of an accessible route. Exception 1 is consistent with the IRC. Exception 2 would be applicable in areas such as service ramps and ramps serving assembly seating areas that do not contain any wheelchair spaces.

**1012.6.4 Change in direction.** Where changes in direction of travel occur at landings provided between *ramp* runs, the landing shall be 60 inches by 60 inches (1524 mm by 1524 mm) minimum.

**Exception:** In Group R-2 and R-3 individual *dwelling* or *sleeping units* that are not required to be *Accessible units*,

*Type A units* or *Type B units* in accordance with Section 1107, landings are permitted to be 36 inches by 36 inches (914 mm by 914 mm) minimum.

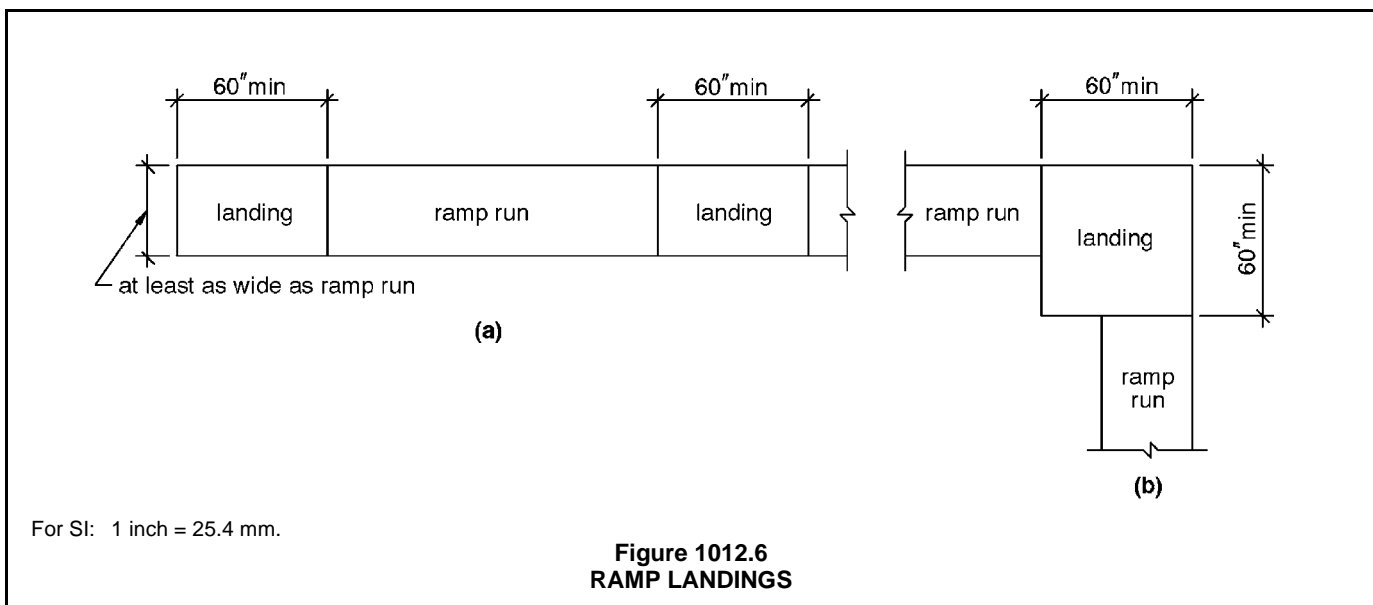
- ❖ When a change in direction is made in the ramp at a landing, the landing must be a square of at least 60 inches (1524 mm). This allows the person confined to a wheelchair enough room to negotiate the turn with minimal effort. The length of the landing may need to exceed 60 inches (1524 mm) to match the widths of the two ramp runs. In any case, the landing would still need to be 60 inches (1524 mm) wide (see Commentary Figures 1012.5.3 and 1012.6). If a door overlaps the landing, Section 1012.5.3 is applicable. It is not the intent of this provision to prohibit curved ramps. As long as the cross slope meets the limitations in Section 1010.4, the curved ramp is permitted.

The exception provides for smaller landings in dwelling and sleeping units where the ramp is not part of an accessible route. This is consistent with requirements in the IRC.

**1012.6.5 Doorways.** Where doorways are located adjacent to a *ramp* landing, maneuvering clearances required by ICC A117.1 are permitted to overlap the required landing area.

- ❖ This section specifies that the area required for maneuvering to open the door and the area of the landing are allowed to overlap. It is not necessary to provide the sum of the two area requirements (see Commentary Figure 1012.5.3). Requirements for maneuvering space and turning space at the top and bottom of ramps are found in Section 405 of ICC A117.1. ICC A117.1 requires a turning space at the top or bottom landing of a ramp where the door may be locked. This allows people to turn around to travel back along the ramp.

**1012.7 Ramp construction.** *Ramps* shall be built of materials consistent with the types permitted for the type of con-



struction of the building, except that wood *handrails* shall be permitted for all types of construction.

- ❖ Material requirements for the type of construction as required by Section 602 for floors are also the material requirements for ramp construction.

**1012.7.1 Ramp surface.** The surface of *ramps* shall be of slip-resistant materials that are securely attached.

- ❖ As the pace of exit travel becomes hurried during emergency situations, the probability of slipping on smooth or slick floor surfaces increases. To minimize the hazard, all floor surfaces in the means of egress are required to be slip resistant. The use of hard floor materials with highly polished, glazed, glossy or finely finished surfaces should be avoided. This is consistent with Section 1003.4.

Field testing and uniform enforcement of the concept of slip resistance is not practical. One method used to establish slip resistance is that the static coefficient of friction between leather [Type 1 (Vegetable Tanned) of Federal Specification KK-L-165C] and the floor surface is greater than 0.5. Laboratory test procedures such as ASTM D2047 can determine the static coefficient of resistance. Bulletin No. 4 entitled "Surfaces" issued by the U.S. Access Board (ATBCB) contains further information regarding slip resistance.

**1012.7.2 Outdoor conditions.** Outdoor *ramps* and outdoor approaches to *ramps* shall be designed so that water will not accumulate on walking surfaces.

- ❖ Outdoor ramps, landings and the approaches to the ramp must be sloped so that surfaces do not accumulate water so as to provide a safe path of egress travel at all times. While not specifically stated, any interior locations, such as near a pool, should also have the ramps designed to limit the accumulation of water in order to maintain slip resistance (see Sections 1003.4 and 1012.7.1).

Where exterior ramps are used in moderate or severe climates, there may also be a concern to pro-

tect the ramp from accumulations of snow and ice to provide a safe path of egress travel at all times, including inclement weather. Maintenance of the means of egress requires an unobstructed path to allow for full instant use in case of a fire or emergency (see Section 1031.3). Typical methods for protecting these egress elements include roof overhangs or canopies, heated slabs and, when approved by the building official, a reliable snow removal maintenance program.

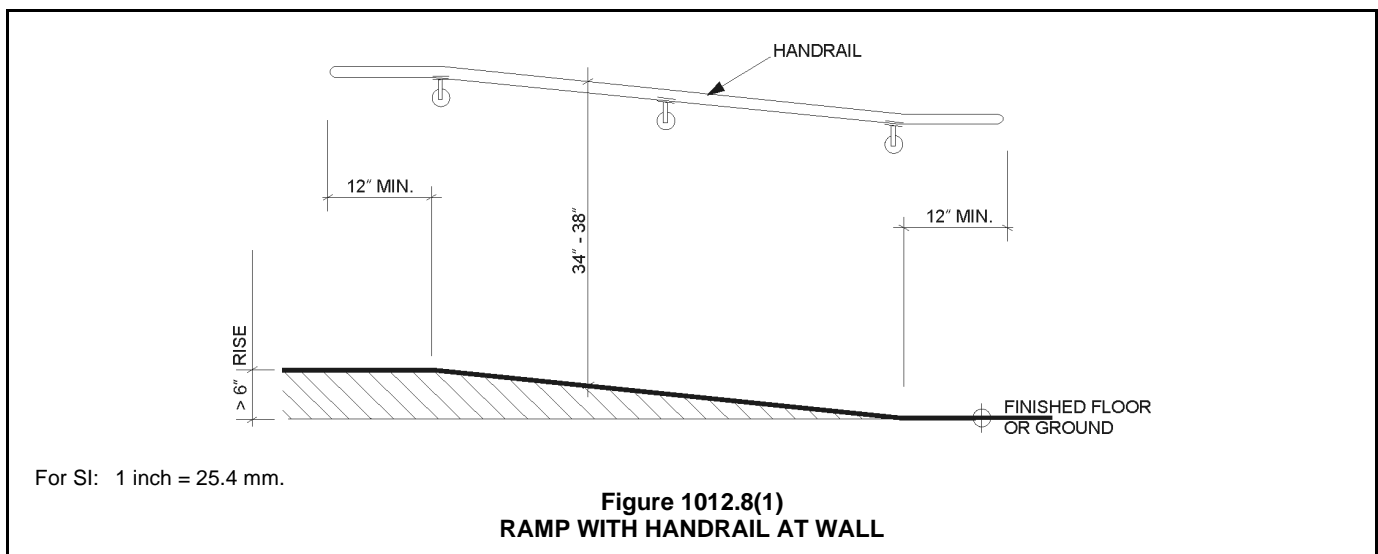
**1012.8 Handrails.** *Ramps* with a rise greater than 6 inches (152 mm) shall have *handrails* on both sides. *Handrails* shall comply with Section 1014.

- ❖ To aid in the use of a ramp, handrails are to be provided. Handrails are intended to provide the user with a graspable surface for guidance and support. All ramps with a vertical rise greater than 6 inches (152 mm) between landings are to be provided with handrails on both sides [see Commentary Figures 1012.8(1) and 1014.2]. General strength requirements for handrails are found in Section 1014 with a reference to IBC Section 1607.8. Note that if the handrail extension is at a location that could be considered a protruding object, the handrail extension must return to the post at a height of less than 27 inches (686 mm) above the floor. Handrails along the ramp runs are not considered protruding objects.

Depending on the configuration of the ramp and the adjacent walking surface, ramps may require a combination of handrails, edge protection and guards. See Commentary Figures 1012.8(1), 1012.8(2), 1012.8(3) and 1012.8(4) for illustrations of some alternatives.

**1012.9 Guards.** *Guards* shall be provided where required by Section 1015 and shall be constructed in accordance with Section 1015.

- ❖ To protect the user from falls to surfaces below, guards are to be provided where the sides of a ramp or landing are more than 30 inches (762 mm) above



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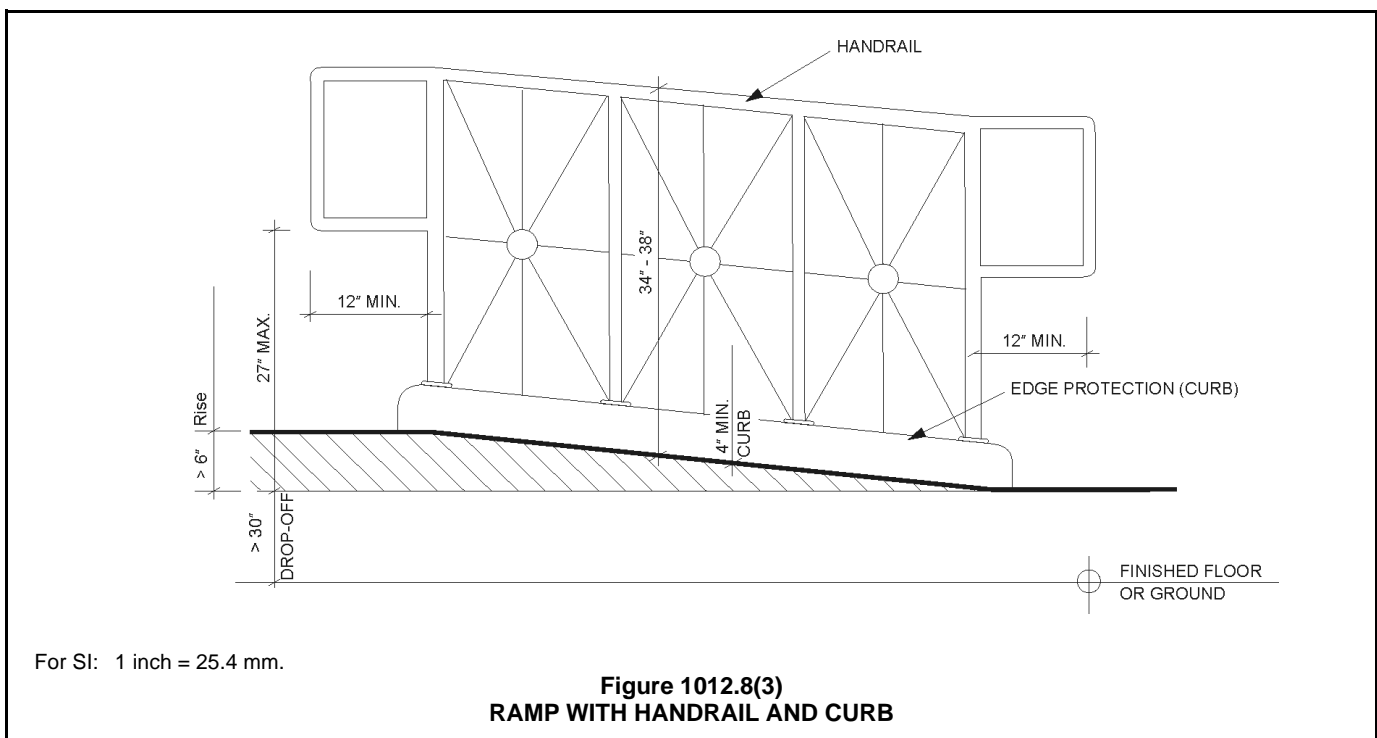
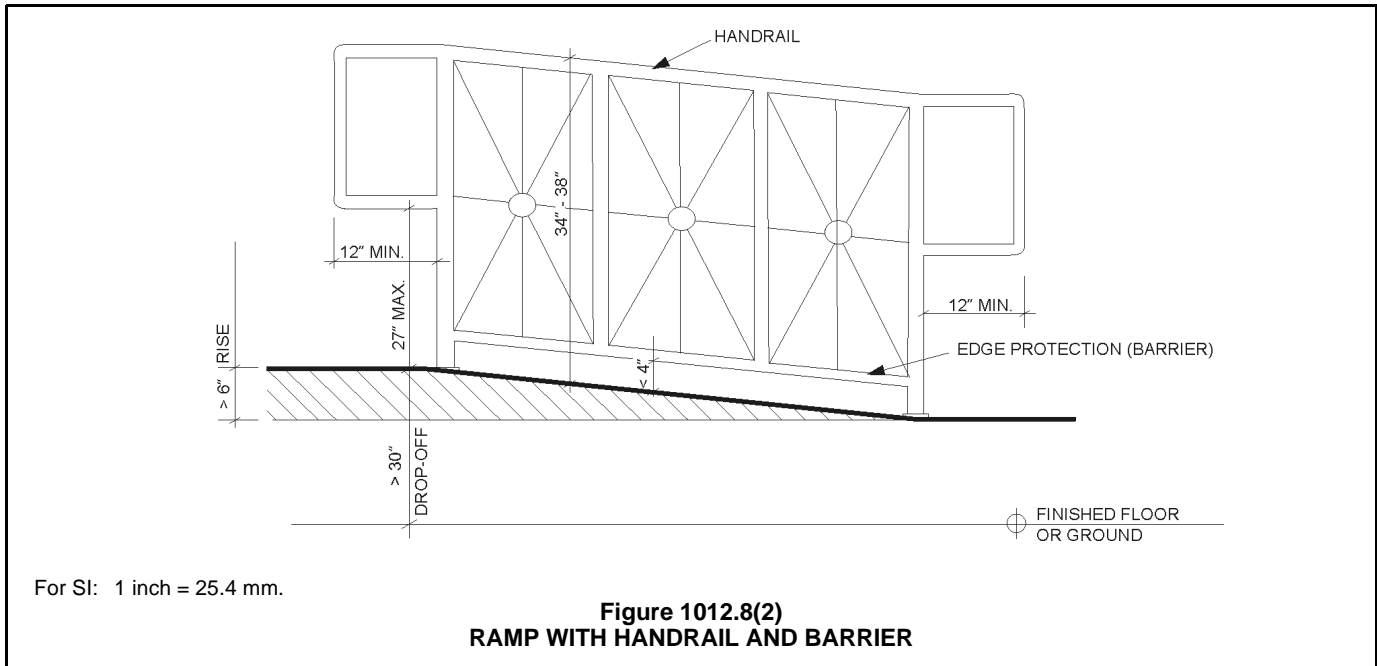
the adjacent grade. Guards are to be constructed in accordance with Section 1015, including the minimum height of 42 inches (1067 mm) [see Commentary Figure 1012.8(4)].

Depending on the configuration of the ramp and the adjacent walking surface, ramps may require a combination of handrails, edge protection and guards. See Commentary Figures 1012.8(1), 1012.8(2), 1012.8(3) and 1012.8(4) for illustrations of some alternatives.

**1012.10 Edge protection.** Edge protection complying with Section 1012.10.1 or 1012.10.2 shall be provided on each side of *ramp* runs and at each side of *ramp* landings.

### Exceptions:

1. Edge protection is not required on *ramps* that are not required to have *handrails*, provided they have flared sides that comply with the *ICC A117.1* curb ramp provisions.
2. Edge protection is not required on the sides of *ramp* landings serving an adjoining *ramp* run or *stairway*.



3. Edge protection is not required on the sides of ramp landings having a vertical dropoff of not more than 1/2 inch (12.7 mm) within 10 inches (254 mm) horizontally of the required landing area.

❖ This section of the code now addresses the comprehensive requirements for edge protection for all ramps. It must be noted that edge protection is not the same as the requirements for guards. The presence of a guard does not necessarily provide adequate edge protection and the presence of adequate edge protection does not satisfy the requirements for a guard. Edge protection is necessary to prevent the wheels of a wheelchair from leaving the ramp surface or becoming lodged between the edge of the ramp and any adjacent construction. For example, a ramp may be located relatively adjacent to the exterior wall of a building. However, between the ramp edge and the exterior wall, there is a strip of earth for landscape purposes. Without adequate edge protection, persons confined to wheelchairs could possibly have their wheels run off the side of the ramp into the landscape, causing them to tip. These requirements are consistent with Section 405 of ICC A117.1 and those in the federal 2010 ADA Standard.

Exception 1 allows a ramp to have minimal edge protection as long as its vertical rise is 6 inches (152 mm) or less. The exception is predicated on the ramp not needing any handrails, which is established by the provisions of Section 1012.8. Such a ramp would only need flared sides or returned curbs. Edge protection without handrails or guards could be a tripping

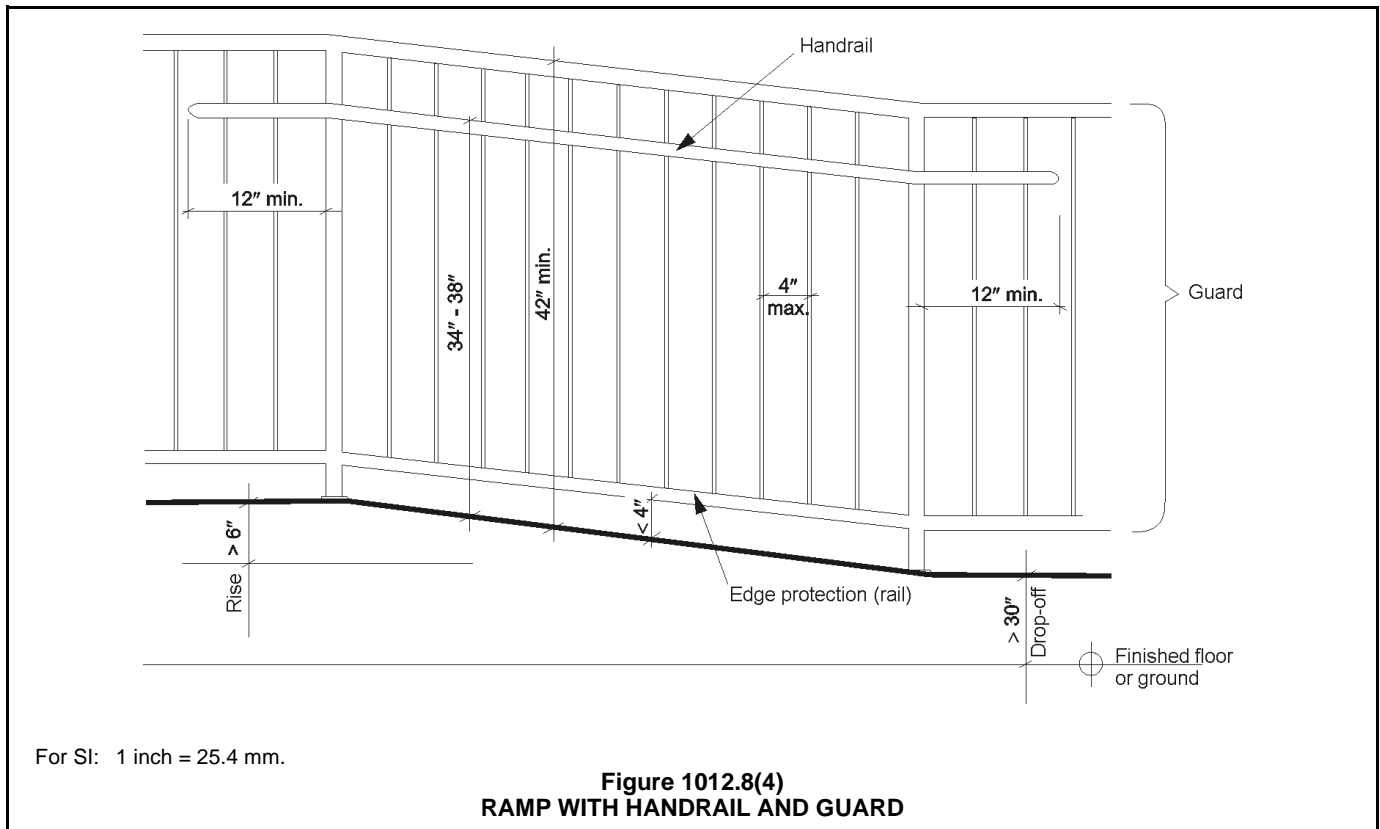
hazard for ambulatory persons. For specific details of these types of edge protection, the provisions of Section 406 of ICC A117.1 for curb ramps must be followed.

Exception 2 reiterates that edge protection is not literally required entirely around a ramp landing. Obviously, edge protection is not required along that portion of the landing that directly adjoins a ramp run; it is only required along the edges of the landing with a dropoff (other than steps of ramp runs).

Exception 3 states that edge protection is not required for those sides of a ramp landing directly adjacent to the ground surface that gently slopes away from the edge of the landing. If the grade adjacent to the ramp landing slopes no more than 1/2:10 (which equates to 1:20) away from the landing, additional edge protection is not required. Such a gradual slope would not be detrimental to persons confined to wheelchairs as they negotiate the ramp landing. Note that this exception is limited to landings, not the ramp surface itself. The ramp must meet the edge protection in Section 1012.10.1 or 1012.10.2.

Depending on the configuration of the ramp and the adjacent walking surface, ramps may require a combination of handrails, edge protection and guards. See Commentary Figures 1012.8(1), 1012.8(2), 1012.8(3) and 1012.8(4) for illustrations of some alternatives.

**1012.10.1 Curb, rail, wall or barrier.** A curb, rail, wall or barrier shall be provided to serve as edge protection. A curb shall be not less than 4 inches (102 mm) in height. Barriers



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shall be constructed so that the barrier prevents the passage of a 4-inch-diameter (102 mm) sphere, where any portion of the sphere is within 4 inches (102 mm) of the floor or ground surface.

❖ Edge protection for ramps and ramp landings may be achieved with a built-up curb or other barrier, such as a rail, wall or guard. The barrier must be located near the surface of the ramp and landing such that a 4-inch-diameter (102 mm) sphere cannot pass through any openings. An example of an effective barrier would be the bottom rail of a guard system. If the bottom rail is located less than 4 inches (102 mm) above the ramp and landing surface, edge protection has been provided. If a curb option is used, the curb must be a minimum of 4 inches (102 mm) high. The curb or barrier prevents the wheel of a wheelchair from running off the edge of the surface and provides people with visual disabilities a toe stop at the edge of the walking surface (see Commentary Figure 1012.10.1).

**1012.10.2 Extended floor or ground surface.** The floor or ground surface of the *ramp* run or landing shall extend 12 inches (305 mm) minimum beyond the inside face of a *hand-rail* complying with Section 1014.

❖ An alternative to providing some type of barrier at the edge of the ramp (see Section 1012.10.1) is to make the ramp surface wider than the handrails provided at either side. The combination of the wider surface and the handrail barrier would assist in preventing a wheelchair or crutch tip from moving very far off the ramp during a temporary slip (see Commentary Figure 1012.10.1).

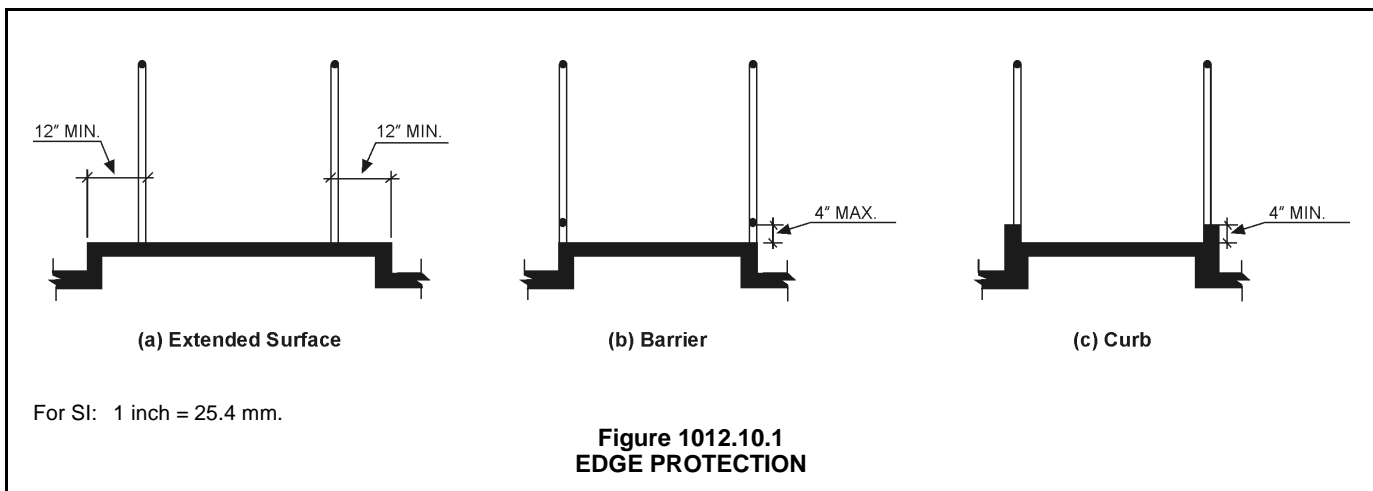
### SECTION 1013 EXIT SIGNS

**1013.1 Where required.** *Exits* and *exit access* doors shall be marked by an *approved* exit sign readily visible from any direction of egress travel. The path of egress travel to *exits* and within *exits* shall be marked by readily visible exit signs to clearly indicate the direction of egress travel in cases where the *exit* or the path of egress travel is not immediately

visible to the occupants. Intervening *means of egress* doors within *exits* shall be marked by exit signs. Exit sign placement shall be such that no point in an *exit access corridor* or *exit passageway* is more than 100 feet (30 480 mm) or the *listed* viewing distance for the sign, whichever is less, from the nearest visible exit sign.

#### Exceptions:

1. Exit signs are not required in rooms or areas that require only one *exit* or *exit access*.
  2. Main exterior *exit* doors or gates that are obviously and clearly identifiable as *exits* need not have exit signs where *approved* by the *building official*.
  3. Exit signs are not required in occupancies in Group U and individual *sleeping units* or *dwelling units* in Group R-1, R-2 or R-3.
  4. Exit signs are not required in dayrooms, sleeping rooms or dormitories in occupancies in Group I-3.
  5. In occupancies in Groups A-4 and A-5, exit signs are not required on the seating side of vomitories or openings into seating areas where exit signs are provided in the concourse that are readily apparent from the vomitories. Egress lighting is provided to identify each vomitory or opening within the seating area in an emergency.
- ❖ Where an occupancy has two or more required exits or exit accesses, the means of egress must be provided with illuminated signs that readily identify the location of, and indicate the path of travel to, the exits. The signs must be illuminated with letters reading "Exit." The illumination may be internal or external to the sign. The signs should be visible from all directions in the exit access route. In cases where the signs are not visible to the occupants because of turns in the corridor or for other reasons, additional illuminated signs must be provided indicating the direction of egress to an exit. Exit signs must be located so that, where required, the nearest one is within 100 feet (30 480 mm), of the sign's listed viewing distance. UL 924 permits exit signs to be listed with a viewing distance of less than 100 feet (30 480



mm) (see Section 1013.5). When a sign is listed for a viewing distance of less than 100 feet (30 480 mm) the label on the sign will indicate the appropriate viewing distance. If such a sign is used, the spacing of the signs should be based on the listed viewing distance.

Typically, once an occupant enters an exit enclosure, exit signs are no longer needed; however, in buildings with more complicated egress layouts, it is possible that the direction for egress travel within the exit is not immediately apparent. For example, exit passageways can be part of the path of exit travel at the level of exit discharge or transfer floors. Evacuees may hesitate or be confused when the vertical travel becomes horizontal travel, which may result in a delay in evacuation. In these situations, exit signs may be needed within the exit enclosure (see Commentary Figure 1013.1).

The exceptions identify conditions where exit signs are not necessary since they would not increase the safety of the egress path.

For Exceptions 1 and 3, the assumption is that the occupants are familiar enough with the space to know the way out and/or the exits are obvious. In addition, in most cases, the way out is the same as the way in.

In accordance with Exception 2, when the main exterior door through which occupants enter the building is obviously an exit, exit signs are not required. For example, a two-story Group B building has a main employee/customer entrance. The entrance consists of a storefront arrangement with glass doors and sidelights. The entrance is centrally located within the building. These main exterior exit doors can be quickly observed as being an exit and would not need to be marked with an exit sign.

In accordance with Exception 4, exit signs are not

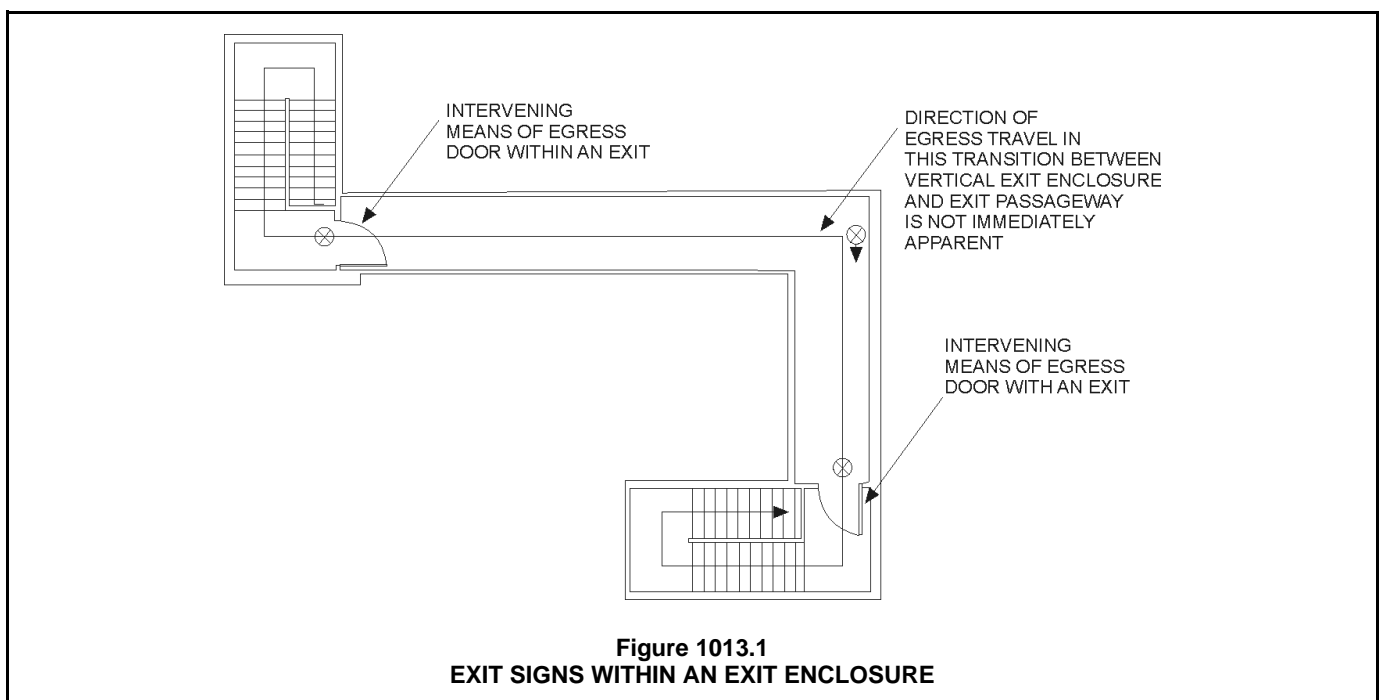
required in detainee living and sleeping room areas of Group I-3 buildings. In cases of emergency, occupants in Group I-3 are escorted by staff to the exits and to safety. exit sign materials can also be potential weapons when they are accessible to the detainees.

In the Group A-4 and A-5 occupancies described in Exception 5, the egress path is obvious and thus exit signs are not needed. Additionally, because of the configuration of the vomitories, the exit signs are not readily visible to the persons immediately adjacent to or above the vomitory.

**1013.2 Floor-level exit signs in Group R-1.** Where exit signs are required in Group R-1 occupancies by Section 1013.1, additional low-level exit signs shall be provided in all areas serving guest rooms in Group R-1 occupancies and shall comply with Section 1013.5.

The bottom of the sign shall be not less than 10 inches (254 mm) nor more than 12 inches (305 mm) above the floor level. The sign shall be flush mounted to the door or wall. Where mounted on the wall, the edge of the sign shall be within 4 inches (102 mm) of the door frame on the latch side.

❖ Because people may be sleeping and because most residents are transient (and thus unfamiliar with the space) in hotels (i.e., Group R-1), low-level exit signs must be provided for emergency exit routes from guestrooms. When smoke at the ceiling obscures the exit signs required by Section 1013.1, these signs will serve as a backup identification of the exit door. By the reference to Section 1013.5, these signs must be internally illuminated and listed and labeled in accordance with UL 924. It is not the intent of this section to require low level exit signs in the guestrooms. The low level exit signs are required only in areas where Section 1013.1 requires exit signs and only leading from the guestroom area, not throughout the entire hotel.



**Figure 1013.1**  
**EXIT SIGNS WITHIN AN EXIT ENCLOSURE**

The exit signs must be mounted on the exit door itself or to the side of the exit door on the latch side. The height of the bottom of the exit sign will allow for exit signs not to conflict with accessible route requirements. ICC A117.1 requires doors on an accessible route to have a smooth surface for the bottom 10 inches (254 mm) so that someone could use the footplates on their wheelchair to assist in opening the door.

The requirements do not indicate what low-level signage is appropriate for exit signs that provide direction rather than at the exit. It is also not clear on how an exit sign on a door will be visible from down the corridor if the door is perpendicular to the direction of the hallway.

**1013.3 Illumination.** Exit signs shall be internally or externally illuminated.

**Exception:** Tactile signs required by Section 1013.4 need not be provided with illumination.

❖ This section simply provides the scope for illumination of regulated exit signs. Exit signs must be illuminated so that they are readily apparent in situations where the lights may be off or the building has lost power. Exit signs with raised letters and braille are specifically addressed in Section 1013.4.

**1013.4 Raised character and braille exit signs.** A sign stating EXIT in visual characters, raised characters and braille and complying with ICC A117.1 shall be provided adjacent to each door to an *area of refuge*, an exterior area for assisted rescue, an *exit stairway* or *ramp*, an *exit passageway* and the *exit discharge*.

❖ The purpose of this sign is to serve as way finding for a person with vision impairments. This is in addition to the exit signs required by Section 1013.1.

“Tactile” is defined as “used for the sense of touch;” therefore, signage that has either raised letters or braille is considered tactile. For exit signage, visual, raised letters and braille are required. ICC A117.1 includes requirements for the sign and the correct placement. Typically, the sign is placed at about 4 feet, 6 inches (1375 mm) above the floor and on the wall at the latch side of the door. While not required to be illuminated by these provisions, illumination would be advantageous for a person with partial sight. High contrast is important (see Commentary Figure 1013.4).

This signage is needed to indicate which doors are serving as exits for those persons with visual impairments. Signs are needed on the required exit doors in the building: including at doors leading to an interior or exterior exit stairway or ramp; doors leading to an exit passageway; within the exit enclosures leading to the outside or to an exit passageway; and exit doors that lead directly to the outside.

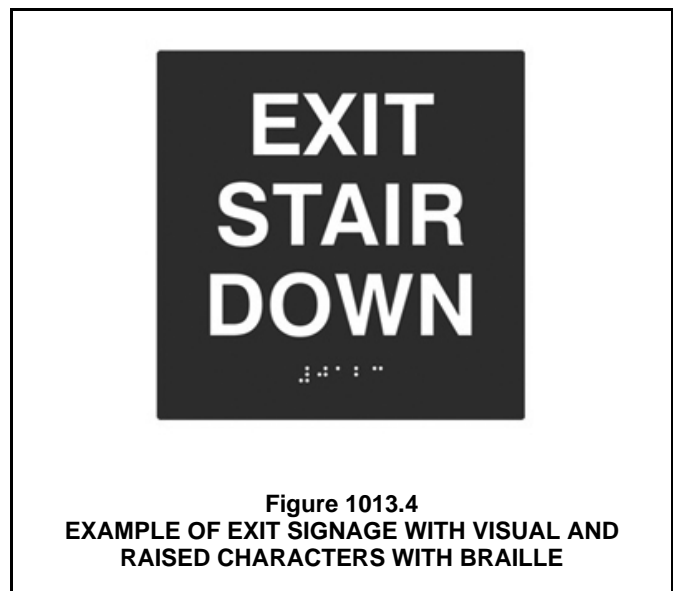
While an area of refuge may be located within an enclosure for an exit stairway, Section 1009.3 also allows the area of refuge to be located immediately outside of the enclosure for the exit stairway. In this

situation, exit signage with visual, raised letters and braille would be required both at the door leading into the area of refuge and the door leading to the exit stairway. Exterior areas for assisted rescue are typically located immediately outside of an exit door (see Section 1009.7).

This is not intended to preclude the signage from including additional information as long as “Exit” is first. For example, labeling the door to the exit enclosure as “Exit Stairway” would indicate to the visually impaired person that once they moved through the door they would be dealing with vertical travel. This could be considered an additional safety feature. This section is also referenced in IBC Section 1111.3. For additional way-finding signage inside the stairway enclosure, see Section 1023.9.

**1013.5 Internally illuminated exit signs.** Electrically powered, *self-luminous* and *photoluminescent* exit signs shall be *listed* and *labeled* in accordance with UL 924 and shall be installed in accordance with the manufacturer’s instructions and Chapter 27. Exit signs shall be illuminated at all times.

❖ All exit signage must be listed and labeled as indicated in UL 924, *Standard for Safety of Emergency Lighting and Power Equipment*. Listed “Exit” signs are required by UL 924 to meet the same graphics, illumination and power sources defined in Sections 1013.6.1 through 1013.6.3 for externally illuminated signs. Internal illumination may be electrically powered or be of a self-luminous or photoluminescent product. Electrically powered would include LED, incandescent, fluorescent and electroluminescent types of signs. If a sign is photoluminescent, the “charging” source must be continually available (see the definitions in Chapter 2 for “Photoluminescent” and “Self-luminous”). “Exit” signs must be illuminated at all times, including when the building may not be fully occupied. If a fire occurs late at night, there may be cleaning crews or persons working overtime in the



**Figure 1013.4**  
**EXAMPLE OF EXIT SIGNAGE WITH VISUAL AND RAISED CHARACTERS WITH BRAILLE**

building who will need to be able to find the exits. The reference to Section 604 is so the signs will be equipped with a connection to an emergency power supply.

**1013.6 Externally illuminated exit signs.** Externally illuminated exit signs shall comply with Sections 1013.6.1 through 1013.6.3.

❖ Externally illuminated exit signage must meet the graphic, illumination and emergency power requirements in the referenced sections. The requirements are the same as for internally illuminated signage.

**1013.6.1 Graphics.** Every exit sign and directional exit sign shall have plainly legible letters not less than 6 inches (152 mm) high with the principal strokes of the letters not less than  $\frac{3}{4}$  inch (19.1 mm) wide. The word "EXIT" shall have letters having a width not less than 2 inches (51 mm) wide, except the letter "I," and the minimum spacing between letters shall be not less than  $\frac{3}{8}$  inch (9.5 mm). Signs larger than the minimum established in this section shall have letter widths, strokes and spacing in proportion to their height.

The word "EXIT" shall be in high contrast with the background and shall be clearly discernible when the means of exit sign illumination is or is not energized. If a chevron directional indicator is provided as part of the exit sign, the construction shall be such that the direction of the chevron directional indicator cannot be readily changed.

❖ Every exit sign and directional sign located in the exit access or exit route is required to have a color contrast vivid enough to make the signs readily visible, even when not illuminated. Letters must be at least 6 inches (152 mm) high and their stroke not less than  $\frac{3}{4}$  inch (19.1 mm) wide (see Commentary Figure 1013.6.1). The sizing of the letters is predicated on the readability of the wording from a distance of 100 feet (30 480 mm).

While red letters are common for exit signs, sometimes green on black is used in auditorium areas with

low-lighting levels, such as theaters, because that color combination tends not to distract the audience's attention. It is more important that the exit sign be readily visible with respect to the background.

Exit signs may be larger than the minimum size specified; however, the standardized proportion of the letters must be maintained. Externally illuminated signage that is smaller could use the requirements in UL 924 for guidance; however, sign spacing would need to be adjusted, and alternative approval would be through the building official having jurisdiction.

A "chevron directional indicator" is the same as a directional arrow. The language is intended to be consistent with UL 924.

**1013.6.2 Exit sign illumination.** The face of an exit sign illuminated from an external source shall have an intensity of not less than 5 footcandles (54 lux).

❖ Every exit sign and directional sign must be continuously illuminated to provide a light intensity at the illuminated surface of at least 5 footcandles (54 lux). It is not a requirement that the exit signs be internally illuminated. An external illumination source with the power capabilities specified by Section 1013.6.3 is acceptable.

**1013.6.3 Power source.** Exit signs shall be illuminated at all times. To ensure continued illumination for a duration of not less than 90 minutes in case of primary power loss, the sign illumination means shall be connected to an emergency power system provided from storage batteries, unit equipment or an on-site generator. The installation of the emergency power system shall be in accordance with Chapter 27.

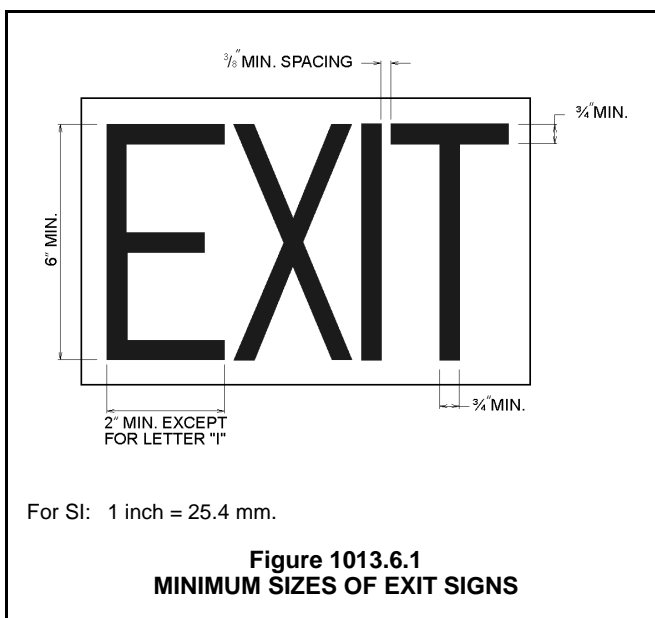
#### Exceptions:

1. *Approved* exit sign illumination means that provide continuous illumination independent of external power sources for a duration of not less than 90 minutes, in case of primary power loss, are not required to be connected to an emergency electrical system.
2. Group I-2 Condition 2 exit sign illumination shall not be provided by unit equipment battery only.

❖ Exit signs must be illuminated on a continuous basis so that when a fire emergency occurs, occupants will be able to identify the locations of the exits. The reliability of the power sources supplying the electrical energy required for maintaining the illumination of exit signs is important. When power interruptions occur, exit sign illumination must be obtained from an emergency power system. This does not imply that the sign must be internally illuminated. Whatever illumination system is used, whether internal or external, it must be connected to a system designed to pick up the power load required by the exit signs after loss of the normal power supply.

Per Exception 1, where self-luminous signs are used, connection to the emergency electrical supply system is not required. A trickle-charge battery to illuminate the exit sign is another option.

Exception 2 is really a more restrictive requirement for hospitals. Hospitals cannot only rely on equipment



batteries for the illumination of their exit signs. Typically, hospitals connect illumination of their exit signage to the emergency on-site generator.

The IFC requirements for emergency power for emergency egress lighting and exit signage in existing buildings only requires a 60-minute time duration. This is not a conflict, but rather recognition of the loss of battery storage capability over a length of time.

## SECTION 1014 HANDRAILS

**1014.1 Where required.** *Handrails* serving *stairways*, *ramps*, stepped *aisles* and ramped *aisles* shall be adequate in strength and attachment in accordance with Section 1607.8. *Handrails* required for *stairways* by Section 1011.11 shall comply with Sections 1014.2 through 1014.9. *Handrails* required for *ramps* by Section 1012.8 shall comply with Sections 1014.2 through 1014.8. *Handrails* for stepped *aisles* and ramped *aisles* required by Section 1029.15 shall comply with Sections 1014.2 through 1014.8.

❖ Handrails are required at stairways and ramps. In all situations, they must be designed in accordance with the structural requirements in Section 1607.8. There are, however, distinct differences in how the handrail requirements are applied in stairways, ramps, stepped aisles and ramped aisles. The specific section references allow for this consideration. Where and how many handrails for stairways and ramps are specified in Sections 1003.5, 1011.11 and 1012.8. Where handrails are required in assembly seating for stepped aisles and ramped aisles is specified in Section 1029.15.

Stairways and their handrails are not part of an accessible route and are not subject to the stairway technical requirements in ICC A117.1. Standards are only referenced to the extent specified by the code (see Section 102.4).

Handrails are also very distinct from guards, even though they are sometimes incorrectly called “guardrails.” The “handrail” is the element that is grasped during vertical travel for guidance, stabilization, pulling and as an aid in arresting a possible fall. Guards are located near the side of an elevated walking surface to minimize the possibility of a fall to a lower level and are discussed in Section 1015. However, in residential applications, in some locations in assembly seating and along alternating tread devices and ship’s ladders, the top rail of a guard may also serve as a handrail (see Section 1015.3, Exceptions 3, 4 and 5, and Section 1029.16).

**1014.2 Height.** *Handrail* height, measured above *stair* tread *nosings*, or finish surface of *ramp* slope, shall be uniform, not less than 34 inches (864 mm) and not more than 38 inches (965 mm). *Handrail* height of *alternating tread devices* and ship’s ladders, measured above tread *nosings*, shall be uni-

form, not less than 30 inches (762 mm) and not more than 34 inches (864 mm).

### Exceptions:

1. Where handrail fittings or bendings are used to provide continuous transition between *flights*, the fittings or bendings shall be permitted to exceed the maximum height.
2. In Group R-3 occupancies; within *dwelling units* in Group R-2 occupancies; and in Group U occupancies that are associated with a Group R-3 occupancy or associated with individual *dwelling units* in Group R-2 occupancies; where handrail fittings or bendings are used to provide continuous transition between *flights*, transition at *winder* treads, transition from *handrail* to *guard*, or where used at the start of a *flight*, the *handrail* height at the fittings or bendings shall be permitted to exceed the maximum height.
3. *Handrails* on top of a guard where permitted along stepped aisles and ramped aisles in accordance with Section 1029.15.

❖ It has been demonstrated that for safe use, the height of handrails must not be less than 34 inches (864 mm) nor more than 38 inches (965 mm) above the leading edge of stairway treads, landings or other walking surfaces (see Commentary Figure 1014.2). This requirement is applicable for all uses, including handrails within a dwelling unit.

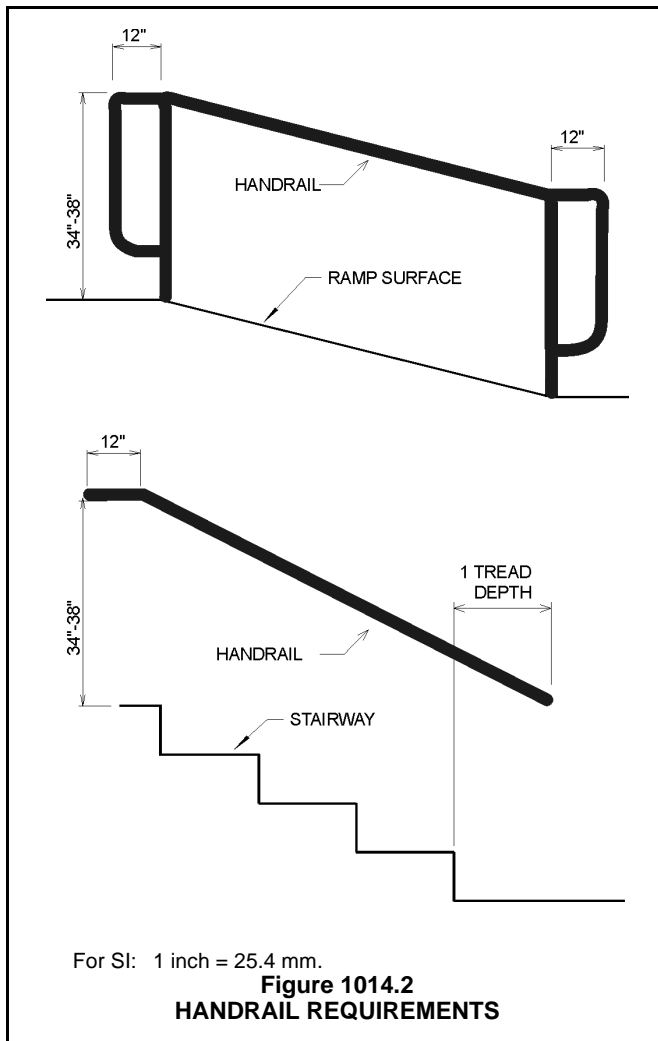
The fundamental stairway requirements are not appropriate for alternating tread devices and ship’s ladders since they differ significantly from other types of stairways. The permitted range for handrail height for alternating tread devices and ship’s ladders allows for a lower height above the tread nosings. The minimum required height is reduced from 34 inches (864 mm) to 30 inches (762 mm), with a maximum permitted height of 34 inches (864 mm). The special features of an alternating tread device or ship’s ladder result in differences of handrail use, such as different arm posture, the hand gripping the handrail near a higher part of the body and the use of handrails under the arms for stabilization when descending. Therefore, a lower handrail height is more appropriate.

Exceptions 1 and 2 allow for the use of common fittings and bendings to provide for continuous transition of the handrail at specified turns and pitch changes in the stairway where the fitting or bending might exceed the maximum handrail height. In some cases, there is no reference for the height when the fitting or handrail might extend beyond the nosings at the intersection of adjoining flights. Exception 1 applies to all stairways between flights. This typically occurs at the center handrail at the landings on a dogleg or switchback stairway configuration. Although the handrails are not required on the land-

ing, the code requirement for handrail extensions or for handrail continuity often creates the need for some type of transition, especially at turns (see also Section 1014.6). This exception would allow for an easing or gooseneck riser over the landing to be used for a smooth transition of the handrail. The use of the new exceptions may permit a more gradual variation in the height even though it will allow for portions of the handrail to exceed the normal 38-inch (965 mm) maximum height. The belief is that handrail continuity is more important than staying within the height limitation.

Exception 2 applies to dwelling units with the intent to allow transition elements at common locations, such as the start of the flight, at winder treads or from handrail to guard at landings. Combined with the guard height reduction in Section 1015.3, Exception 1, the end result may be fewer transition pieces. This is consistent with provisions in the IRC.

Exception 3 is in recognition of the special allowances for the top rail of a guard to serve as a handrail in limited situations in an assembly seating area. See Section 1029.15 for specifics.



**1014.3 Handrail graspability.** Required *handrails* shall comply with Section 1014.3.1 or shall provide equivalent graspability.

**Exception:** In Group R-3 occupancies; within *dwelling units* in Group R-2 occupancies; and in Group U occupancies that are accessory to a Group R-3 occupancy or accessory to individual *dwelling units* in Group R-2 occupancies; *handrails* shall be Type I in accordance with Section 1014.3.1, Type II in accordance with Section 1014.3.2 or shall provide equivalent graspability.

❖ The abilities to grasp a handrail firmly and slide a hand along the rail's gripping surface without meeting obstructions are important factors in the safe use of stairways and ramps. These properties are largely functions of the shape of the handrail. Handrails for stairways and ramps must meet the specifications of Section 1014.3.1 or be determined to have grasping properties and attributes equivalent to profiles allowed in Section 1014.3.1. Such determinations of equivalence are an allowed option made by local building officials based on the profile presented and the building official's evaluation of its properties. A complete evaluation will consider the four basic functions of a handrail: guidance, stabilization, pulling and aid in arresting a fall. The determination is best made by comparative use on stairs or ramps of properly mounted samples. Handrails that meet neither Type I nor Type II characteristics may be considered to have equivalent graspability. Complete evaluation will also consider the mounting of the handrail and understanding the interference of handrail mounts on the gripping surfaces of smaller profiles. For a discussion of this, see Section 1014.4.

The exception allows for an alternative, Type II handrails, within residential units and their associated structures. A handrail on common stairways within an apartment building or on the steps to the front door of a townhouse could not use this exception unless approved by the building official as being equivalent to Type I. The residential allowance is consistent with the IRC.

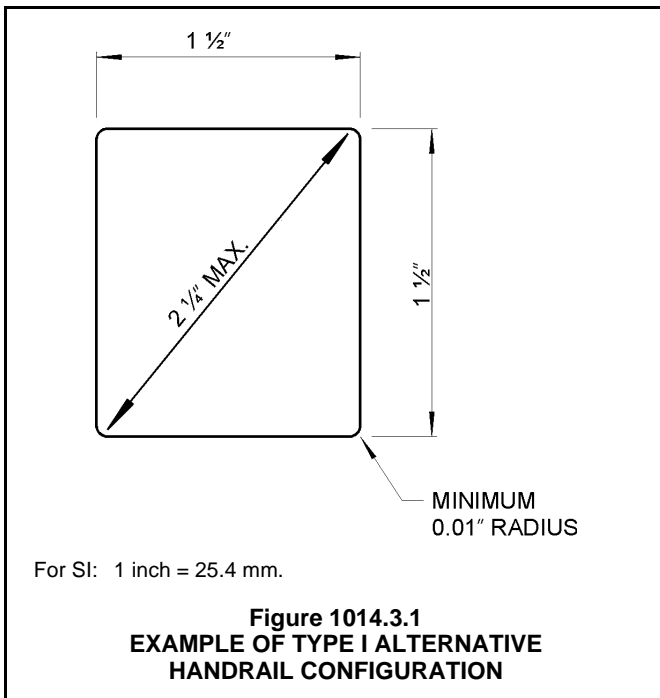
**1014.3.1 Type I.** *Handrails* with a circular cross section shall have an outside diameter of not less than 1<sup>1</sup>/<sub>4</sub> inches (32 mm) and not greater than 2 inches (51 mm). Where the *handrail* is not circular, it shall have a perimeter dimension of not less than 4 inches (102 mm) and not greater than 6<sup>1</sup>/<sub>4</sub> inches (160 mm) with a maximum cross-sectional dimension of 2<sup>1</sup>/<sub>4</sub> inches (57 mm) and minimum cross-sectional dimension of 1 inch (25 mm). Edges shall have a minimum radius of 0.01 inch (0.25 mm).

❖ Handrails have traditionally been regulated as either circular or noncircular rails. The noncircular rails have previously been limited to a maximum perimeter dimension of 6<sup>1</sup>/<sub>4</sub> inches (160 mm), with other limitations addressing minimum perimeter and minimum and maximum cross-sectional dimensions. These handrails shapes are now referred to as Type I handrails.

Type I handrails include circular cross sections with an outside diameter of at least  $1\frac{1}{4}$  inches (32 mm) but not greater than 2 inches (51 mm). This limits the perimeter of the cross section such that the gripping surface incorporates the bottom of the rail. A handrail with either a very narrow or a large cross section is not graspable in a power grip by all able-bodied users and certainly not by those with hand-strength or flexibility deficiencies. A power grip typically accesses the bottom surface of the handrail, such as around a bar. A pinching grip is not as effective when there is a need to arrest a fall. An example of a pinching grip would be where a 2x4 stud on edge was used as a handrail. This would not comply with graspability concerns.

Noncircular Type I cross sections must meet the alternative noncircular criteria in this section, and the bottom of the rail must be considered part of the suitable gripping surface. Of note is that this criteria now includes a minimum cross section of 1 inch (25 mm) to provide for designs that reduce the interference of fingers and an opposing thumb that occurs when small objects are tightly grasped. Edges must be slightly rounded and not sharp. An example is shown in Commentary Figure 1014.3.1.

Ramp requirements in ICC A117.1 are referenced as part of the accessible route requirements in Chapter 11. Current handrail provisions are largely coordinated with the Type I handrail requirements in this section. Section 103 of ICC A117.1 would also permit alternative handrail shapes if they provided equivalent or better graspability.



**1014.3.2 Type II.** Handrails with a perimeter greater than  $6\frac{1}{4}$  inches (160 mm) shall provide a graspable finger recess area on both sides of the profile. The finger recess shall begin within a

distance of  $\frac{3}{4}$  inch (19 mm) measured vertically from the tallest portion of the profile and achieve a depth of not less than  $\frac{5}{16}$  inch (8 mm) within  $\frac{7}{8}$  inch (22 mm) below the widest portion of the profile. This required depth shall continue for not less than  $\frac{3}{8}$  inch (10 mm) to a level that is not less than  $1\frac{3}{4}$  inches (45 mm) below the tallest portion of the profile. The width of the handrail above the recess shall be not less than  $1\frac{1}{4}$  inches (32 mm) to not greater than  $2\frac{3}{4}$  inches (70 mm). Edges shall have a minimum radius of 0.01 inch (0.25 mm).

❖ Handrail profiles having a perimeter dimension greater than  $6\frac{1}{4}$  inches (160 mm), identified as Type II handrails, are acceptable within dwelling units and their associated structures when complying with all of the specific dimensional requirements.

Research has shown that Type II handrails have graspability that is essentially equal to or greater than the graspability of handrails meeting the long-accepted and codified shape and size now defined as Type I.

The key features of the graspability of Type II handrails are graspable finger recesses on both sides of the handrail. These recesses allow users to firmly grip a properly proportioned grasping surface on the top of the handrail, ensuring that the user can tightly retain a power-span grip on the handrail for all forces that are associated with attempts to arrest a fall.

This class of handrails incorporates a grip surface with controlled recesses for the purchase of the fingers and opposing thumb. These handrail shapes allow the use of power-span grips that need not encompass the bottom surfaces of the rail, allowing the design of taller cross sections that can eliminate the interference of mountings and provide a completely uninterrupted gripping surface for the user. The limits of the position and depth of the required recesses represent the minimum standard. Optimizing the design within the parameters with larger recesses and complete finger clearance from mountings will enhance the performance of these profiles. Although this standard allows design flexibility, it is important to follow the specifications accurately to comply. Each drawing in Commentary Figure 1014.3.2 illustrates the requirements of each sentence for clarity.

**1014.4 Continuity.** Handrail gripping surfaces shall be continuous, without interruption by newel posts or other obstructions.

#### Exceptions:

1. Handrails within *dwelling units* are permitted to be interrupted by a newel post at a turn or landing.
2. Within a *dwelling unit*, the use of a volute, turnout, starting easing or starting newel is allowed over the lowest tread.
3. Handrail brackets or balusters attached to the bottom surface of the handrail that do not project horizontally beyond the sides of the handrail within  $1\frac{1}{2}$  inches (38 mm) of the bottom of the handrail shall not be considered obstructions. For each  $\frac{1}{2}$  inch

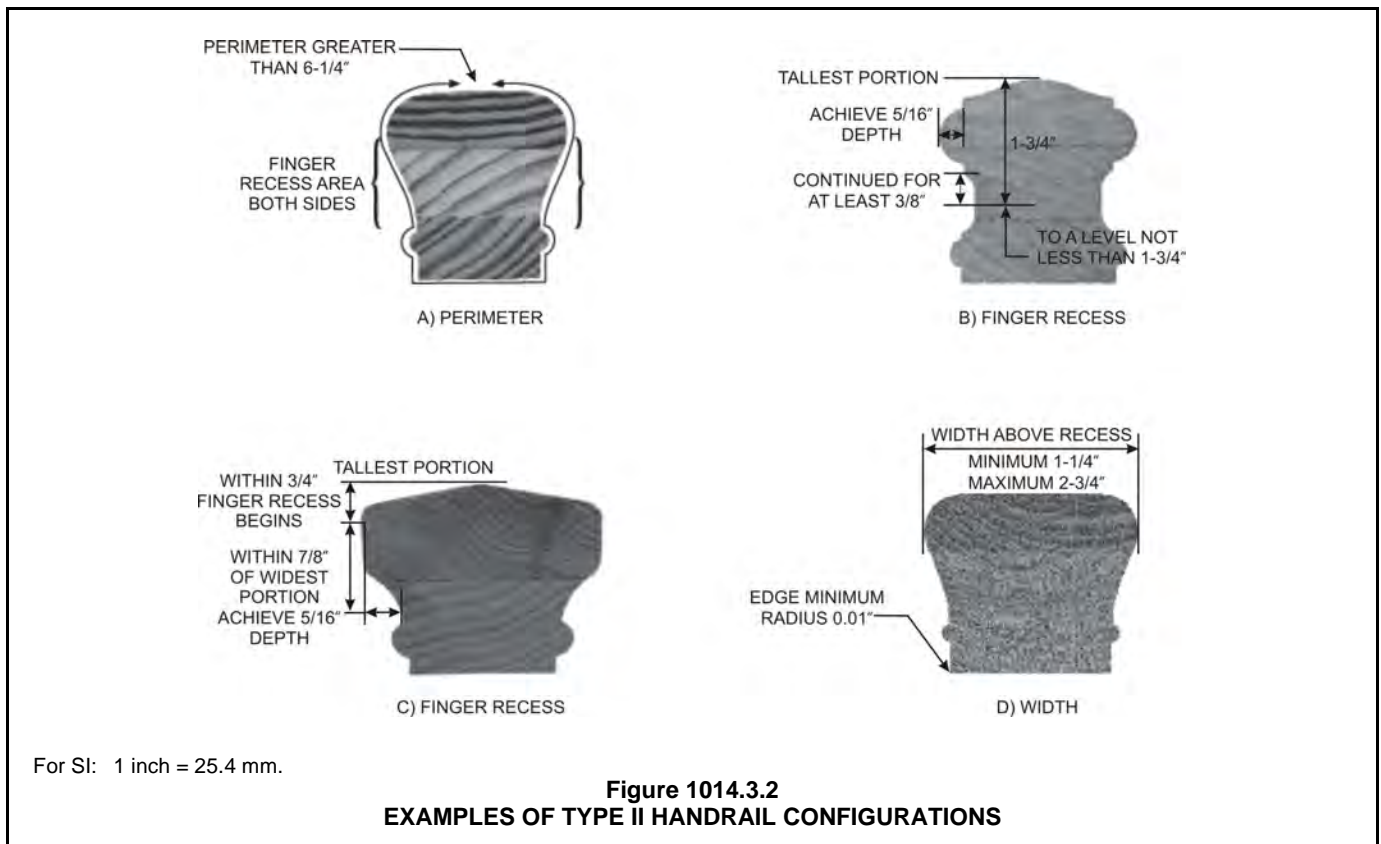
(12.7 mm) of additional handrail perimeter dimension above 4 inches (102 mm), the vertical clearance dimension of 1½ inches (38 mm) shall be permitted to be reduced by 1⁄8 inch (3.2 mm).

4. Where *handrails* are provided along walking surfaces with slopes not steeper than 1:20, the bottoms of the handrail gripping surfaces shall be permitted to be obstructed along their entire length where they are integral to crash rails or bumper guards.
5. *Handrails* serving stepped *aisles* or ramped *aisles* are permitted to be discontinuous in accordance with Section 1029.15.1.

❖ Handrails must be usable for their entire length without requiring the users to release their grasp. Typically, when using the handrail while traveling the means of egress, an individual's arm is extended to lead the body with the hand forming a loose grip on the top and sides of the rail. If handrails are to be of service to users, they must be uninterrupted and continuous. Oversize newels, changes in the guard system, or excessive supports at the bottom of small perimeter handrails can cause interruption of the handrail, requiring the occupants to release their grip [see Commentary Figure 1014.4(1)]. Exception 1 allows the interruption of the handrail by a newel post at the intersection of two handrail sections at a turn within a flight or at a landing in dwelling units; however, this exception is not applicable to curved or spiral stairs. Exception 2 provides for familiar and historical handrail details, often combined with

guards, that have been used for decades in dwelling units without substantiated detriment to the safety of the occupants. Exception 3 provides specifications for the attachment of brackets and balusters to the bottom of handrails to provide for minimum finger clearance such that they will not be considered obstructions. This method of handrail support limits interruptions of the grip surfaces at the bottom of smaller perimeter shapes that otherwise would deter or impede the user's ability to attain a stabilizing grip essential to safe stairway use. Larger handrail sizes permit shorter brackets since geometrically the finger clearance is still maintained [see Commentary Figure 1014.4(2)]. For example, a Type II handrail may elevate the fingertips completely above the supports, allowing the rail to be mounted by other means that do not obstruct when providing the clearances specified. Exception 4 allows for products that serve dual purposes, such as the bumper guard/handrail found in hospitals and nursing homes along corridors, to have a continuous bottom support. Since these are only permitted on slopes that are less than what is defined as a ramp, the handrails are more for assistance in mobility or balance rather than to arrest a fall.

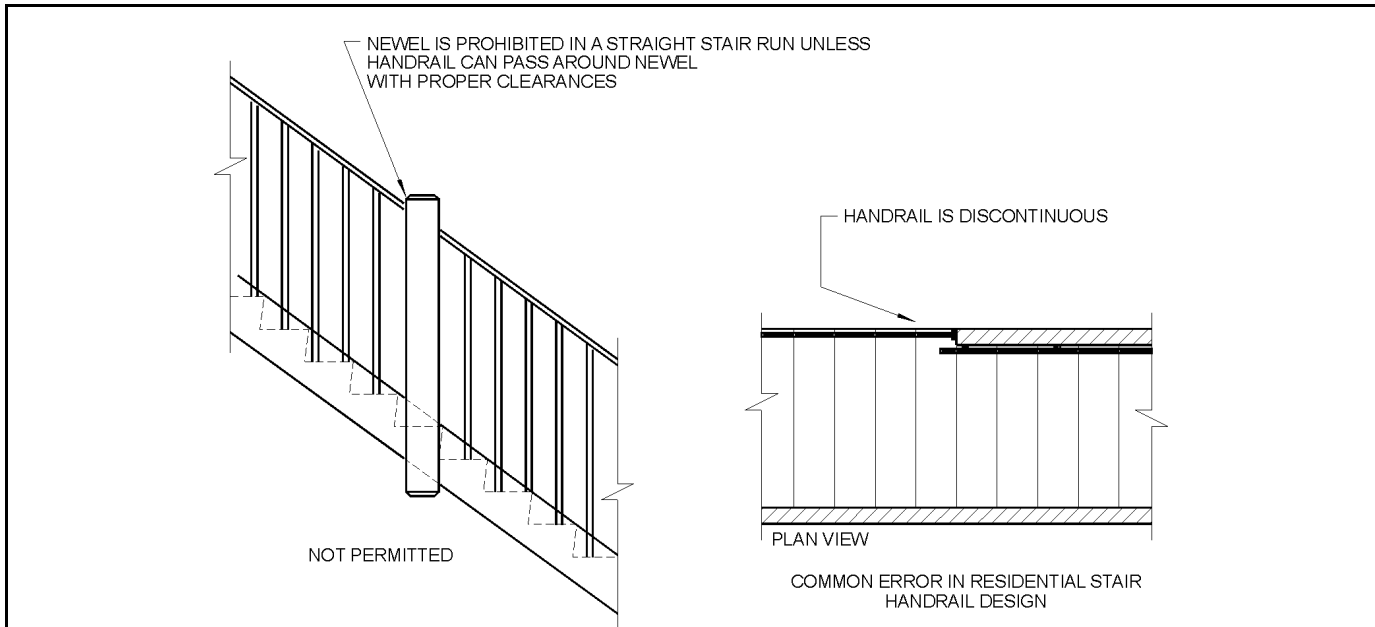
Exception 5 references back to provisions for stepped and ramped aisles in assembly seating. Discontinuous handrails are permitted to allow for access to seats. Such discontinuous handrails must still extend the full run of the aisle stairs or ramp. See Section 1029.15.1.



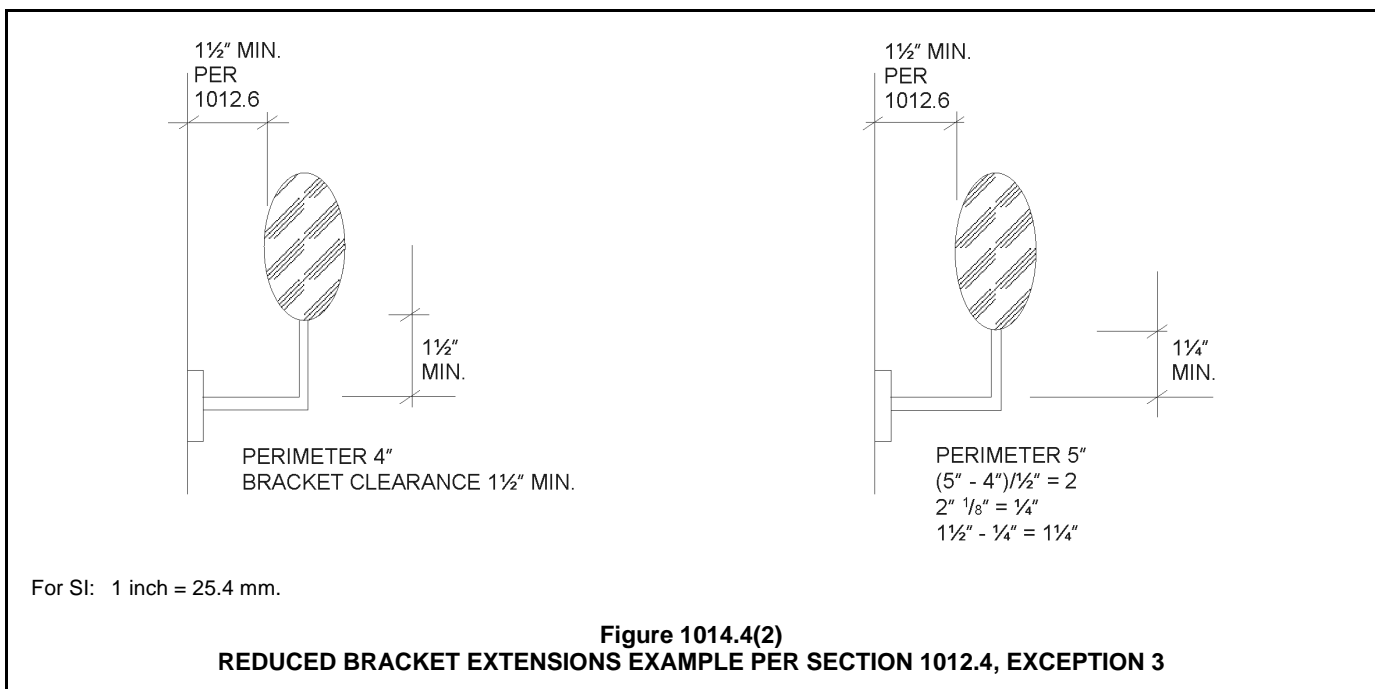
**1014.5 Fittings.** *Handrails* shall not rotate within their fittings.

- ❖ Fittings are those component pieces of a continuous handrail that are shaped or bent and attached to the longer sections of straight or curved handrail to provide for transition at changes in pitch, direction or to provide for termination of a continuous handrail. Fittings and handrails must be securely joined to ensure a stable handrail that does not allow any portion to rotate when grasped.

**1014.6 Handrail extensions.** *Handrails* shall return to a wall, *guard* or the walking surface or shall be continuous to the handrail of an adjacent *flight of stairs* or *ramp* run. Where *handrails* are not continuous between *flights*, the *handrails* shall extend horizontally not less than 12 inches (305 mm) beyond the top riser and continue to slope for the depth of one tread beyond the bottom riser. At *ramps* where *handrails* are not continuous between runs, the *handrails* shall extend horizontally above the landing 12 inches (305 mm) minimum beyond the top and bottom of *ramp* runs. The extensions of



**Figure 1014.4(1)**  
**EXAMPLES OF PROHIBITED HANDRAIL DESIGNS**



**Figure 1014.4(2)**  
**REDUCED BRACKET EXTENSIONS EXAMPLE PER SECTION 1012.4, EXCEPTION 3**

*handrails* shall be in the same direction of the *flights of stairs* at *stairways* and the *ramp runs* at *ramps*.

**Exceptions:**

1. *Handrails* within a *dwelling unit* that is not required to be *accessible* need extend only from the top riser to the bottom riser.
2. *Handrails* serving aisles in rooms or spaces used for assembly purposes are permitted to comply with the handrail extensions in accordance with Section 1029.15.
3. *Handrails* for *alternating tread devices* and ship's ladders are permitted to terminate at a location vertically above the top and bottom risers. *Handrails* for *alternating tread devices* are not required to be continuous between *flights* or to extend beyond the top or bottom risers.

❖ The purpose of return requirements at handrail ends is to prevent a person from catching an article of clothing or satchel straps, or from being injured by falling on the extended end of a handrail.

The length that a handrail extends beyond the top and bottom of a stairway, ramp or intermediate landing where handrails are not continuous to another stair flight or ramp run is an important factor for the safety of the users. An occupant must be able to grasp securely a handrail beyond the last riser of a stairway or the last sloped segment of a ramp. Handrail terminations that bend around a corner do not provide this stability; therefore, the handrail must extend in the direction of the stair flight or ramp run. The handrail extensions are not required where a user could keep his or her hand on the handrail, such as the continuous handrail at the landing of a switch-back stairway or ramp (see Section 1014.2, Exception 1).

For stairways, handrails must be extended 12 inches (305 mm) horizontally beyond the top riser and sloped a distance of one tread depth beyond the bottom riser. For ramps, handrails must be extended 12 inches (305 mm) horizontally beyond the last sloped ramp segment at both the top and bottom locations. These handrail extensions are not only required at the top and bottom on both sides of stairways and ramps, but also at other places where handrails are not continuous, such as landings and platforms. These requirements are intended to reflect the current provisions of ICC A117.1 (see Commentary Figure 1014.2) and the 2010 ADA Standard. Note that if the handrail extension is at a location that could be considered a protruding object, the handrail must return to the post at a height of less than 27 inches (686 mm) above the floor (see Sections 1003.3.2 and 1003.3.3).

In accordance with Exception 1, handrail extensions are not required where a dwelling unit is not required to meet any level of accessibility (i.e., Accessible unit, Type A unit or Type B unit). Handrail exten-

sions are permitted to end at a newel post or turnaround.

Exception 2 provides for handrails along ramped or stepped aisles in assembly seating configurations, such as in sports facilities, theaters and lecture halls. It is necessary to limit handrail extensions in assembly aisles so that circulation in cross aisles that run perpendicular to the stepped or sloped aisles is not compromised.

Exception 3 allows for the unique construction considerations for alternating tread devices and ship's ladders. Again, usage of these devices is very limited. Since alternative tread devices and ship's ladders are typically utilized as a safer alternative to a vertical ladder, they are often located in tight spaces where traditional-type stairs cannot be used or are not required. With a much steeper angle than traditional stairs and differing usage, handrail extensions and continuity provisions are not practical.

**1014.7 Clearance.** Clear space between a handrail and a wall or other surface shall be not less than 1½ inches (38 mm). A handrail and a wall or other surface adjacent to the *handrail* shall be free of any sharp or abrasive elements.

❖ A clear space is needed between a handrail and the wall or other surface to allow the user to slide his or her hand along the rail with fingers in the gripping position without contacting the wall surface, which could have an abrasive texture. In climates where persons may be expected to be wearing heavy gloves during the winter, an open design with greater clearance would be desirable at an exterior stairway, or a stairway directly inside the entrance to a building. [See Commentary Figures 1014.4(2) and 1014.8(2) for an illustration of handrail clearance.]

**1014.8 Projections.** On *ramps* and on ramped *aisles* that are part of an *accessible route*, the clear width between *handrails* shall be 36 inches (914 mm) minimum. Projections into the required width of *aisles*, *stairways* and *ramps* at each side shall not exceed 4½ inches (114 mm) at or below the handrail height. Projections into the required width shall not be limited above the minimum headroom height required in Section 1011.3. Projections due to intermediate *handrails* shall not constitute a reduction in the egress width. Where a pair of intermediate *handrails* are provided within the *stairway* width without a walking surface between the pair of intermediate *handrails* and the distance between the pair of intermediate *handrails* is greater than 6 inches (152 mm), the available egress width shall be reduced by the distance between the closest edges of each such intermediate pair of *handrails* that is greater than 6 inches (152 mm).

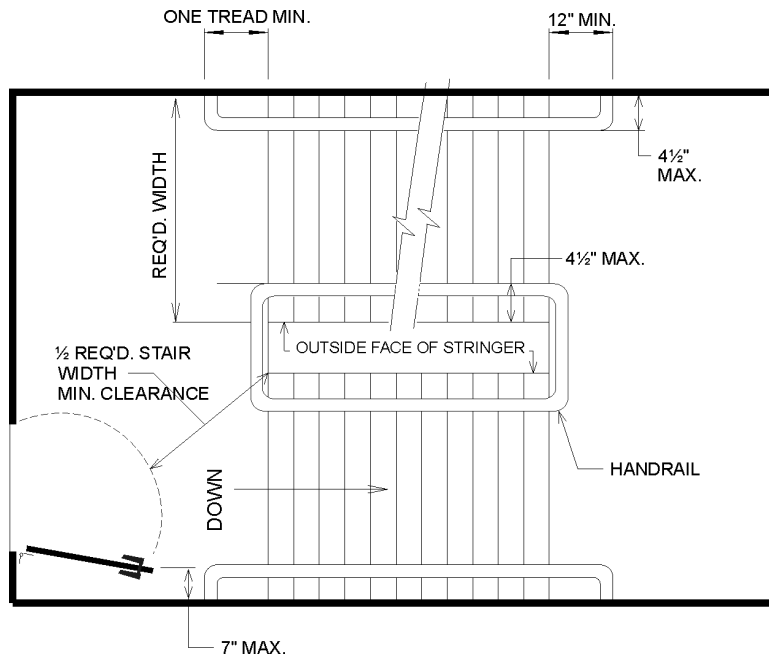
❖ Handrails may not project more than 4½ inches (114 mm) into the required width of a stairway, so that the clear width of the passage will not be seriously reduced [see Commentary Figure 1014.8(1)]. This is consistent with Section 1003.3.3. This projection may exist below the handrail height as well [see Commentary Figure 1014.8(2)]. The projection can be greater

**MEANS OF EGRESS**

on stairways or ramps exceeding minimum width requirements.

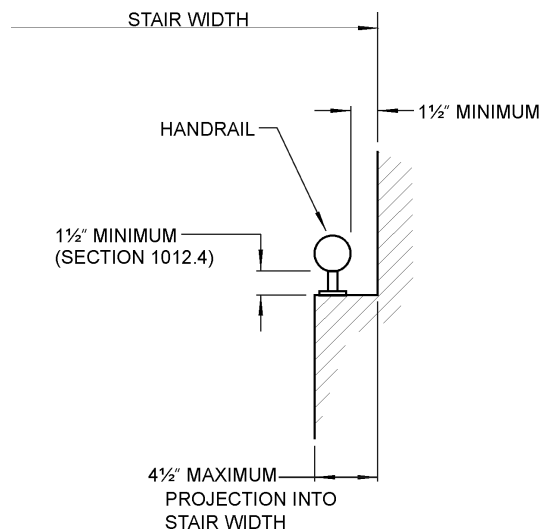
The requirement for some stairways to have center handrails (Section 1014.9) could result in a single or double handrail down the center of the flight of stairs. Since these stairways are 60 inches (1525 mm) or wider, a center handrail would typically not be an obstruction and, therefore, would not reduce the

capacity of the stairway. Schools and large assembly spaces commonly put in center handrails to aid in the flow up and down the stairs during peak usage times. If the center handrail is a double rail with a spacing of more than 6 inches (152mm), the width of the stairway may need to be adjusted to compensate for the loss of available width.



For SI: 1 inch = 25.4 mm.

**Figure 1014.8(1)**  
**TYPICAL HANDRAIL ARRANGEMENT**



For SI: 1 inch = 25.4 mm.

**Figure 1014.8(2)**  
**PROJECTION OF HANDRAIL**

**1014.9 Intermediate handrails.** *Stairways* shall have intermediate *handrails* located in such a manner that all portions of the *stairway* minimum width or required capacity are within 30 inches (762 mm) of a handrail. On monumental *stairs*, *handrails* shall be located along the most direct path of egress travel.

❖ In order to always be available to the user of the stairway, the maximum horizontal distance to a handrail from within the width required must not exceed 30 inches (762 mm). People tend to walk close to handrails, and if intermediate handrails are not provided for very wide stairways, the center portion of such stairways will normally receive less use. More importantly, in emergencies, the center portions of wide stairways with handrails would enhance egress travel rather than delay it by overcrowding at the sides with the handrails. This would especially be true under panic conditions where the use of wide interior stairways could become particularly hazardous.

The distance to the handrail applies to the "required" width of the stairway. If a stairway is greater than 60 inches (1524 mm) in width, but only 60 inches (1524 mm) total width is required based on occupant load (see Section 1005.3.1), intermediate handrails are not required. Adequate safety is provided since every user is within 30 inches (762 mm) of a handrail.

Monumental stairways are typically provided for architectural effect and may or may not be considered required egress stairs. The criteria for monumental egress stairways deal with the very wide stairway in relation to the required width. While hand-

rails on both sides of the stairway may be sufficient to accommodate the required width, the handrails may not be near the stream of traffic or even apparent to the user. In this case, the handrails are to be placed in a location more reflective of the egress path (see Commentary Figure 1014.9).

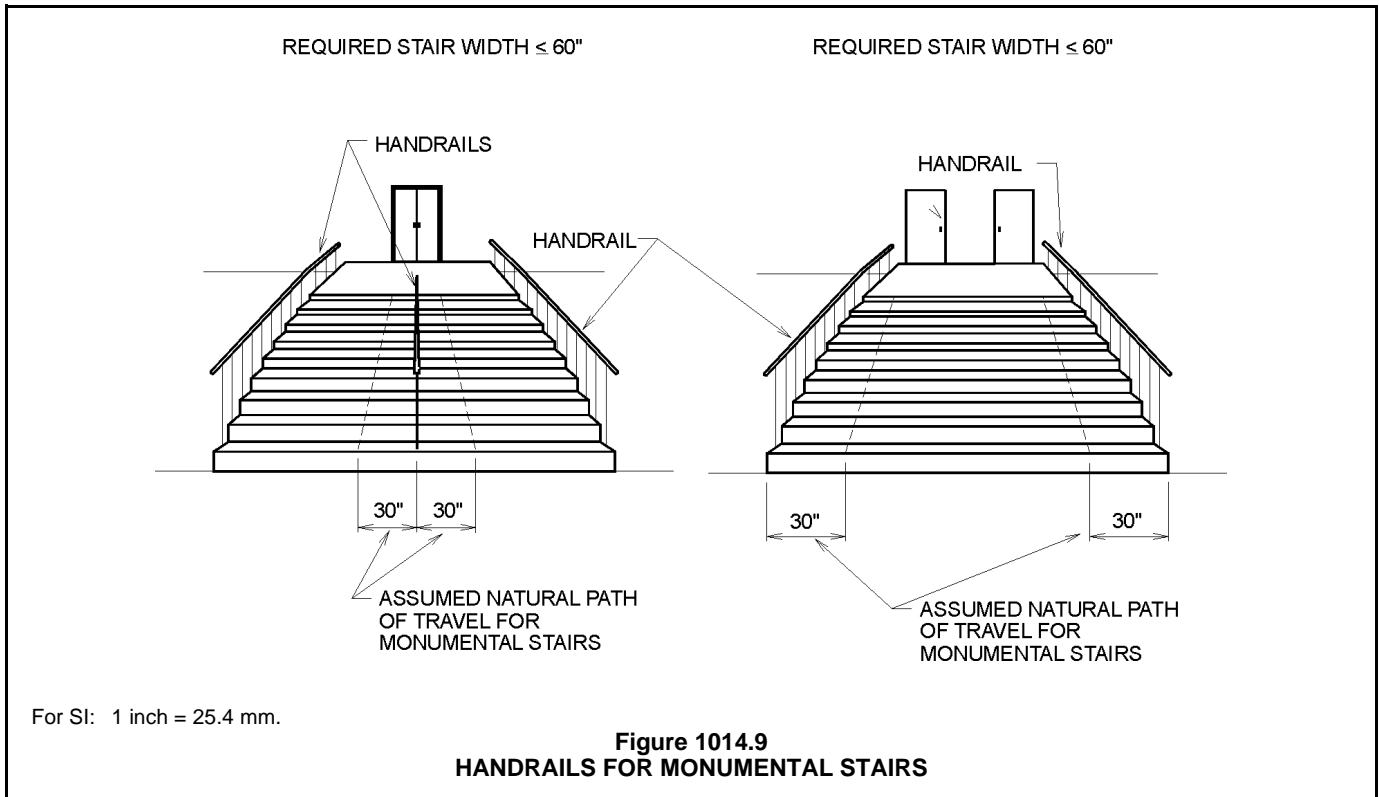
**SECTION 1015  
GUARDS**

**1015.1 General.** *Guards* shall comply with the provisions of Sections 1015.2 through 1015.7. Operable windows with sills located more than 72 inches (1829 mm) above finished grade or other surface below shall comply with Section 1015.8.

❖ Guards required along dropoffs must comply with the provisions for height, strength and opening limitations. Special provisions are provided for unique locations, such as screened-in porches, around mechanical equipment on platforms or roofs and at hatch openings.

Where there are operable windows on upper floors, there is a concern over the possibility of a child falling; thus, the placement of this requirement is in the guard section. Such windows must comply with Section 1015.8.

**1015.2 Where required.** *Guards* shall be located along open-sided walking surfaces, including *mezzanines*, *equipment platforms*, *aisles*, *stairs*, *ramps* and landings that are located more than 30 inches (762 mm) measured vertically to the floor or grade below at any point within 36 inches (914 mm) horizontally to the edge of the open side. *Guards* shall



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be adequate in strength and attachment in accordance with Section 1607.8.

**Exception:** *Guards* are not required for the following locations:

1. On the loading side of loading docks or piers.
  2. On the audience side of *stages* and raised *platforms*, including *stairs* leading up to the *stage* and raised *platforms*.
  3. On raised *stage* and *platform* floor areas, such as runways, *ramps* and side *stages* used for entertainment or presentations.
  4. At vertical openings in the performance area of *stages* and *platforms*.
  5. At elevated walking surfaces appurtenant to *stages* and *platforms* for access to and utilization of special lighting or equipment.
  6. Along vehicle service pits not accessible to the public.
  7. In assembly seating areas at cross aisles in accordance with Section 1029.16.2.
- ❖ Where one or more sides of a walking surface are open to the floor level or grade below, a guard system must be provided to minimize the possibility of occupants accidentally falling to the surface below. A guard is required only where the difference in elevation between the higher walking surface and the surface below is greater than 30 inches (762 mm). When the ground slopes away from the edge, the vertical distance from the walking surface to the grade or floor below must also be more than 30 inches (762 mm) on

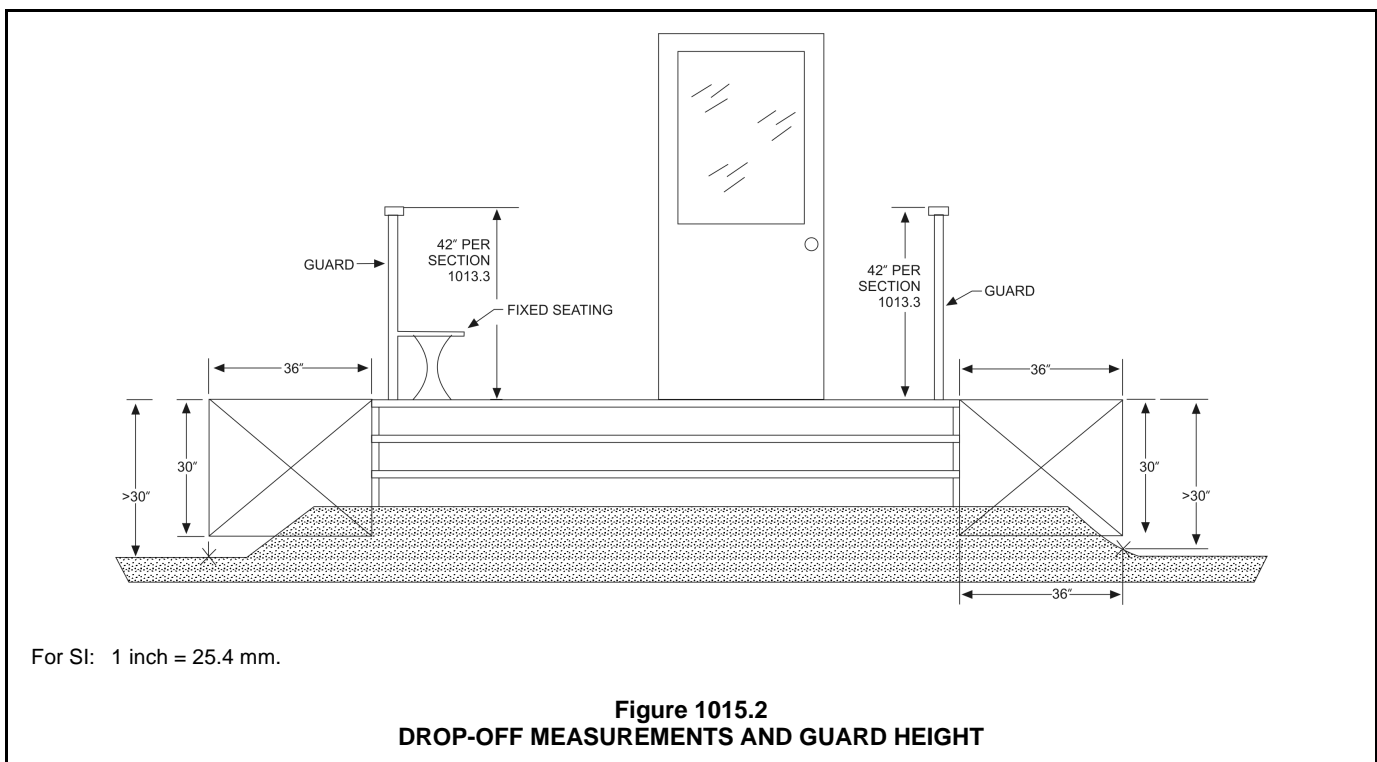
the lowest point within a 36-inch (914 mm) radius measured horizontally from the edge of the open-sided walking surface (see Commentary Figure 1015.2).

The loads for guard design are addressed in IBC Section 1607 and are typically 50 plf (222 N) along the top with a 200-pound (90.72 kg) concentrated force. If glazing is used as part of a guard system, or windows are located adjacent to stairways or ramps, the guard must also comply with Section 1015.2.1 (see Section 1015.2.1 and IBC Sections 1607.8 and 2407).

Most of the exceptions identify situations where guards are not practical, such as along loading docks, stages and their approaches, and vehicle service pits. Exception 7 references assembly spaces where a lower guard is permitted or the alternative of seat backs where the dropoff is adjacent to a cross aisle.

**1015.2.1 Glazing.** Where glass is used to provide a *guard* or as a portion of the *guard* system, the *guard* shall comply with Section 2407. Where the glazing provided does not meet the strength and attachment requirements of Section 1607.8, complying *guards* shall be located along glazed sides of open-sided walking surfaces.

❖ Glazing in guards may be infill or structural. The loads for guard design in Section 1015.2, which references IBC Section 1607, are typically 50 plf (222 N) along the top with a 200-pound (90.72 kg) concentrated force. Two different situations are addressed with glazing: where glazing is installed in a guard on the side of a stairway, ramp or landing; or when a stairway, ramp or landing is immediately adjacent to a window where the glazing has not been designed to resist the forces from a fall (see IBC Sections 1607.8 and 2407 and Commentary Figure 1015.2.1).





**Figure 1015.2.1**  
**GUARD SYSTEM WITH GLAZING**

**1015.3 Height.** Required *guards* shall be not less than 42 inches (1067 mm) high, measured vertically as follows:

1. From the adjacent walking surfaces.
2. On *stairways* and stepped *aisles*, from the line connecting the leading edges of the tread *nosings*.
3. On *ramps* and ramped *aisles*, from the *ramp* surface at the *guard*.

**Exceptions:**

1. For occupancies in Group R-3 not more than three stories above grade in height and within individual *dwelling units* in occupancies in Group R-2 not more than three stories above grade in height with separate *means of egress*, required *guards* shall be not less than 36 inches (914 mm) in height measured vertically above the adjacent walking surfaces or adjacent *fixed seating*.
2. For occupancies in Group R-3, and within individual *dwelling units* in occupancies in Group R-2, *guards* on the open sides of *stairs* shall have a height not less than 34 inches (864 mm) measured vertically from a line connecting the leading edges of the treads.

3. For occupancies in Group R-3, and within individual *dwelling units* in occupancies in Group R-2, where the top of the *guard* also serves as a *handrail* on the open sides of *stairs*, the top of the *guard* shall be not less than 34 inches (864 mm) and not more than 38 inches (965 mm) measured vertically from a line connecting the leading edges of the treads.
4. The *guard* height in assembly seating areas shall comply with Section 1029.16 as applicable.
5. Along *alternating tread devices* and ship's ladders, *guards* where the top rail also serves as a *handrail* shall have height not less than 30 inches (762 mm) and not more than 34 inches (864 mm), measured vertically from the leading edge of the device tread *nosing*.

❖ *Guards* must not be less than 42 inches (1067 mm) in height as measured vertically from the top of the guard down to the sloped line connecting the leading edge of the tread along stairways or stepped aisles or to an adjacent walking surface for floors, ramps and ramped aisles [see Commentary Figures 1015.2, 1015.4(1) and (2) and 1012.8(4)]. Experience has shown that 42 inches (1067 mm) or more provides adequate height to minimize accidental falls in occupancies where crowding is more likely to occur. This puts the top of the guard above the center of gravity of the average adult. The height requirement is not intended to consider such items as planters or loose furniture next to the dropoff as walking surfaces. Because of safety concerns, the designer often chooses to install a barrier where there is a dropoff of less than 30 inches (762 mm). Decorative barriers may be utilized to support handrails or serve as part of the edge protection along a ramp. Where nonrequired guards/barriers are provided, provisions for guard height, openings and strength may be used for design, but are not required. It is common practice to follow the strength provisions, but not always the opening or height provisions for nonrequired guards.

Exception 1 measures the guard height differently. In Group R-2 and R-3 units that are three stories or less, where there is a fixed seat along the edge of deck or balcony, it is reasonable to consider the additional exposure for young children that may use the seat as standing or walking surfaces. In this situation, while the dropoff is measured from the floor, the guard height is measured from the top of the seat surface (see Commentary Figure 1015.3). Within dwelling units the incidence of the exposure to crowds and to egress from higher occupancy spaces is extremely limited, thus a minimum guard height of 36 inches (914 mm) is appropriate. Exception 1 is consistent with provisions in the 2012 IRC, however, the requirement to measure the guard height above a fixed seat has been deleted in the 2015 IRC.

Where the minimum guard height requirement is 42 inches (1067 mm), where both a guard and handrail are required, the handrail cannot be the top of the guard, but must be placed along the inside face of the

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guard unless specifically permitted in Exceptions 2 through 5.

Exceptions 2 and 3 are for nontransient residential occupancies and only address guard heights along the stairways, not at other dropoffs such as balconies or second-floor landings. For Group R-2, these guard height exceptions are only permitted for stairways within individual dwelling units, not common stairways within the building. The handrail provisions allow some residential stairways to only have one handrail (see Section 1011.11). Exceptions 2 and 3 allow for a reduced guard height when the guard is also used as a handrail and when it just serves the purpose of a guard along a stairway. The reduced allowable guard height along stairways is consistent with current construction practice. Unless a dwelling could comply with Exception 1, the guard height along other dropoffs would have to be 42 inches (1067 mm) measured from the floor.

Exception 4 references the lower guards permitted at limited locations where a line of sight for assembly spaces is part of the consideration. There are also allowances in Section 1029.16 that would allow for the top of the guard to serve as a handrail.

Exception 5 permits a reduction in guard heights based on the limited used and unique design considerations for alternating tread devices and ship's ladders (see Sections 1011.14 and 1011.15).

**1015.4 Opening limitations.** Required *guards* shall not have openings that allow passage of a sphere 4 inches (102 mm) in diameter from the walking surface to the required *guard* height.

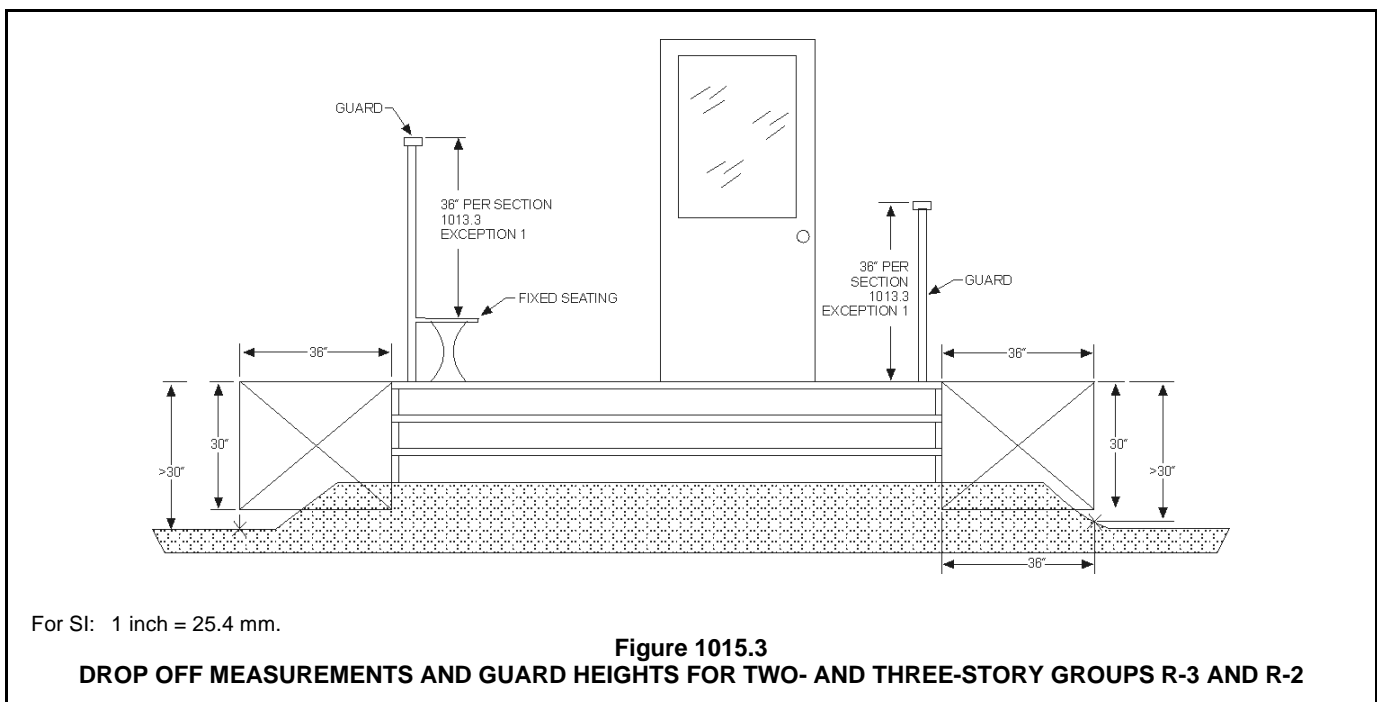
### Exceptions:

1. From a height of 36 inches (914 mm) to 42 inches (1067 mm), *guards* shall not have openings that

allow passage of a sphere  $4\frac{3}{8}$  inches (111 mm) in diameter.

2. The triangular openings at the open sides of a *stair*, formed by the riser, tread and bottom rail shall not allow passage of a sphere 6 inches (152 mm) in diameter.
3. At elevated walking surfaces for access to and use of electrical, mechanical or plumbing systems or equipment, *guards* shall not have openings that allow passage of a sphere 21 inches (533 mm) in diameter.
4. In areas that are not open to the public within occupancies in Group I-3, F, H or S, and for *alternating tread devices* and ship's ladders, *guards* shall not have openings that allow passage of a sphere 21 inches (533 mm) in diameter.
5. In assembly seating areas, *guards* required at the end of aisles in accordance with Section 1029.16.4 shall not have openings that allow passage of a sphere 4 inches (102 mm) in diameter up to a height of 26 inches (660 mm). From a height of 26 inches (660 mm) to 42 inches (1067 mm) above the adjacent walking surfaces, *guards* shall not have openings that allow passage of a sphere 8 inches (203 mm) in diameter.
6. Within individual *dwelling units* and *sleeping units* in Group R-2 and R-3 occupancies, *guards* on the open sides of *stairs* shall not have openings that allow passage of a sphere  $4\frac{3}{8}$  (111 mm) inches in diameter.

❖ The opening limitations in a guard are based on anthropometric research that indicates children in the 99th percentile who have developed to the point of being able to crawl will have chest depth and head



size of at least 4<sup>3</sup>/<sub>4</sub> inches. Both the 4-inch (102 mm) and the 4<sup>3</sup>/<sub>8</sub>-inch (111 mm) sphere rules are intended to provide an additional margin of safety. Note that the opening limitations are stated as preventing the passage of a sphere, requiring the openings to be smaller than the dimension stated.

Exception 1 allows the 4<sup>3</sup>/<sub>8</sub>-inch (203 mm) opening limitation at heights where falling through the guard is not a risk for children of early development who cannot access the opening [i.e., above 36 inches (914 mm) in height] [see Commentary Figure 1015.4(1)].

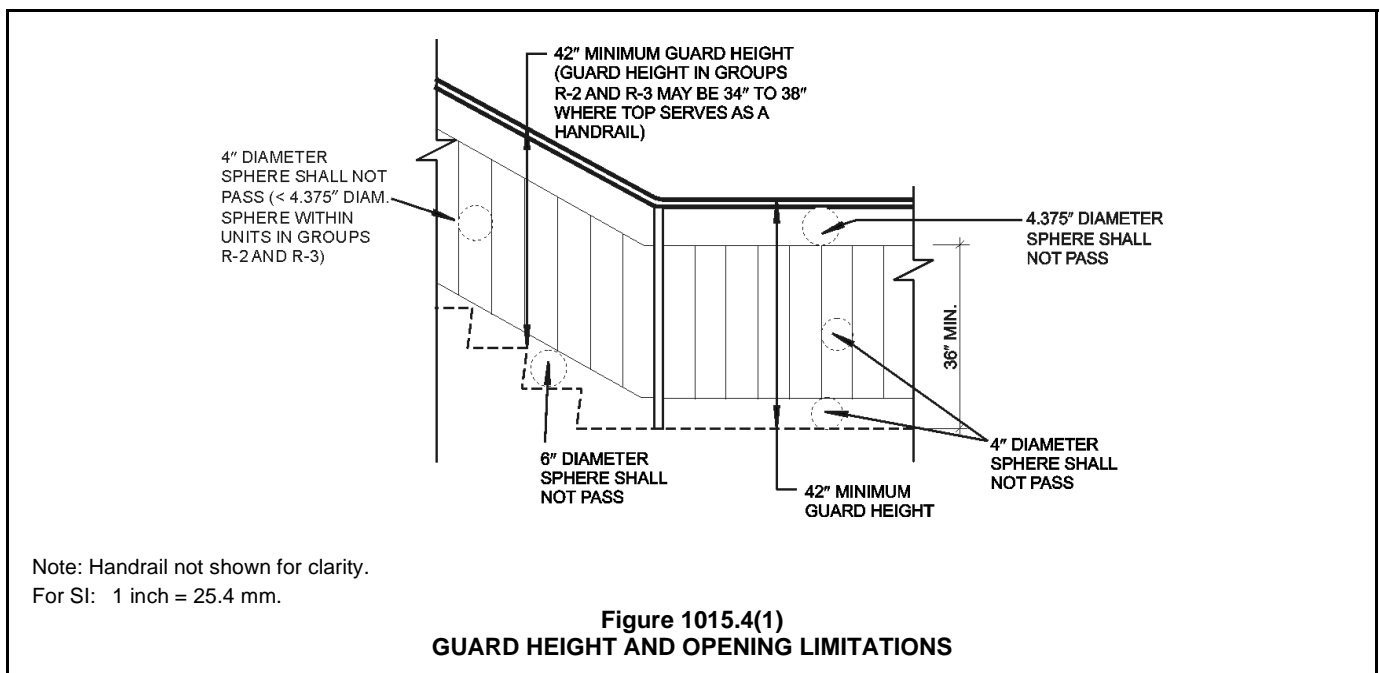
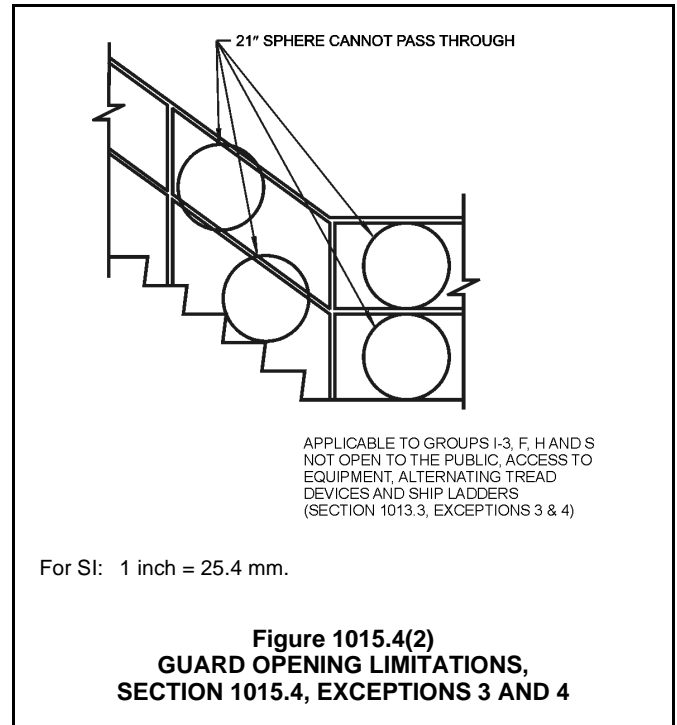
Exception 2 allows a 6-inch (152 mm) opening limitation at openings formed by the riser, tread and bottom rail of guards at the open side of a stairway. The geometry of these openings is such that the entire body cannot pass through the triangular opening, and further limiting such openings is impractical to achieve with a sloped bottom member in the guard without intersecting the tread nosings [see Commentary Figure 1015.4(1)].

Exceptions 3 and 4 address areas where the presence of small children is unlikely and often prohibited. Guards along walkways leading to electrical, mechanical and plumbing systems or equipment and in occupancies in Groups I-3, F, H and S may be constructed in such a way that a sphere 21 inches (533 mm) in diameter will not pass through any of the openings [see Commentary Figure 1015.4(2)]. This requirement allows the use of one horizontal intermediate member with the standard top-of-guard height of 42 inches (1067 mm).

Exception 5, for the guard infill near the top of the aisle guard in assembly seating areas, is provided to reduce sightline problems in limited locations (see Section 1029.16.4).

Exception 6 recognizes a standard construction practice within residential units. In practicality this

allows a stairway with the 7-inch riser height/11-inch tread depth (178 mm riser height/279 mm tread depth) step geometry to have two common 1<sup>1</sup>/<sub>4</sub>-inch (32 mm) balusters per stair tread instead of three. Where the 7<sup>3</sup>/<sub>4</sub>-inch riser height/10-inch tread depth (197 mm riser height/254 mm tread depth) step geometry (see Section 1011.5.2, Exception 3) is utilized, the two balusters would meet the 4-inch (102 mm) opening limitation and most profiled or turned balusters would meet the 4<sup>3</sup>/<sub>8</sub>-inch (111 mm) sphere rule.



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The provisions of guards are to minimize accidental falls through or over a guard. Opening limitations do not prohibit the use of horizontal members or ornamentation infill as guard components. Research has shown that no practical design for guard infill, including solid panels, can prevent climbing; but good design practices can greatly reduce the opportunity for small children to “climb” the guard [see Commentary Figure 1015.4(3)]. In this example, the handrail stops a child from climbing the guard.



**Figure 1015.4(3)**  
**EXAMPLE OF GUARD WITH HORIZONTAL MEMBERS**

**1015.5 Screen porches.** Porches and decks that are enclosed with insect screening shall be provided with *guards* where the walking surface is located more than 30 inches (762 mm) above the floor or grade below.

❖ Insect screening located on the open sides of porches and decks does not provide an adequate barrier to reasonably protect an occupant from falling to the surface below. Guards are required on the open sides of porches and decks where the floor is located more than 30 inches (762 mm) above the surface below. The guards must comply with all of the provisions of Section 1015.

**1015.6 Mechanical equipment, systems and devices.** *Guards* shall be provided where various components that require service are located within 10 feet (3048 mm) of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches (762 mm) above the floor, roof or grade below. The *guard* shall extend not less than 30 inches (762 mm) beyond each end of such components. The *guard* shall be constructed so as to prevent the passage of a sphere 21 inches (533 mm) in diameter.

**Exception:** *Guards* are not required where permanent fall arrest/restraint anchorage connector devices that comply with ANSI/ASSE Z 359.1 are affixed for use during the entire roof covering lifetime. The devices shall be reevaluated for possible replacement when the entire roof covering is replaced. The devices shall be placed not more than

10 feet (3048 mm) on center along hip and ridge lines and placed not less than 10 feet (3048 mm) from the roof edge or open side of the walking surface.

❖ The purpose of this requirement is to protect workers from falls off of roofs or from open-sided walking surfaces when doing maintenance work on equipment. The guard opening is allowed to be up to 21 inches (533 mm) since children are not likely to be in such areas. Either the equipment should be located so that it is more than 10 feet from the roof edge, or a guard or raised parapet must be provided to prevent falls. The guard also has to extend at least 30 inches (762 mm) in all directions past the corners of the equipment (see Commentary Figure 1015.7).

The exception for the guards is an alternative of a personal fall arrest system with anchorage points, more commonly called tie down points for restraining harnesses. The code does not specify who has to provide the equipment that fits the maintenance crew and attaches to the system. If this option is chosen, when the roof covering is replaced, the system must also be reevaluated and possibly replaced. This system is more commonly used on sloped roofs while guards are more often used on flat roofs.

**1015.7 Roof access.** *Guards* shall be provided where the roof hatch opening is located within 10 feet (3048 mm) of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches (762 mm) above the floor, roof or grade below. The *guard* shall be constructed so as to prevent the passage of a sphere 21 inches (533 mm) in diameter.

**Exception:** *Guards* are not required where permanent fall arrest/restraint anchorage connector devices that comply with ANSI/ASSE Z 359.1 are affixed for use during the entire roof covering lifetime. The devices shall be reevaluated for possible replacement when the entire roof covering is replaced. The devices shall be placed not more than 10 feet (3048 mm) on center along hip and ridge lines and placed not less than 10 feet (3048 mm) from the roof edge or open side of the walking surface.

❖ The code already requires guards around equipment on the roof; this section is intended to provide the same level of safety at the hatch opening service personnel use to access the roof (see Commentary Figure 1015.7 and the commentary to Section 1015.6). While not specifically indicated for roof hatches, Section 1015.6 requires the guard to extend at least 30 inches (752 mm) past the corners of the equipment.

**1015.8 Window openings.** Windows in Group R-2 and R-3 buildings including *dwelling units*, where the top of the sill of an operable window opening is located less than 36 inches above the finished floor and more than 72 inches (1829 mm) above the finished grade or other surface below on the exterior of the building, shall comply with one of the following:

1. Operable windows where the top of the sill of the opening is located more than 75 feet (22 860 mm) above the finished grade or other surface below and that are pro-

vided with window fall prevention devices that comply with ASTM F2006.

2. Operable windows where the openings will not allow a 4-inch-diameter (102 mm) sphere to pass through the opening when the window is in its largest opened position.
  3. Operable windows where the openings are provided with window fall prevention devices that comply with ASTM F2090.
  4. Operable windows that are provided with window opening control devices that comply with Section 1015.8.1.
- ❖ The window limitations specified here are intended for Group R-2 and R-3 units. These facilities have the highest potential for infants and toddlers being present for an extended period of time. The requirement is intended to provide a level of protection to children and to help limit the chances of them falling through window openings. In most cases, these provisions are not applicable to first-floor windows. Typically, the 72 inches (1829 mm) to finished grade would make these provisions applicable for windows starting at the second floor. For windows in bedrooms that may also be required to serve as emergency escape and rescue openings, see Section 1030.

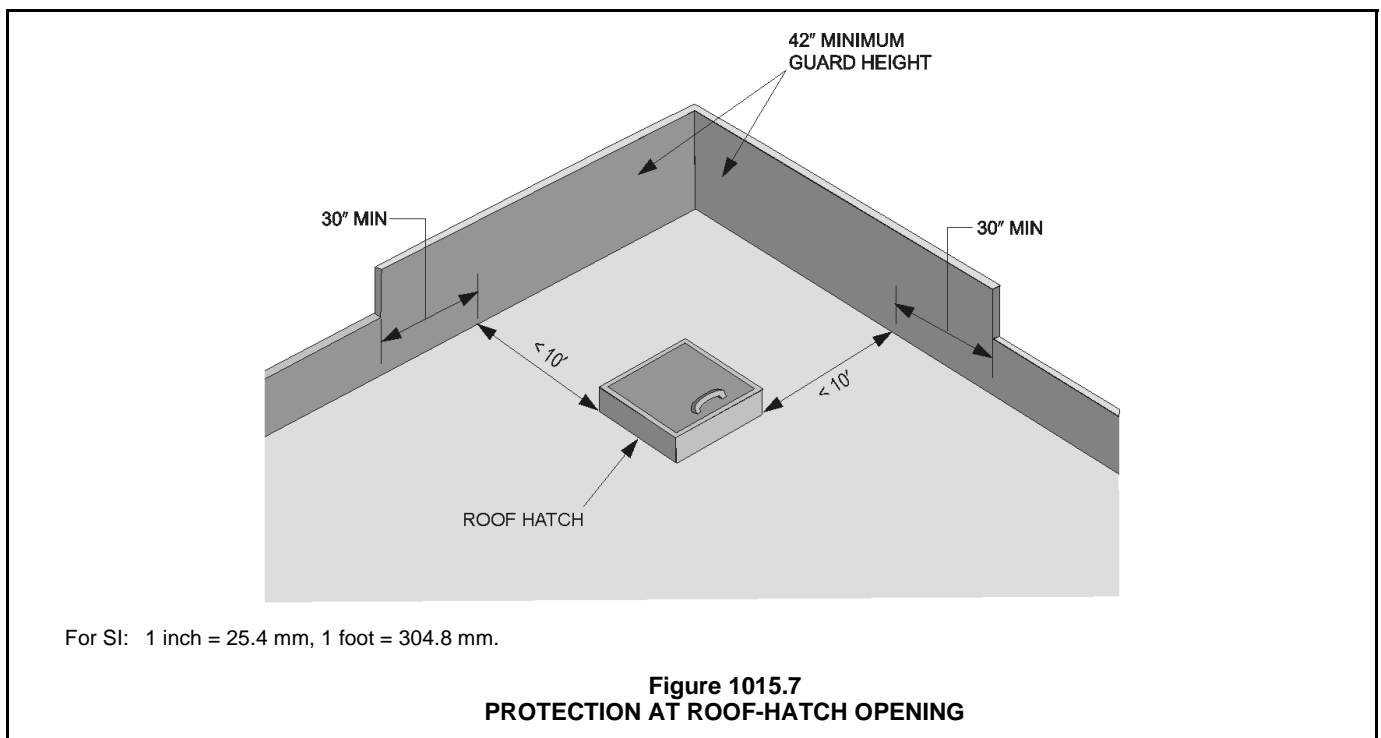
There are basically five options offered:

One option is to locate the window so that any opening is at least 36 inches (915 mm) above the floor. By raising the lowest operable portion of a window to 36 inches (915 mm) or more, the sill height is above the center of gravity of smaller children. The National Ornamental & Miscellaneous Metals Association (NOMMA) commissioned a paper on child

safety related to falls. The report indicates that the standing center of gravity of children aged 2 to 3.5 years is 24.1 inches (612 mm) [50th percentile is 22.2 inches (564 mm)] and of children aged 3.5 to 4.5 years is 25.2 inches (640 mm) [50th percentile is 23.6 inches (599 mm)]. The 36-inch (915 mm) sill height was chosen to reduce the ability of a child to climb onto the sill, enabling the fall through the opening. Windows that are also to serve as emergency escape windows must also comply with Section 1030.3 sill height requirements for 44 inches (1118 mm) maximum. Note that Section R612.2 of the IRC requires a minimum sill height of 24 inches (610 mm).

A second option (Item 1) would be for windows with an opening lower than 36 inches (915 mm) to limit the opening to 4 inches (102 mm) maximum. This opening size is consistent with the guard opening provisions (see Section 1015.4). Many awning or hopper-type casement windows have control arms that limit the opening width.

The third option offered (Item 2) allows for fixed fall-prevention devices to be installed in accordance with ASTM F2006. The limitation for window sills over 75 feet (22 860 mm) is for consistency with Section 1.3 of ASTM F2006, which states: "This safety specification applies only to devices intended to be applied to windows installed at height of more than 75 feet above the ground level in multiple family dwelling buildings. This safety specification is not intended to apply to windows below 75 feet (22 860 mm) because all windows below 75 feet (22 860 mm) that are operable could be used as a possible secondary means of escape." Since these devices will always prevent the opening of the window, they cannot be



used for windows that are required to also serve as emergency escape openings.

ASTM F2090 includes window fall prevention devices (Item 3) and window opening control devices (Item 4) (see Section 1015.8.1). Window fall-prevention devices (such as a window guard) must be removable from the interior of the building so the window can be used for emergency escape. Window opening-control devices allow the window to be opened beyond 4 inches, so that a window can be used for emergency escape. This standard is specifically written for window openings within 75 feet (22 860 mm) of grade and specifically allows for windows to be used for emergency escape and rescue. Both the code and IRC reference ASTM F2090, *Specification for Window Fall Prevention Devices with Emergency Escape (Egress Release Mechanisms)*. This standard was updated in 2008 to address window opening control devices. Opening control devices allow for normal operation to result in a 4-inch (102 mm) maximum opening (Section 1015.8 and Section R612.4.1 of the IRC). This control device can be released from the inside to allow the window to be fully opened in order to comply with the emergency escape provisions in both the code (Section 1030.2) and IRC (Section R310.1.1).

Criteria have also been added to IEBC to address window opening controls in existing buildings.

**1015.8.1 Window opening control devices.** Window opening control devices shall comply with ASTM F2090. The window opening control device, after operation to release the control device allowing the window to fully open, shall not reduce the minimum net clear opening area of the window unit to less than the area required by Section 1030.2.

❖ See the commentary to Section 1015.8.

## SECTION 1016 EXIT ACCESS

**1016.1 General.** The *exit access* shall comply with the applicable provisions of Sections 1003 through 1015. *Exit access* arrangement shall comply with Sections 1016 through 1021.

❖ Sections 1016 through 1021 include the design requirements for exit access and exit access components. The general requirements that also apply to the exit access are in Sections 1003 through 1015.

The following sections are included under exit access:

- Section 1016 deals with egress through intervening spaces, as well as travel and separation of the common path of travel to the exit.
- Section 1017 lists the total exit access travel distance from an occupied space to an exit. This distance includes the common path of travel addressed in Sections 1006.2.1 and 1006.3.2.
- Section 1018 takes a look at requirements for aisles and aisle accessways for occupancies other than assembly spaces. Aisle and aisle

accessways in spaces used for assembly purposes are specifically addressed in Section 1029.

- Section 1019 provides criteria for when an open stairway between floors can serve as a required exit access stairway.
- Section 1020 deals with another type of confined part of the exit access path: corridors.
- Section 1021 addresses egress balconies, where the path of travel to the exterior exit stairway is partially open to the exterior.

**1016.2 Egress through intervening spaces.** Egress through intervening spaces shall comply with this section.

1. *Exit access* through an enclosed elevator lobby is permitted. Access to not less than one of the required *exits* shall be provided without travel through the enclosed elevator lobbies required by Section 3006. Where the path of exit access travel passes through an enclosed elevator lobby, the level of protection required for the enclosed elevator lobby is not required to be extended to the *exit* unless direct access to an *exit* is required by other sections of this code.
2. Egress from a room or space shall not pass through adjoining or intervening rooms or areas, except where such adjoining rooms or areas and the area served are accessory to one or the other, are not a Group H occupancy and provide a discernible path of egress travel to an *exit*.
 

**Exception:** *Means of egress* are not prohibited through adjoining or intervening rooms or spaces in a Group H, S or F occupancy where the adjoining or intervening rooms or spaces are the same or a lesser hazard occupancy group.
3. An *exit access* shall not pass through a room that can be locked to prevent egress.
4. *Means of egress* from *dwelling units* or sleeping areas shall not lead through other sleeping areas, toilet rooms or bathrooms.
5. Egress shall not pass through kitchens, storage rooms, closets or spaces used for similar purposes.

### Exceptions:

1. *Means of egress* are not prohibited through a kitchen area serving adjoining rooms constituting part of the same *dwelling unit* or *sleeping unit*.
2. *Means of egress* are not prohibited through stockrooms in Group M occupancies where all of the following are met:
  - 2.1. The stock is of the same hazard classification as that found in the main retail area.
  - 2.2. Not more than 50 percent of the *exit access* is through the stockroom.
  - 2.3. The stockroom is not subject to locking from the egress side.

2.4. There is a demarcated, minimum 44-inch-wide (1118 mm) *aisle* defined by full- or partial-height fixed walls or similar construction that will maintain the required width and lead directly from the retail area to the *exit* without obstructions.

- ❖ This section allows adjoining spaces to be considered a part of the room or space from which egress originates, provided that there are reasonable assurances that the continuous egress path will always be available. The code does not limit the number of intervening or adjoining rooms through which egress can be made, provided that all other code requirements (e.g., travel distance, number of doorways, etc.) are met. An exit access route, for example, may be laid out such that an occupant leaves a room or space, passes through an adjoining space, enters an exit access corridor, passes through another room and, finally, into an exit [see Commentary Figure 1016.2(2)], as long as all other code requirements are satisfied.

The intent of Item 1 is to correlate the provision for corridor continuity (Section 1020.6) and elevator lobbies. This is especially important since elevator lobbies for fire service access elevators require direction connection to a stairway. Therefore, occupants may need to egress through an elevator lobby to get to the exit stairway. In a two-exit building, only one exit can be through an elevator lobby, but at the same time, the elevator lobby will not be considered an intervening room [see Commentary Figure 1020.6(3)]. This also clarifies that the protection requirements for corridors would not be put on top of protection requirements for the elevator lobbies.

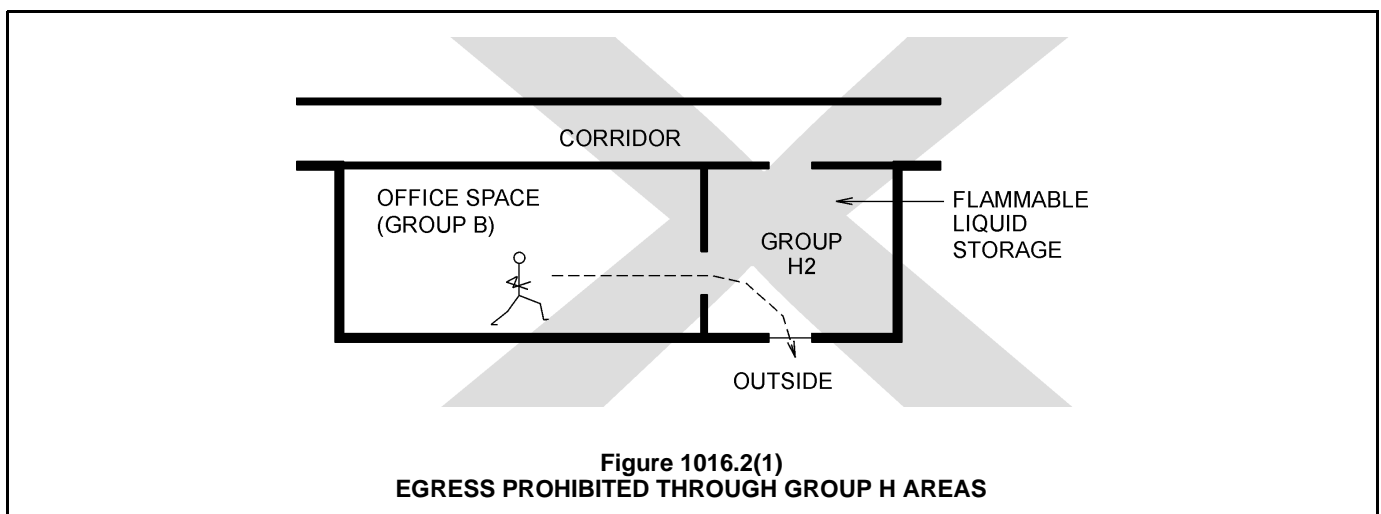
The intent of Item 2 is not that the accessory space be limited to the 10-percent area in IBC Section 508.2.3, but that the spaces be interrelated so that doors between the spaces will not risk being blocked or locked. For example, a conference room and managers' offices could exit through the secretary's office to reach the exit access corridor; or several office

spaces could exit through a common reception/lobby area. Requiring occupants to egress from an area and pass through an adjoining Group H that can be characterized by rapid fire buildup places them in an unreasonable risk situation [see Commentary Figure 1016.2(1)]; therefore, this illustrated egress path would be prohibited. As an exception to Item 2, in facilities that may contain a Group H area, buildings of Group H, S or F can exit through adjoining rooms or spaces that have the same or lesser hazard. For example, a person exiting from a Group H storage room (see IBC Section 415) could egress either through a similar Group H storage area or through the factory to get to an exit, but the person in the factory could not egress through the Group H storage rooms to get to the outside.

As expressed in Item 3, a common code enforcement problem is a locked door in the egress path. Twenty-five workers perished in September 1991 when they were trapped inside the Imperial Food Processing Plant in Hamlet, North Carolina, in part because of locked exit doors. As long as the egress door is readily openable in the direction of egress travel without the use of keys, special knowledge or effort (see Section 1010.1.9.5), the occupants can move unimpeded away from a fire emergency. Relying on an egress path through an adjacent dwelling unit to be available at all times is not a reasonable expectation. Egress through an adjacent business tenant space can be unreasonable given the security and privacy measures the adjacent tenant may take to secure such a space. However, egress through a reception area that serves a suite of offices of the same tenant is clearly accessible and is permitted.

Item 4 addresses concerns along the path of egress travel within individual dwelling or sleeping units. The concern once again is possible locking devices. Egress for one bedroom should not be through another bedroom or bathroom.

The concern in Item 5 is that kitchens, storage rooms and similar spaces may be subject to locking or blockage of the exit access path. This is not a gen-



## MEANS OF EGRESS

eral provision for all Group S occupancies; therefore, it is not the intent of this provision to address the situation of egress for offices through an associated warehouse space. Item 5, Exception 1, does not apply this same prohibition to areas within dwelling or sleeping units. However, for other spaces, a customer means of egress should not be through the working portions of a commercial kitchen in a restaurant or the stock storage area of a storage room in a mercantile occupancy. A dedicated path must be established through such space. The four items listed in Item 5, Exception 2, are intended to provide measurable criteria to increase the likelihood that the exit access path of travel would always be available and identifiable through the stock room of a store. It is not acceptable to just mark the path on the floor. Whatever defines the route must permanently establish the egress path in a manner to maintain the minimum required unobstructed width.

**1016.2.1 Multiple tenants.** Where more than one tenant occupies any one floor of a building or structure, each tenant space, *dwelling unit* and *sleeping unit* shall be provided with access to the required *exits* without passing through adjacent tenant spaces, *dwelling units* and *sleeping units*.

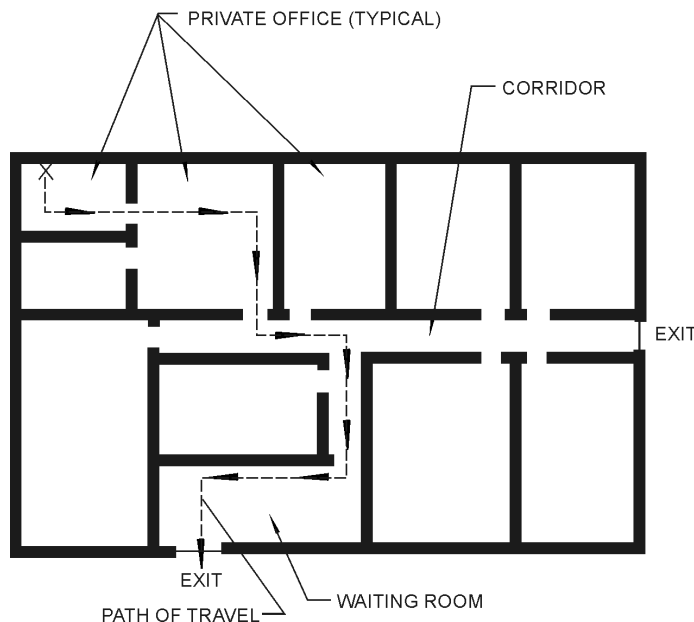
**Exception:** The *means of egress* from a smaller tenant space shall not be prohibited from passing through a larger adjoining tenant space where such rooms or spaces of the smaller tenant occupy less than 10 percent of the area of the larger tenant space through which they pass; are the same or similar occupancy group; a discernible path of egress travel to an *exit* is provided; and the *means of egress* into the adjoining space is not subject to locking from the egress side. A required *means of egress* serving

the larger tenant space shall not pass through the smaller tenant space or spaces.

- ❖ Where a floor is occupied by multiple tenants, each tenant must be provided with full and direct access to the required exits serving that floor without passing through another tenant space. Tenants typically lock the doors to their spaces for privacy and security. Should an egress door that is shared by both tenants be locked, occupants in one of the spaces could be trapped and unable to reach a secondary exit. Therefore, an egress layout where occupants from one tenant space travel through another tenant space to gain access to one of the required exits from that floor is prohibited.

This limitation is so that occupants from all tenant spaces will have unrestricted access to the required egress elements while maintaining the security and privacy of the individual tenants. This limitation is based on one of the fundamental principles of egress: to provide a means of egress where all components are capable of being used by the occupants without keys, tools, special knowledge or special effort (see Section 1010.1.9.5).

A common practice is to have a bank or small restaurant located within a large grocery store or department store. These can be separate tenants. In these situations, the small tenants are not open when the main store is closed. The intent of the exception is to allow those small tenants to egress through the large tenant. Since there may be times when the larger tenant is open and the smaller is closed (e.g., bank holidays), the larger tenant cannot exit through the smaller tenant.



**Figure 1016.2(2)**  
**EGRESS THROUGH ADJOINING ROOMS AND SPACES**

**SECTION 1017  
EXIT ACCESS TRAVEL DISTANCE**

**1017.1 General.** Travel distance within the *exit access* portion of the *means of egress* system shall be in accordance with this section.

❖ “Exit access” is defined as “that portion of a means of egress system that leads from any occupied portion of a building or structure to an exit” (see the commentary for the definition in Chapter 2). Exit access includes rooms, spaces, aisles and corridors that an occupant would travel along to get to an exit. This can also include stairways and ramps between levels, or between stories where permitted by Section 1019. Doors and doorways along this route are exit access doorways, but may sometimes be called “exit doors.” True exits for this exit access travel can be: 1. An exterior exit door at grade; 2. The door to an enclosure for an interior exit stairway, ramp or exit passageway; 3. The exit door leading to an exterior exit door or ramp; or 4. A door leading through a horizontal exit. How exit access travel distance is measured is one of the key differences between interior exit access stairways/ramps (see Section 1017.3.1) and interior exit stairways/ramps (see Section 1017.3).

It is important to understand the relationship between the common path of travel limitations of Sections 1006.2.1 and 1006.3.2 and the exit access travel distance limitations of this section. Measurements start at the same location, i.e., the most remote location in any occupied space. Both are measured in the exit access portion of the means of egress system. The common path of travel is measured to the point where the occupant has two distinct paths of travel, which will lead to two distinct exits. Travel distance is measured all the way until the exit is reached. The common path of travel measurement can end within a space or at a corridor where a single means of egress space (Section 1006.2.1) has its door to a corridor that provides access to two exits.

**1017.2 Limitations.** *Exit access* travel distance shall not exceed the values given in Table 1017.2.

❖ The table includes the travel distance measurements for buildings with or without sprinkler systems. “Not Permitted” is in support of the Chapter 9 requirements for all Group I and H occupancies to be sprinklered. While the other occupancies may also be required to be sprinklered, the exit access travel distance is indicated for existing buildings.

**TABLE 1017.2.** See next column.

❖ This table reflects the maximum distance a person is allowed to travel from any point in a building floor area to the nearest exit along a natural and unobstructed path. While quantitative determinations or formulas are not available to substantiate the tabular distances, empirical factors are utilized to make relative judgments as to reasonable limitations. Such considerations include the nature and fitness of the

occupants; the typical configuration within the space; the level of fire hazard with respect to the specific uses of the facilities, including fire spread and the potential intensity of a fire. The inclusion of an automatic sprinkler system throughout the building can serve to control, confine or possibly eliminate the fire threat to the occupants so an increased travel distance is permitted. Increased travel distances are permitted when an automatic sprinkler system is installed in accordance with NFPA 13 or 13R.

**[BE] TABLE 1017.2  
EXIT ACCESS TRAVEL DISTANCE<sup>a</sup>**

OCCUPANCY	WITHOUT SPRINKLER SYSTEM (feet)	WITH SPRINKLER SYSTEM (feet)
A, E, F-1, M, R, S-1	200	250 <sup>b</sup>
I-1	Not Permitted	250 <sup>b</sup>
B	200	300 <sup>c</sup>
F-2, S-2, U	300	400 <sup>c</sup>
H-1	Not Permitted	75 <sup>d</sup>
H-2	Not Permitted	100 <sup>d</sup>
H-3	Not Permitted	150 <sup>d</sup>
H-4	Not Permitted	175 <sup>d</sup>
H-5	Not Permitted	200 <sup>c</sup>
I-2, I-3, I-4	Not Permitted	200 <sup>c</sup>

For SI: 1 foot = 304.8 mm.

- a. See the following sections for modifications to exit access travel distance requirements:
  - Section 402.8 of the *International Building Code*: For the distance limitation in malls.
  - Section 404.9 of the *International Building Code*: For the distance limitation through an atrium space.
  - Section 407.4 of the *International Building Code*: For the distance limitation in Group I-2.
  - Sections 408.6.1 and 408.8.1 of the *International Building Code*: For the distance limitations in Group I-3.
  - Section 411.4 of the *International Building Code*: For the distance limitation in special amusement buildings.
  - Section 412.7 of the *International Building Code*: For the distance limitations in aircraft manufacturing facilities.
  - Section 1006.2.2.2: For the distance limitation in refrigeration machinery rooms.
  - Section 1006.2.2.3: For the distance limitation in refrigerated rooms and spaces.
  - Section 1006.3.2: For buildings with one *exit*.
  - Section 1017.2.2: For increased distance limitation in Groups F-1 and S-1.
  - Section 1029.7: For increased limitation in assembly seating.
  - Section 3103.4 of the *International Building Code*: For temporary structures.
  - Section 3104.9 of the *International Building Code*: For pedestrian walkways.
- b. Buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2. See Section 903 for occupancies where *automatic sprinkler systems* are permitted in accordance with Section 903.3.1.2.
- c. Buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.
- d. Group H occupancies equipped throughout with an *automatic sprinkler system* in accordance with Section 903.2.5.1.

When measuring travel distance, it is important to consider the natural path of travel [see Commentary Figure 1017.3(1)]. In many cases, the actual layout of furnishings and equipment is not known or is not identified on the plans submitted with the permit application. In such instances, it may be necessary to measure travel distance using the legs of a triangle instead of the hypotenuse [see Commentary Figure 1017.3(2)]. Since most people tend to migrate to more open spaces while egressing, measurement of the natural path of travel typically excludes floor areas within 1 foot (305 mm) of walls, corners, columns and other permanent construction. Where the travel path includes passage through a doorway, the natural route is generally measured through the centerline of the door openings.

The common path of travel addressed in Sections 1006.2.1 and 1006.3.2 is part of the overall exit access travel distance, with both starting at the same point. Common path of travel stops when the occupant has a choice of at least two exits, and overall travel distance stops when an occupant gets to the closest exit. The references in Note a are to sections where specific requirements are addressed—this can be an increase or decrease in travel distance.

Note a is a reference to other travel distance limitations in the code. Notes b and c are simply references to the allowed types of sprinkler system—NFPA 13 or 13R. Some travel distance increases are based on the type of sprinkler system provided. The table does not currently address a building with an NFPA 13D sprinkler system.

Note d addresses the sprinkler requirements in Group H. Group H occupancies are only required to be sprinklered within Group H and not throughout the building; therefore, Note d distinguishes this requirement from Notes b and c. The travel distance is the same if the path is through Group H or leaves Group H and continues through a nonsprinklered occupancy (see Section 1018.2, Item 2.)

**1017.2.1 Exterior egress balcony increase.** *Exit access* travel distances specified in Table 1017.2 shall be increased up to an additional 100 feet (30 480 mm) provided the last portion of the *exit access* leading to the *exit* occurs on an exterior egress balcony constructed in accordance with Section 1021. The length of such balcony shall be not less than the amount of the increase taken.

❖ This section allows an additional travel distance on exterior egress balconies since smoke disperses rapidly. Note that the length of the increase is not to be more than the length of the exterior balcony. For example, if the length of the balcony is 75 feet (22 860 mm), the additional travel distance is limited to 75 feet (22 860 mm). In order for the increase to apply, the exterior balcony must be located at the end of the path of egress travel and not in some other portion of the egress path.

**1017.2.2 Group F-1 and S-1 increase.** The maximum *exit access* travel distance shall be 400 feet (122 m) in Group F-1

or S-1 occupancies where all of the following conditions are met:

1. The portion of the building classified as Group F-1 or S-1 is limited to one story in height.
2. The minimum height from the finished floor to the bottom of the ceiling or roof slab or deck is 24 feet (7315 mm).
3. The building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

❖ This section provides the criteria for an increased exit access travel distance of 400 feet in Group F-1 and S-1 occupancies when three criteria are met: the S-1/F-1 area is one story, has a ceiling height of at least 24 feet, and is sprinklered.

The travel distance increase is only applicable to portions of the building that are one story in height. This is not intended to preclude a building with a one-story storage warehouse or factory area and a two-story office or a mezzanine from also utilizing this section. The section is written so that the one-story limitation is only applicable to the area where the 400-foot travel distance is utilized.

The 24 feet of clearance is based on the "Fire Modeling Analysis Report" by Aon Fire Protection Engineering. The ceiling height is used to provide a volume for the smoke to accumulate during the fire and provide time for egress, much like the concept used for smoke-protected seating. Control mode sprinklers were utilized in the fire modeling to demonstrate the more conservative approach.

The building is required to be sprinklered in accordance with NFPA 13 requirements. While not required, ESFR or specialty sprinklers would be more effective.

**1017.3 Measurement.** *Exit access* travel distance shall be measured from the most remote point within a story along the natural and unobstructed path of horizontal and vertical egress travel to the entrance to an *exit*.

**Exception:** In *open parking garages*, *exit access* travel distance is permitted to be measured to the closest riser of an *exit access stairway* or the closest slope of an *exit access ramp*.

❖ The length of travel, as measured from the most remote point within a structure to an exit, is limited to restrict the amount of time that the occupant is exposed to a potential fire condition [see Commentary Figure 1017.3(1)]. The route must be assumed to be the natural path of travel without obstruction. This commonly results in a rectilinear path similar to what can be experienced in most occupancies, such as a schoolroom or an office with rows of desks [see Commentary Figure 1017.3(2)]. The "arc" method, using an "as the crow flies" linear measurement, must be used with caution, as it seldom represents typical floor design and room layout and, in most cases, would not be the natural, unobstructed path.

The travel distance is measured from every occupi-

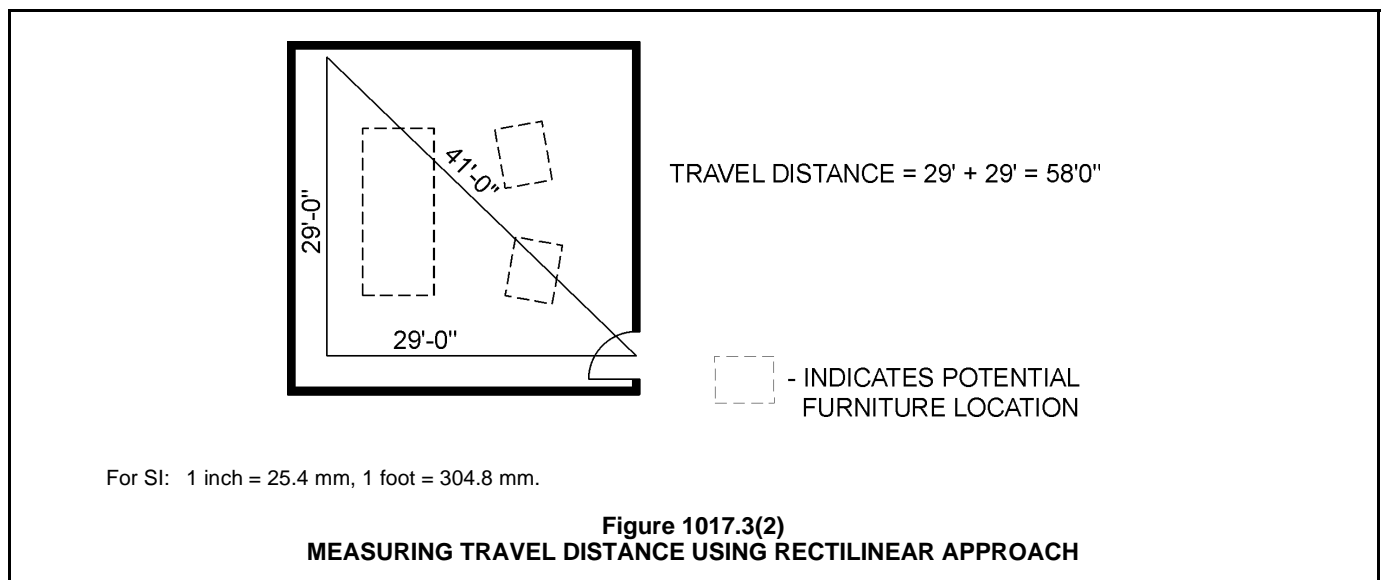
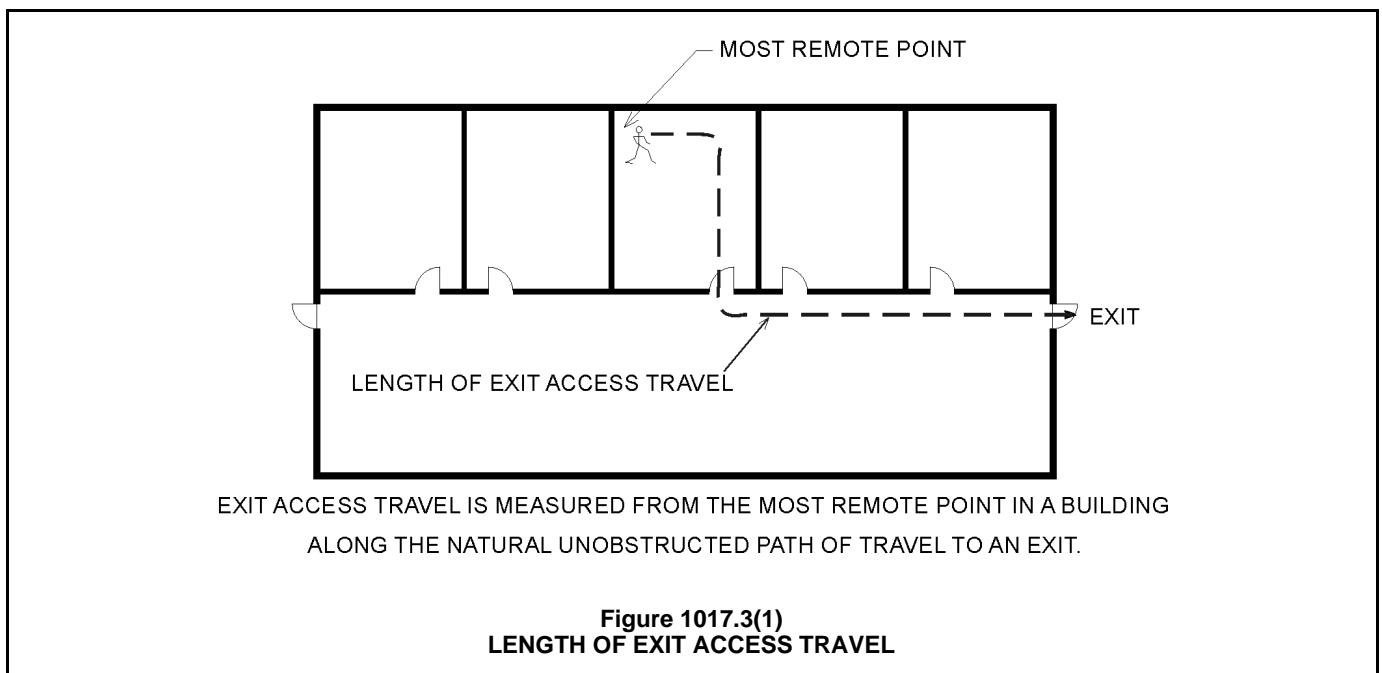
able point on a floor to the closest exit. While each occupant may be required to have access to a second or third exit, the travel distance limitation is only applicable to the distance to the nearest exit. In effect, this means that the distance an occupant must travel to the second or third exit is not regulated.

For exit access travel distances that include vertical elements, such as stairways or ramps, see Section 1017.3.1. For outdoor assembly seating, see Section 1029.7.

The exception provides for a travel distance terminating at the top of an open exit access stairway in an open parking structure (see Section 1019.3, Exception 6). This is appropriate in view of the low hazard and minimal possible smoke accumulation in these facilities. While Section 1006.3 does say that an open

exit access stairway can only be used for one story, travel distance typically does include the exit access stairway. With the exception here for travel distance, the intent is to allow open parking garages to have open exit access stairways all the way down and out of the building. The number of means of egress requirements are met when the exit access travel distance requirement is met on each floor.

The distance of travel within an exit enclosure (e.g., enclosed interior exit stairway or ramp or exit passageway) and in the exit discharge portion of the means of egress are also not regulated. Section 1006.3.2 permits certain buildings to be provided with a single exit. In instances where there is a single exit, travel distances less than those permitted in Table 1017.2 apply [see Tables 1006.3(1) and 1006.3(2)].



**1017.3.1 Exit access stairways and ramps.** Travel distance on *exit access stairways* or *ramps* shall be included in the *exit access* travel distance measurement. The measurement along *stairways* shall be made on a plane parallel and tangent to the *stair tread nosings* in the center of the *stair* and landings. The measurement along *ramps* shall be made on the walking surface in the center of the *ramp* and landings.

❖ Travel distance is measured along the exit access path. Exit access travel distance may include travel on an interior stairway or ramp if it is not enclosed and constructed to meet the definition of an exit (see Section 1023). An example of exit access stairways would be unenclosed exit access stairways from a mezzanine level, open exit access stairways from a second floor (see Section 1019.3, Exception 1), or steps along the path of travel in a split floor-level situation. An example of an open exit access ramp would be a ramp between levels or ramps leading from the upper levels in an open parking garage (see Section 1019.3, Exception 7). For the last example, Section 1016.3, Exception 1, allows for the exit access travel distance to be measured to the top of the ramp or stairway rather than down the ramp or stairway and to the exit.

When Section 1019.3 permits an exit access stairway to be unenclosed, the travel distance would also include travel down the open stairway and to an enclosed exit stairway, a horizontal exit or an exit door to the outside. An example of this would be an open exit stairway within an individual dwelling unit (see Section 1019.3, Exception 2) or an open exit stairway from a press box (see Section 1019.3, Exception 8).

## SECTION 1018 AISLES

**1018.1 General.** *Aisles* and *aisle accessways* serving as a portion of the *exit access* in the *means of egress* system shall comply with the requirements of this section. *Aisles* or *aisle accessways* shall be provided from all occupied portions of the *exit access* that contain seats, tables, furnishings, displays and similar fixtures or equipment. The minimum width or required capacity of *aisles* shall be unobstructed.

**Exception:** Encroachments complying with Section 1005.7.

❖ This section addresses aisles and aisle accessways, primarily in occupancies other than assembly seating areas. Current provisions address aisles in all uses, but only address aisle accessways for assembly spaces and mercantile.

“Aisle accessway” is defined in Chapter 2 as “that portion of exit access that leads to an aisle.” The term “Aisle” is defined in Chapter 2 as “an exit access component that defines and provides a path of egress travel.” Given the many possible configurations of fixtures and furniture, both permanent and movable, the determination of where aisle accessways stop and

aisles begin is often subject to interpretation.

Typically, the aisle accessways lead to the aisles, which in turn lead to the exits. Since the aisle serves as a path for means of egress similar to a corridor, the requirements for doors obstructing the aisle are the same (see Section 1005.7).

A cross reference back to Section 1005.7 from the exceptions for width in aisles (see Section 1018.1), corridors (see Section 1020.3), exit passageways (see Section 1024.2) and exit courts (see Section 1028.4.1) reinforces the fact that encroachment limits are generally applicable for these types of confined routes.

**1018.2 Aisles in assembly spaces.** *Aisles* and *aisle accessways* serving a room or space used for assembly purposes shall comply with Section 1029.

❖ The provisions for aisles and aisle accessways in spaces with assembly seating, such as restaurants, theaters and sports arenas, are unique. See Section 1029 for criteria.

**1018.3 Aisles in Groups B and M.** In Group B and M occupancies, the minimum clear aisle width shall be determined by Section 1005.1 for the *occupant load* served, but shall be not less than that required for corridors by Section 1020.2.

**Exception:** Nonpublic *aisles* serving less than 50 people and not required to be *accessible* by Chapter 11 need not exceed 28 inches (711 mm) in width.

❖ This requirement establishes aisle-width criteria for Group B and M occupancies based on the occupant load served by the aisle. While not providing as confined a path as corridors, the displays or equipment would limit the choice of paths, so the minimum width is the same as corridors (see Section 1020.2). The reference to Section 1005.1 would trigger a requirement for aisles wider than 44 inches (914 mm) when the anticipated occupant load that the aisle served was larger than 220 (44 inches/0.2 = 220 occupants for nonsprinklered buildings and 44 inches/0.15 = 293 occupants in sprinklered buildings). When an aisle allows for access to exits in two directions, the occupant load could be split, similar to corridors. The exception addresses aisles that may be found in an archival file room or stock storage racks.

For mercantile, if fixtures are permanent, such as in a typical grocery store or office cubicles in a business, the aisle provisions would be applicable throughout. In a situation where there were groups of displays separated by aisles, the area within the displays may be considered aisle accessways (see Section 1018.4).

**1018.4 Aisle accessways in Group M.** An *aisle accessway* shall be provided on not less than one side of each element within the *merchandise pad*. The minimum clear width for an *aisle accessway* not required to be *accessible* shall be 30 inches (762 mm). The required clear width of the *aisle accessway* shall be measured perpendicular to the elements and merchandise within the *merchandise pad*. The 30-inch

(762 mm) minimum clear width shall be maintained to provide a path to an adjacent *aisle* or *aisle accessway*. The *common path of egress travel* shall not exceed 30 feet (9144 mm) from any point in the *merchandise pad*.

**Exception:** For areas serving not more than 50 occupants, the *common path of egress travel* shall not exceed 75 feet (22 860 mm).

- ❖ The definition for “Merchandise pad” can be found in Chapter 2. The idea is that a merchandise pad contains movable displays and aisle accessways. A surrounding aisle or permanent walls or displays would define the extent of the merchandise pad. Large department stores will have numerous merchandise pads (see Commentary Figure 1018.3). In accordance with IBC Section 105.2, Item 13, movable cases, counters and partitions not over 5 feet, 9 inches (1753 mm) in height do not require a building permit to move, add or alter. Every element within a merchandise pad must adjoin a minimum 30-inch-wide (762 mm) aisle accessway on at least one side. Travel within a merchandise pad is limited, with a maximum common path of travel of 30 feet (9144 mm). The common path of travel limitation is extended to 75 feet (22 m) in those areas serving a maximum occupant load of 50.



**Figure 1018.3**  
**AISLES AND AISLE ACCESSWAYS IN MERCANTILE**

**1018.5 Aisles in other than assembly spaces and Groups B and M.** In other than rooms or spaces used for assembly purposes and Group B and M occupancies, the minimum clear *aisle* capacity shall be determined by Section 1005.1 for the occupant load served, but the width shall be not less than that required for corridors by Section 1020.2.

**Exception:** Nonpublic *aisles* serving less than 50 people and not required to be *accessible* by Chapter 11 need not exceed 28 inches (711 mm) in width.

- ❖ Aisles can occur in other occupancies when there is a confined path of travel to the exit access or exit door leading from a space.

While not providing as confined a path as corridors, the displays or equipment would limit the choice of paths, so the minimum width is the same as corridors (see Section 1020.2). The reference to Section 1005.1 would trigger a requirement for aisles wider than 44 inches (914 mm) when the anticipated occupant load that the aisle served was larger than 220 (44 inches/0.2 = 220 occupants for nonsprinklered buildings and 44 inches/0.15 = 293 occupants in sprinklered buildings). When an aisle allows for access to exits in two directions, the occupant load could be split, similar to corridors. The exception addresses aisles that may be found in an archival file room or stock storage racks.

## SECTION 1019 EXIT ACCESS STAIRWAYS AND RAMPS

**1019.1 General.** *Exit access stairways* and *ramps* serving as an *exit access* component in a *means of egress* system shall comply with the requirements of this section. The number of stories connected by *exit access stairways* and *ramps* shall include *basements*, but not *mezzanines*.

- ❖ This is a general scoping section. Exit access stairways can be between levels or between stories. Section 1019.3 addresses egress between stories. It is important to clarify that basements are considered a story, but not mezzanines. While the exit access travel distance would be measured along the open stairway or ramp for a change in level, a mezzanine, a basement or a second floor, a mezzanine is a space that is considered part of the room to which it is open and is addressed accordingly. Exit stairways are addressed under Sections 1023 and 1027. All stairways and ramps are required to comply with Sections 1011 and 1012, respectively.

**1019.2 All occupancies.** *Exit access stairways* and *ramps* that serve floor levels within a single story are not required to be enclosed.

- ❖ Exit access stairways and ramps between levels on the same story and between a story and an associated mezzanine are always permitted to be open unless they are part of a fire-resistance-rated corridor (see Section 1020.6).

**1019.3 Occupancies other than Groups I-2 and I-3.** In other than Group I-2 and I-3 occupancies, floor openings containing *exit access stairways* or *ramps* that do not comply with one of the conditions listed in this section shall be enclosed with a shaft enclosure constructed in accordance with Section 713.

1. *Exit access stairways* and *ramps* that serve or atmospherically communicate between only two stories. Such interconnected stories shall not be open to other stories.
2. In Group R-1, R-2 or R-3 occupancies, *exit access stairways* and *ramps* connecting four stories or less serving and contained within an individual *dwelling unit* or *sleeping unit* or *live/work unit*.

3. *Exit access stairways* serving and contained within a Group R-3 congregate residence or a Group R-4 facility are not required to be enclosed.
  4. *Exit access stairways* and *ramps* in buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, where the area of the vertical opening between stories does not exceed twice the horizontal projected area of the *stairway* or *ramp* and the opening is protected by a draft curtain and closely spaced sprinklers in accordance with NFPA 13. In other than Group B and M occupancies, this provision is limited to openings that do not connect more than four stories.
  5. *Exit access stairways* and *ramps* within an *atrium* complying with the provisions of Section 404.
  6. *Exit access stairways* and *ramps* in *open parking garages* that serve only the parking garage.
  7. *Exit access stairways* and *ramps* serving open-air seating complying with the *exit access* travel distance requirements of Section 1029.7.
  8. *Exit access stairways* and *ramps* serving the balcony, gallery or press box and the main assembly floor in occupancies such as theaters, *places of religious worship*, auditoriums and sports facilities.
- ❖ This section includes conditions which permit unprotected floor openings for exit access stairways and ramps. Groups I-2 and I-3 use smoke compartments as part of their defend-in-place strategies; as such, they are addressed separately in Section 1019.4.

The allowances listed are for “interior exit access stairways and ramps” that are between stories. Exit access stairways and ramps between elevation changes on the same story or serving mezzanines do not serve different stories; therefore, the enclosure requirements in this section are not applicable. The general provisions for stairways in Section 1011 and ramps in Section 1012 would be applicable. For simplicity in the commentary to Sections 1019.3 and 1019.4, when interior exit access stairways are mentioned, let it be understood that the same rules apply to interior exit access ramps.

The primary difference between “interior exit access stairways” and “interior exit stairways” is how exit access travel distance is measured (see Section 1017.3). Where a designer chooses to use an exit access stairway, the exit access travel distance includes travel along the slope of the exit access stairway, similar to stairways leading from an open mezzanine or steps at a change in level on a floor.

The base requirement is that exit access stairways between floors are protected in a similar manner as floor openings (see IBC Section 713). The enclosure is needed because a stairway penetrates the floor/ceiling assemblies between the levels, thus creating a vertical opening or shaft. In cases of fire, a vertical opening may act as a chimney, causing smoke, hot gases and light-burning products to flow upward (buoyant force). If an opening is unprotected, these

products of combustion will be forced by positive pressure differentials to spread horizontally into the building spaces. There are exceptions for shaft protection around openings in IBC Section 712.1 or exit access stairways as permitted in this section in Items 1 through 8 (see also IBC Section 712.1.12).

Exit access stairways are not required to discharge directly to the exterior as are interior exit stairways (see Section 1023.3). Instead, exit access stairways are part of the route that leads to the exit (i.e., exterior exit door, horizontal exit or enclosed interior exit stairway). See the commentary to IBC Sections 712 and 713 for a discussion of other differences in protection permitted for the enclosure of exit access stairways versus exit stairways.

While this section does not state that exit access stairways cannot be used for any purpose other than means of egress (see Section 1021.1), the provisions for no obstructions in the path of travel or reduction of the capacity for means of egress (Section 1003.6) are applicable. If one of the items eliminating enclosures for a stairway is utilized, the exit access stairway openings would still have to meet the exit and exit access door separation requirement specified in Section 1006 for the space or floor.

It is important to remember that while exit access stairways may be open for multiple floors, Section 1006.3 states “Access to exits at other levels shall be from an adjacent story.” However, single-exit buildings do allow for exit access from any story. Therefore, if there are provisions in both Sections 1006.3.3 and 1019.3, the exit access travel distance could be measured all the way down the open exit access stairway.

Item 1 allows an open exit access stairway when the opening is only between two floors. There cannot be any other unprotected openings that connect to other floors since this could create a staggered stack effect for the movement of smoke between multiple stories. In two-story buildings, this would allow for open stairways between the basement and ground level or between the first and second floors. Another example would be an open exit access stairway between the fifth and sixth floors of a building, provided there were no other unprotected openings between the fourth and fifth floor or the sixth and seventh floors. This is consistent with IBC Section 712.1.9 for openings between two stories.

In Item 2, for residential occupancies, exit access stairways within a single-family home or townhouse are not required to be enclosed because of the small occupant load and resident familiarity with the space. Examples of “within an individual dwelling or sleeping unit” would be a two-story hotel suite or a multistory apartment unit. See Section 1006.3.3, Items 3 and 7, for the allowance for these to be single-exit stories. Live/work units call for the egress to be designed for the “function served,” and vertical opening are not required to be enclosed (see IBC Sections 419.3 and 419.4); therefore, it is appropriate to allow open exit

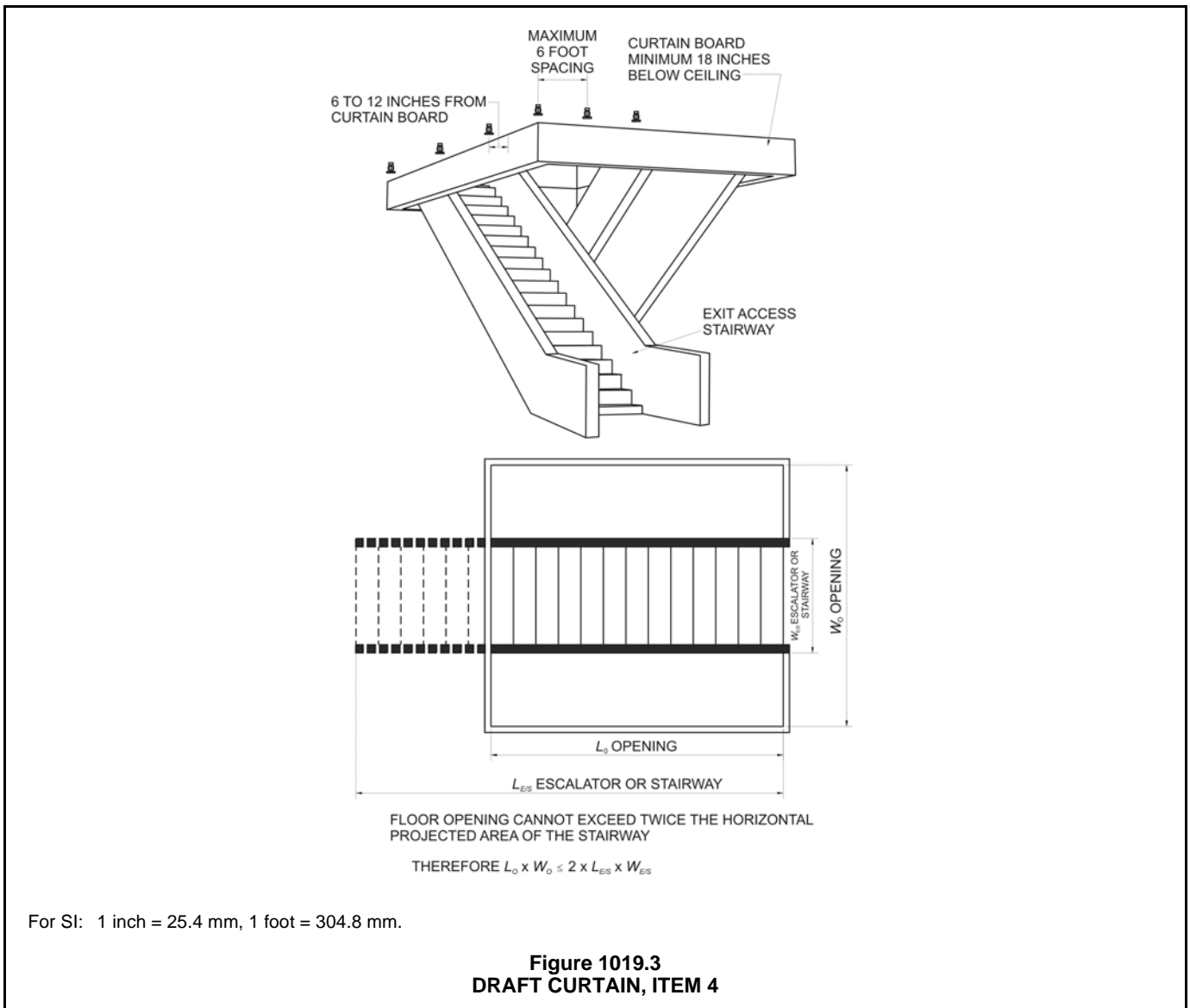
access stairways to serve the dwelling portion of the live/work unit. Note that IBC Section 712.1.2 limits any vertical opening within dwelling units, including stairways, to four stories or less.

Item 3 - A congregate residence would not be considered an individual dwelling unit so Item 2 would not be applicable; however, these small facilities operate similarly to a single-family home. Thus, they have an allowance for open exit access stairways for the same reasons as dwelling units in Item 2. See Section 1006.3.2, Item 4, which allows a single exit in Group R-3 and R-4 congregate residences. These congregate residences are limited to 16 occupants that are capable of self-preservation in IBC Sections 308.3.3, 310.5 and 310.6. If a facility offers medical care, it needs to comply with Section 1019.4.

Item 4 discusses buildings sprinklered throughout with an NFPA 13 system. The size of the opening is limited to twice the size of the stairway footprint. The opening must be protected with a draft curtain and

closely spaced sprinklers (see Commentary Figure 1019.3). This allows for such an opening to extend the entire height of the building; however, to serve as part of the means of egress, the exit access stairway must still be able to meet the exit access travel distance and provide the number of exits or access to exits from each story (see Section 1006.3). This item is similar to what is permitted for escalators (see IBC Sections 712.1.3 and 712.1.3.1). The power-operated automatic shutter permitted in IBC Section 712.1.3.2 would not be an option for exit access stairways since they must be available for exit access travel. For groups other than business and mercantile, there is the additional limitation of a maximum of four stories.

Item 5 allows for exit access stairways to travel down through an atrium. Atriums often penetrate more than two floors. Atriums must meet the provisions in IBC Section 404 for sprinklers, fire alarms, smoke control, enclosure, limitations on flame spread



and smoke development of interior finishes, and the reduction in the normal exit access travel distance. In no case can the exit access travel distance through the atrium, including travel along the stairway, be more than 200 feet (60 960 mm). If the stairway in the atrium serves as part of the required means of egress, each story must also meet the number of exits or access to exits required by Section 1006.

In Item 6, exit access stairways located in open parking structures are exempt from the enclosure requirements because of the ease of accessibility by the fire services, the natural ventilation of such structures, the low level of fire hazard, the small number of people using the structure at any one time and the excellent fire record of such structures. The exception to Section 1017.3 permits the exit access travel distance to be measured to the top step of the exit access stairway in open parking garages. In essence, open parking garages using this item can have open stairways for the full height of the building. By the travel distance being met at the top of the stairway, the means of egress requirements have been met.

In Item 7, stairways in outdoor facilities (i.e., Group A-5) in which the means of egress is essentially open to the outside need not be enclosed because of the ability to vent the fire to the outside. This item is coordinated with the requirements for open-air seating as regulated by Section 1028.7, which allows unlimited travel distance in noncombustible construction that has open-air seating and 400 feet in combustible construction.

Item 8 addresses the unique situation for large indoor assembly seating areas. Since press boxes, galleries and balconies all have the same atmosphere and fire recognition ability as the rest of the seating, the stairways serving these spaces are protected by the same system as the seating (e.g., open to the interior volume and smoke protected; open to the outside); therefore, it is logical to treat the access to these spaces the same as the seating bowl. Open exit access stairways can serve the press box where those stairways move the occupants directly from the press box into the seating bowl. See Sections 1029.5 and 1029.8 for the number of exit access stairways required.

**1019.4 Group I-2 and I-3 occupancies.** In Group I-2 and I-3 occupancies, floor openings between stories containing *exit access stairways* or *ramps* are required to be enclosed with a shaft enclosure constructed in accordance with Section 713.

**Exception:** In Group I-3 occupancies, *exit access stairways* or *ramps* constructed in accordance with Section 408 are not required to be enclosed.

❖ Groups I-2 and I-3 use smoke compartments as part of their defend-in-place strategies; as such, they are addressed separately in this section. Any openings in the floors must be protected the same as a shaft.

The exception allows for observation and security needs in detention facilities, and exit access stair-

ways within a housing unit to not be required to be enclosed (see IBC Section 408.5.1). Section 1023.2 also includes a limited exception for enclosure of exit stairways within jails per IBC Section 408.3.8.

## SECTION 1020 CORRIDORS

**1020.1 Construction.** *Corridors* shall be fire-resistance rated in accordance with Table 1020.1. The *corridor* walls required to be fire-resistance rated shall comply with Section 708 for *fire partitions*.

### Exceptions:

1. A *fire-resistance rating* is not required for *corridors* in an occupancy in Group E where each room that is used for instruction has not less than one door opening directly to the exterior and rooms for assembly purposes have not less than one-half of the required *means of egress* doors opening directly to the exterior. Exterior doors specified in this exception are required to be at ground level.
2. A *fire-resistance rating* is not required for *corridors* contained within a *dwelling unit* or *sleeping unit* in an occupancy in Groups I-1 and R.
3. A *fire-resistance rating* is not required for *corridors* in *open parking garages*.
4. A *fire-resistance rating* is not required for *corridors* in an occupancy in Group B that is a space requiring only a single *means of egress* complying with Section 1006.2.
5. *Corridors* adjacent to the *exterior walls* of buildings shall be permitted to have unprotected openings on unrated *exterior walls* where unrated walls are permitted by Table 602 and unprotected openings are permitted by Table 705.8.

❖ It is not the intent of this section to require corridors. Once corridors are provided, so that occupants are limited to a confined path of travel, then these provisions apply.

The purpose of corridor enclosures is to provide fire protection to occupants as they travel the confined path, perhaps unaware of a fire buildup in an adjacent floor area. The base protection is a fire partition having a 1-hour fire-resistance rating (see Table 1020.1). The table allows a reduction or elimination of the fire-resistance rating depending on the occupant load and the presence of an NFPA 13 or 13R automatic sprinkler system throughout the building.

IBC Section 708 addresses the continuity of fire partitions serving as corridor walls. In addition to allowing the fire partitions to terminate at the underside of a fire-resistance-rated floor/ceiling or roof/ceiling assembly, the supporting construction need not have the same fire-resistance rating in buildings of Type IIB, IIIB and VB construction as specified in IBC Section 708. If such walls were required to be sup-

ported by fire-resistance-rated construction, the use of these construction types would be severely restricted when the corridors are required to have a fire-resistance rating. IBC Section 407.3 requires that corridor walls in Group I-2 occupancies that are required to have a fire-resistance rating must be continuous to the underside of the floor or roof deck above or at a smoke-limiting ceiling membrane. Continuity is required because of the defend-in-place protection strategy utilized in such buildings. Requirements for corridor construction within Group I-3 occupancies are found in IBC Section 408.8. Dwelling unit separation in Groups I-1, R-1, R-2 and R-3 is found in IBC Sections 420.2 and 420.3. Ambulatory care facilities have special requirements in IBC Section 422.2 when some of the patients can be incapable of self-preservation. For additional requirements for an elevator lobby that is adjacent to or part of a corridor, see the commentaries to IBC Sections 713.14 and 3006.

Exception 1 indicates a fire-resistance rating is not required for corridors in Group E when any room adjacent to the corridor that is used for instruction or assembly purposes has a door directly to the outside. The need for a fire-resistance-rated corridor is eliminated because these rooms are provided with an alternative egress path because of the requirement for exterior exits. This option is typically utilized in nonsprinklered buildings, such as day care facilities, since a sprinkler system would also allow for unrated corridors in Group E (see Table 1020.1). Grade schools and high schools have security concerns that sometimes make the outdoor exit for every classroom not a preferred option.

In accordance with Exception 2, a fire-resistance rating for a corridor contained within a single dwelling unit (e.g., apartment, townhouse) or sleeping unit (e.g., hotel guestroom, assistive living suite) is not required for practical reasons. It is unreasonable to expect fire doors and the associated hardware and closing devices to be within dwellings and similar occupancies.

Given the relatively smoke-free environment of open parking structures, Exception 3 does not require rated corridors in these types of facilities.

If an office suite is small enough that only one means of egress is required from the suite, Exception 4 indicates that a rated corridor would not be required in that area. The main corridor that connected these suites to the exits would be evaluated in accordance with Table 1020.1.

Exception 5 addresses when the exterior wall of a building is also the wall of the corridor. The exterior wall is not required to be rated by the corridor provisions where there is a sufficient fire separation distance for the exterior wall to be able to have unprotected openings. This is similar to the exterior wall for an enclosed interior exit stairway. The fire is assumed to be inside the building, so that is where the protection is required.

**TABLE 1020.1**  
**CORRIDOR FIRE-RESISTANCE RATING**

OCCUPANCY	OCCUPANT LOAD SERVED BY CORRIDOR	REQUIRED FIRE-RESISTANCE RATING (hours)	
		Without sprinkler system	With sprinkler system <sup>c</sup>
H-1, H-2, H-3	All	Not Permitted	1
H-4, H-5	Greater than 30	Not Permitted	1
A, B, E, F, M, S, U	Greater than 30	1	0
R	Greater than 10	Not Permitted	0.5
I-2 <sup>a</sup> , I-4	All	Not Permitted	0
I-1, I-3	All	Not Permitted	1 <sup>b</sup>

- For requirements for occupancies in Group I-2, see Sections 407.2 and 407.3.
- For a reduction in the *fire-resistance rating* for occupancies in Group I-3, see Section 408.8.
- Buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2 where allowed.

❖ The required fire-resistance ratings of corridors serving adjacent spaces are provided in Table 1020.1. The fire-resistance rating is based on the group classification (considering characteristics such as occupant mobility, density and familiarity with the building as well as the fire hazard associated with the classification), the total occupant load served by the corridor and the presence of an automatic sprinkler system.

Where the corridor serves a limited number of people (second column in Table 1020.1), the fire-resistance rating is eliminated because of the limited size of the facility and the likelihood that the occupants would become aware of a fire buildup in sufficient time to exit the structure safely. The total occupant load that the corridor serves is used to determine the requirement for a rated corridor enclosure. The number of occupants served is the total occupants that will move into the corridor to egress. Corridors serving a total occupant load equal to or less than that indicated in the second column of Table 1020.1 are not required to be enclosed with fire-resistance-rated construction. For example, a corridor serving an occupant load of 30 or less in an unsprinklered Group B occupancy is not required to be enclosed with fire-resistance-rated construction. This example is illustrated in Commentary Figure 1020.1.

The purpose of corridor enclosures is to provide fire protection to occupants as they travel the confined path, perhaps unaware of a fire buildup in an adjacent floor area. The base protection is a fire partition having a 1-hour fire-resistance rating. The table allows a reduction or elimination of the fire-resistance rating depending on the occupant load and the presence of an NFPA 13 or 13R automatic sprinkler system throughout the building.

A common mistake is assuming a building is sprinklered throughout and utilizing the corridor rating reductions, when in fact certain requirements in NFPA 13 would not consider the building sprinklered throughout. For example, a health club installs a

sprinkler system, but chooses to eliminate the sprinklers over the swimming pool in accordance with the exception in IBC Section 507.4. Any corridors within the building that serve greater than 30 occupants must be rated because the building would not be considered sprinklered throughout in accordance with NFPA 13 requirements.

Note that because of the hazardous nature of occupancies in Groups H-1, H-2 and H-3, fire-resistance-rated corridors are required under all conditions. Regardless of the presence of a fire sprinkler system, a 1-hour-rated corridor enclosure is required in high-hazard occupancies with detonation, deflagration, accelerated burning, readily supported combustion or physical hazards. Group H-4 and H-5 occupancies that contain semiconductor fabrication materials or operations constituting a health hazard do not pose the same relative fire or explosion hazard as Group H-1, H-2 or H-3 materials. As such, in Group H-4 or H-5, where the corridor serves a total occupant load of 30 or less, a fire-resistance-rated enclosure is not required. The “not permitted” in the third column is in coordination with Section 903.2.5, which requires all Group H buildings to be fully sprinklered.

The code acknowledges that an automatic sprinkler system can serve to control or eliminate fire development that could threaten the exit access corridor. Most occupancies where sleeping rooms are not present (Groups A, B, E, F, M, S and U) are permitted to have nonfire-resistance-rated corridors if a sprinkler system is installed throughout the building in accordance with NFPA 13.

In residential facilities, the response time to a fire may be delayed because the residents may be sleeping. With this additional safety concern, the requirements for corridors are more restrictive than for nonresidential occupancies. If the corridor serves more than 10 occupants, it is required to be rated for 1 hour. If the building is sprinklered throughout with either an NFPA 13 or 13R system, then the rating of

the corridor may be reduced to 1/2 hour. Note the exception for fire-resistance-rated corridors within an individual dwelling or sleeping unit in Section 1020.1. Also note that the reduction in the rating of the corridor walls is not permitted when an NFPA 13D sprinkler system is provided.

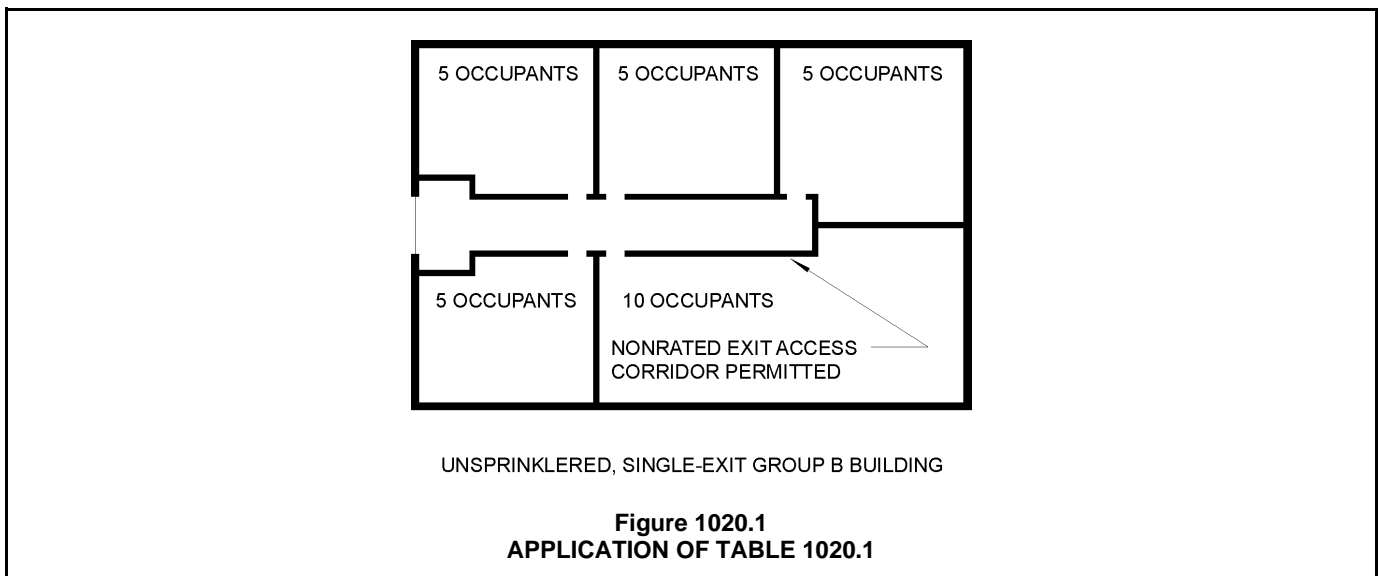
While all Group I facilities are supervised environments, the level of supervision in Group I-2 and I-4 occupancies would permit assisted evacuation by staff in an emergency; therefore, corridors are not required to be rated. Corridors in Groups I-2 are also regulated by IBC Section 407.3. Because of the lower staff/resident ratio in Group I-1 and the limitation on free egress in Group I-3, corridors must have a 1-hour fire-resistance rating (see IBC Section 408.8 for a reduction in the corridors in Group I-3). The “not permitted” in the third column is in coordination with Section 903.2.6, which requires all Group I buildings to be fully sprinklered.

**1020.2 Width and capacity.** The required capacity of *corridors* shall be determined as specified in Section 1005.1, but the minimum width shall be not less than that specified in Table 1020.2.

**Exception:** In Group I-2 occupancies, *corridors* are not required to have a clear width of 96 inches (2438 mm) in areas where there will not be stretcher or bed movement for access to care or as part of the defend-in-place strategy.

❖ The corridor widths specified in Table 1020.2 are long-established minimums originally derived from human dimensions, practical concerns, occupant loads and psychological considerations. Additional corridor capacity, when necessary for large crowds, is determined in accordance with Section 1005.

The number of occupants using a corridor for egress establishes the required capacity of a corridor, as well as for any specific portion of a multilevel corridor system. Portions of a corridor system may differ in width for a variety of reasons not related to code minimums. The designer and building official are



expected to verify that corridor widths and corridor fire-resistance ratings are in accordance with Sections 1005 and 1020, whichever is more restrictive.

The required occupant capacity of a corridor is based on the total occupant load of the rooms and spaces served by the corridor as determined by Section 1004. Where a corridor is served by two exits in opposite directions, the corridor capacity is split to determine the minimum required width of those exits (i.e., exit door, exit stairway) at each end of the corridor. The total occupant load served by a corridor is not split to establish the corridor fire-resistance rating (see Section 1020.1) or the required capacity.

The exception is because of an item in Table 1020.2 that requires a 96-inch-wide (2438 mm) corridor in Group I-2 facilities. In a hospital, while this is required in the area of patient sleeping rooms and patient care areas, there are a large number of areas that will not be for the movement of beds, either for patient care or for the hospital's defend-in-place strategies. For example, the hospital may have office or therapy areas where patients are brought in walking on their own or using wheelchairs. Many nursing homes do not move patients in beds at all. The intent of the exception is to clarify that the 96-inch (2438 mm) corridor width is not a minimum for all corridors throughout a hospital or nursing home, but only in certain areas.

**TABLE 1020.2  
MINIMUM CORRIDOR WIDTH**

OCCUPANCY	MINIMUM WIDTH (inches)
Any facilities not listed below	44
Access to and utilization of mechanical, plumbing or electrical systems or equipment	24
With an occupant load of less than 50	36
Within a <i>dwelling unit</i>	36
In Group E with a <i>corridor</i> having an occupant load of 100 or more	72
In <i>corridors</i> and areas serving stretcher traffic in occupancies where patients receive outpatient medical care that causes the patient to be incapable of self-preservation	72
Group I-2 in areas where required for bed movement	96

For SI: 1 inch = 25.4 mm.

❖ The widths of passageways, aisles and corridors are functional elements of building construction that allow the occupants to circulate freely and comfortably throughout the floor area under nonemergency conditions. Under emergency situations, the egress paths must provide the needed width to accommodate the number of occupants that must utilize the corridor for egress.

When the occupant load of the space exceeds 49, the minimum width of the passageway, aisle or corridor serving that space is required to be at least 44 inches (1118 mm) to permit two unimpeded parallel columns of users to travel in opposite directions. When the total occupant load served by a corridor is 49 or less, a minimum width of 36 inches (914 mm) is permitted and the users are expected to encounter some intermittent travel interference from fellow users, but the lower occupant load makes those occasions infrequent and tolerable. The 36-inch (914 mm) minimum width is also required within a dwelling unit.

Passageways that lead to building equipment and systems must be at least 24 inches (610 mm) in width to provide a means to access and service the equipment when needed. Because of the frequency of the servicing intervals and the limited number of occupants in these normally unoccupied areas, a reduced width is warranted. This minimum width criteria applies to many common situations, such as stage lighting and special-effects catwalks; catwalks leading to heating and cooling equipment; as well as passageways providing access to boilers, furnaces, transformers, pumps, piping and other equipment.

Except for small buildings, Group E occupancies are required to have minimum 72-inch-wide (1829 mm) corridors where the corridors serve educational areas. This width is needed not only for proper functional use, but also because of the edge effect caused by student lockers and other boundary attractions and objects. Service and other corridors outside of educational areas, such as an administrative area, would be regulated consistent with their use. Note that Section 1020.3 would not allow the wall lockers to overlap the required corridor width.

In Group I-2 occupancies, where the corridor is utilized during a fire emergency for moving patients confined to beds, it is required to be at least 96 inches (2438 mm) in clear width. This width requirement is applicable to all areas where there are patient sleeping rooms, and may also be required in some of the treatment room areas where in-house patients will be brought in on beds or rolling stretchers. This minimum width allows two rolling beds or stretchers to pass in a corridor and permits the movement of a bed/stretcher into the corridor through a room door. In Group I-2 and ambulatory care center areas, where the movement of beds is not anticipated, such as administrative and some outpatient areas of a hospital or clinic, the corridor would not be required to be 96 inches (2438 mm) wide. The minimum width would be determined by one of the appropriate applicable criteria. For outpatient medical care, where the patient may be incapable of self-preservation, such as some outpatient surgery areas or dialysis treatment areas, the 72-inch-wide (1829 mm) corridor is required. This would include Group I surgical areas, areas such as MRI suites or dialysis centers, emergency rooms or Group B ambulatory care centers.

## MEANS OF EGRESS

**1020.3 Obstruction.** The minimum width or required capacity of *corridors* shall be unobstructed.

**Exception:** Encroachments complying with Section 1005.7.

❖ It is important to maintain required corridor width so that the path of travel to an exit is continually available and unobstructed. Because corridors tend to be lined with user passage doors, there are allowances under Section 1005.7. In no case may a door block more than 50 percent of the required corridor width. In addition, when fully open, the doors must not protrude more than 7 inches (178 mm) into the required width. Where doors swing out into the corridor, options would be to move doors back into alcoves or to provide corridors wider than the required width. The alcoves would have to be deep enough to also meet the 7-inch (118 mm) maximum protrusion when doors are open, or at least 29 inches (737 mm) deep. For an example of the wider corridor: a standard door is 36 inches (914 mm) wide, and the typical minimum corridor width is 44 inches (1118 mm). By adding the door leaf and half the required corridor width ( $36+22=58$ ), a designer could provide a corridor width of 58 inches (1473 mm) and not have any issues with encroachment of doors. This is consistent with the provisions in aisles, corridors, stairways, ramps, exit passageways and exit discharge courts.

A cross reference back to Section 1005.7 from the exceptions for width in (see Section 1019.1), corridors (see Section 1020.3), aisles exit passageways (see Section 1024.2) and exit courts (see Section 1028.4.1) reinforces the fact that the protrusion limits provision is generally applicable for these types of confined routes.

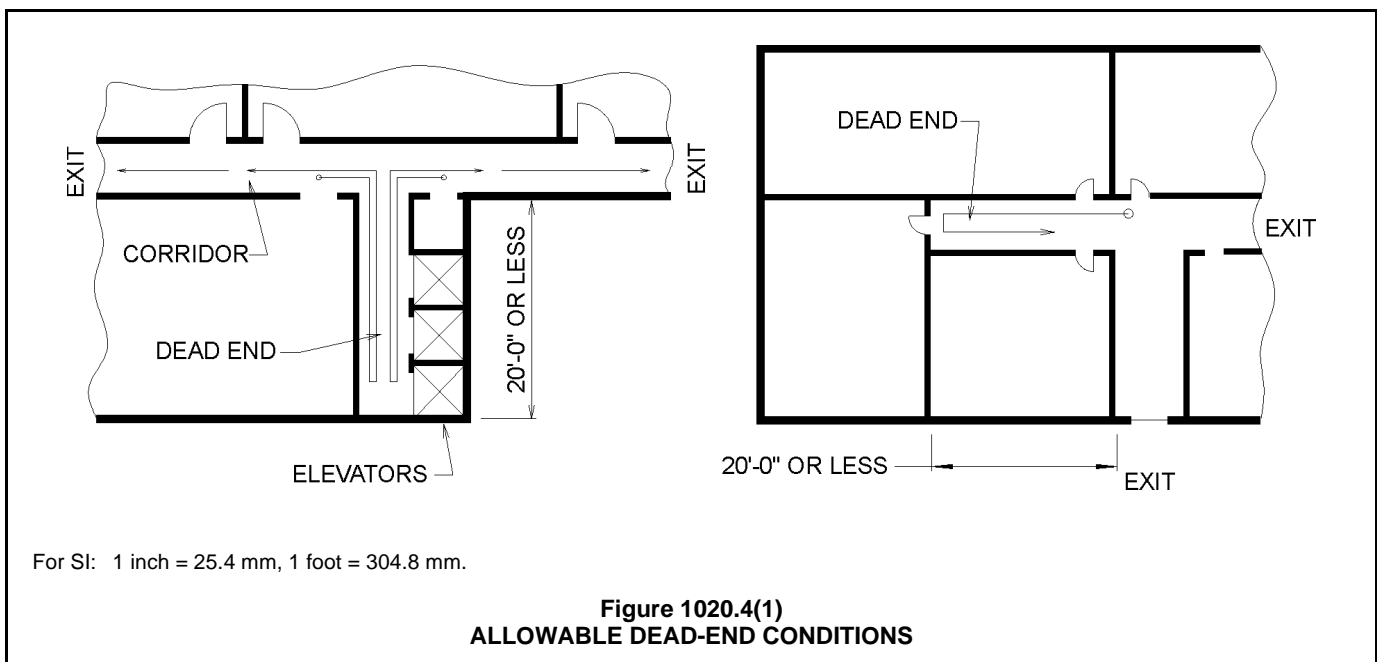
**1020.4 Dead ends.** Where more than one *exit* or *exit access doorway* is required, the *exit access* shall be arranged such

that there are no dead ends in *corridors* more than 20 feet (6096 mm) in length.

### Exceptions:

1. In occupancies in Group I-3 of Condition 2, 3 or 4, the dead end in a *corridor* shall not exceed 50 feet (15 240 mm).
  2. In occupancies in Groups B, E, F, I-1, M, R-1, R-2, R-4, S and U, where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, the length of the dead-end *corridors* shall not exceed 50 feet (15 240 mm).
  3. A dead-end *corridor* shall not be limited in length where the length of the dead-end *corridor* is less than 2.5 times the least width of the dead-end *corridor*.
- ❖ The requirements of this section apply where a space is required to have more than one means of egress according to Section 1006.2.

Dead ends in corridors and passageways can seriously increase the time needed for an occupant, especially if unfamiliar with the space, to locate the exits. More importantly, dead ends will allow a single fire event to eliminate access to all of the exits by trapping the occupants in the dead-end area. A dead end exists whenever a user of the corridor or passageway has only one direction to travel to reach any building exit [see Commentary Figure 1020.4(1)]. While a preferred building layout would be one without dead ends, a maximum dead-end length of 20 feet (6096 mm) is permitted and is to be measured from the extreme point in the dead end to the point where occupants have a choice of two directions to separate exits. Having to go back only 20 feet (6096 mm) after coming to a dead end is not such a signifi-



cant distance as to cause a serious delay in reaching an exit during an emergency situation.

A dead end results whether or not egress elements open into it. A dead end is a hazard for occupants who enter the area from adjacent spaces, travel past an exit into a dead end or enter a dead end with the mistaken assumption that an exit is directly accessible from the dead end.

Note that IBC Section 402.8.6 deals with dead-end distances in a covered mall and assumes that, with a sufficiently wide mall in relation to its length, alternative paths of travel will be available in the mall itself to reach an exit (i.e., the common mall area is not to be construed as a corridor).

Under special conditions, exceptions to the 20-foot (6096 mm) dead-end limitation apply.

Exception 1 is permitted based on the considerations of the functional needs of Group I-3 Occupancy Condition 2, 3 or 4, the requirements for smoke compartmentalization in IBC Section 408.6 and the requirement for automatic sprinkler protection of the facility in Section 903.2.6.

Exception 2 recognizes the fire protection benefits and performance history of automatic fire sprinkler systems. While the degree of hazard in Group B, E, F, M, S and U occupancies does not initially require an automatic fire suppression system, the length of a dead-end corridor or passageway is permitted to be extended to 50 feet (15 240 mm) where an automatic fire sprinkler system in accordance with NFPA 13 is provided throughout the building. This exception is also permitted in Group I-1, R-1, R-2 and R-4 occupancies, but only when they use an NFPA 13 system, not an NFPA 13R system. In addition, these provisions are consistent with those in the IEBC and IFC in the regulation of dead-end corridors in existing buildings undergoing alterations. Dead-end provisions are not applicable in single-exit spaces; therefore, dead-

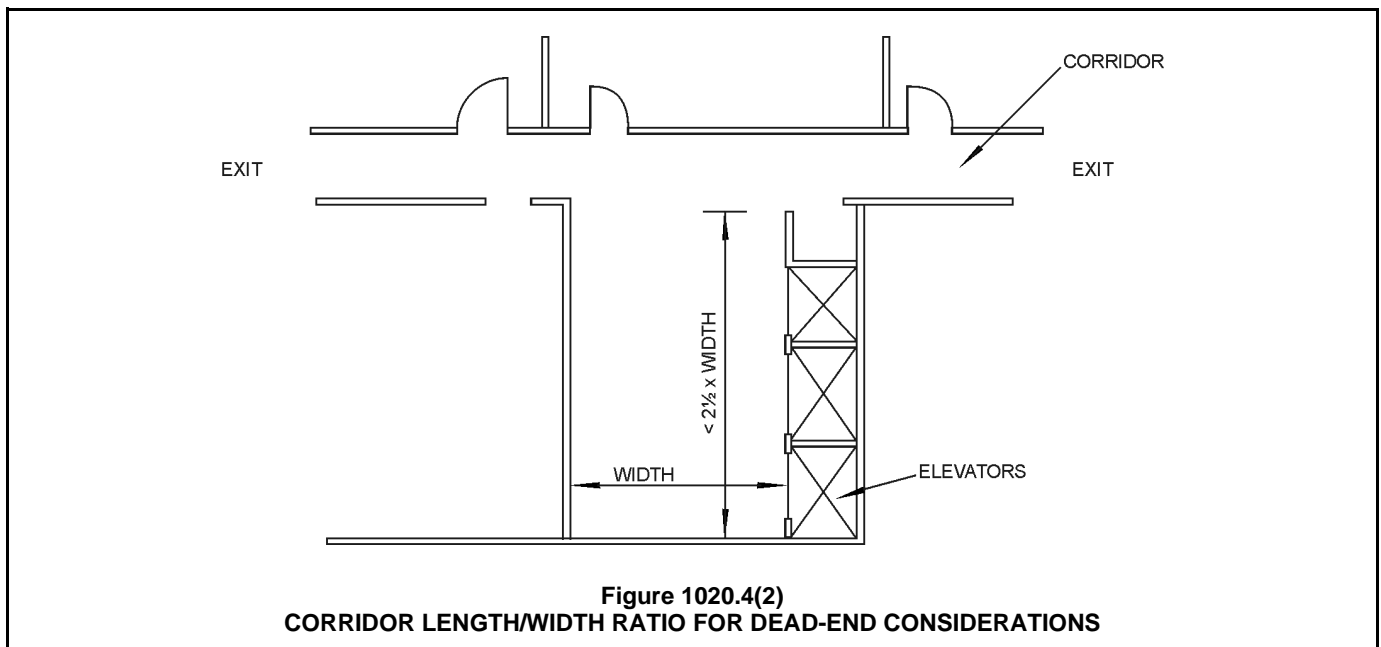
end provisions are not applicable in Group R-3 and R-4 occupancies.

Exception 3 addresses the condition presented by “cul-de-sac” elevator lobbies directly accessible from exit access corridors. In such an elevator lobby, lengths of 20 to 30 feet (6096 to 9144 mm) are common for three- or four-car elevator banks. Typically, the width of this elevator lobby is such that the possibility of confusion with a path of egress is minimized. Below the  $2\frac{1}{2}$ :1 ratio, the dead end becomes so wide that it is less likely to be perceived as a corridor leading to an exit. For example, based on the  $2\frac{1}{2}$ :1 ratio limitation, a 25-foot-long (7620 mm) dead end over 10 feet (3048 mm) in width would not be considered a dead-end corridor [see Commentary Figure 1020.4(2)]. For additional elevator lobby requirements, see the commentaries to IBC Sections 713.14 and 3006.

**1020.5 Air movement in corridors.** *Corridors* shall not serve as supply, return, exhaust, relief or ventilation air ducts.

**Exceptions:**

1. Use of a *corridor* as a source of makeup air for exhaust systems in rooms that open directly onto such *corridors*, including toilet rooms, bathrooms, dressing rooms, smoking lounges and janitor closets, shall be permitted, provided that each such *corridor* is directly supplied with outdoor air at a rate greater than the rate of makeup air taken from the *corridor*.
2. Where located within a *dwelling unit*, the use of *corridors* for conveying return air shall not be prohibited.
3. Where located within tenant spaces of 1,000 square feet (93 m<sup>2</sup>) or less in area, utilization of *corridors* for conveying return air is permitted.



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4. Incidental air movement from pressurized rooms within health care facilities, provided that the *corridor* is not the primary source of supply or return to the room.
- ❖ Two of the most critical elements of the means of egress are the required exit stairways and corridors. Exit stairways serve as protected areas in the building that provide occupants with safe passage to the level of exit discharge. Since required exits and corridors are critical elements in the means of egress, the potential spread of smoke and fire into these spaces must be minimized. The scope of this section is corridors. For requirements for the exits, see Section 1023.

The use of these corridors as part of the air distribution system could render those egress elements unusable. The intent is to have positive pressure in the corridors. Therefore, any air movement condition that could introduce smoke into these vital egress elements is prohibited. It is not the intent of this section to prohibit the air movement necessary for ventilation and space conditioning of corridors, but rather to prevent those spaces from serving as conduits for the distribution of air to, or the collection of air from, adjacent spaces. This restriction also extends to door transoms and door grilles that would allow the spread of smoke into a corridor. This limitation is not, however, intended to restrict slight pressure differences across corridor doors, such as a negative pressure differential maintained in kitchens to prevent odor migration into dining rooms. Note that air distribution via ducted systems located in or above corridors is acceptable since the corridor itself would not be functioning as a duct.

The four exceptions to this section identify conditions where a corridor can be utilized as part of the air distribution system. The exceptions apply only to exit access corridors, not to exit passageways.

Exception 1 addresses the common practice of using air from the corridor as makeup air for small exhaust fans in adjacent rooms. Where the corridor is supplied directly with outdoor air at a rate equal to or greater than the makeup air rate, negative pressure will not be created in the corridor with respect to the adjoining rooms and smoke would generally not be drawn into the corridor.

Regarding Exception 2, it is common practice to locate return air openings in the corridors of dwelling units and draw return air from adjoining spaces through the corridor. Such use of dwelling unit corridors for conveying return air is not considered to be a significant hazard and is permitted. Individual dwelling units are permitted to have unprotected openings between floors. Corridors within dwelling units that serve small occupant loads are short in length and are not required to be fire-resistance rated. For these reasons, the use of the corridor or the space above a corridor ceiling for conveying return air does not constitute an unacceptable hazard.

Exception 3 permits corridors located in small ten-

ant spaces to be used for conveying return air based on the relatively low occupant load and the relatively short length of the corridor. These conditions do not pose a significant hazard. In the event of an emergency, the occupants of the space would tend to simply retrace their steps to the entrance.

Health care facilities require direct pressurization control of certain rooms to provide a clean and sterile environment for patients. For example, operating rooms and pharmacies are required to have positive air pressure in the room, resulting in a general air movement out of the room. This ensures that airborne contaminants do not infect a sterile procedure or supplies. Pressurization is achieved by supplying air at a greater or lesser rate than the return air. Exception 4 recognizes the need of infection control and clarifies that the corridor should not be the primary source of supply return. There should be supply and return air in the room.

**1020.5.1 Corridor ceiling.** Use of the space between the *corridor* ceiling and the floor or roof structure above as a return air plenum is permitted for one or more of the following conditions:

1. The *corridor* is not required to be of *fire-resistance-rated* construction.
  2. The *corridor* is separated from the plenum by *fire-resistance-rated* construction.
  3. The air-handling system serving the *corridor* is shut down upon activation of the air-handling unit *smoke detectors* required by the *International Mechanical Code*.
  4. The air-handling system serving the *corridor* is shut down upon detection of sprinkler water flow where the building is equipped throughout with an *automatic sprinkler system*.
  5. The space between the *corridor* ceiling and the floor or roof structure above the *corridor* is used as a component of an approved engineered smoke control system.
- ❖ This section identifies five different conditions where the space above the corridor ceiling is permitted to serve as a return air plenum. Since a return air plenum operates at a negative pressure with respect to the corridor, any smoke and gases within the plenum should be contained within that space. Conversely, a supply plenum operates at a positive pressure with respect to the corridor, thus increasing the likelihood that smoke and gases will infiltrate the corridor enclosure. Where any one of the five conditions is present, the use of the corridor ceiling space as a return air plenum is permitted. This is consistent with IMC Section 601.2.1.

Where the corridor is permitted to be constructed without a fire-resistance rating (see Section 1020.1), Item 1 permits the space above the ceiling to be utilized as a return air plenum without requiring it to be separated from the corridor with fire-resistance-rated construction.

Item 2 is only applicable to corridors that are required to be enclosed with fire-resistance-rated construction. Compliance with this item requires the plenum to be separated from the corridor by fire-resistance-rated construction equivalent to the rating of the corridor enclosure itself. Therefore, the ceiling membrane itself must provide the fire-resistance rating required of the corridor enclosure. IBC Section 708.4, Exception 3, is an example of this method of construction.

Items 3 and 4 recognize that the hazard associated with smoke spread through a plenum is minimized if the air movement is stopped.

It is not uncommon for an above-ceiling plenum to be utilized as part of the smoke removal system. This practice is permitted by Item 5. Because of the way these systems are designed, the higher equipment ratings and the power supply provisions, this is considered acceptable.

**1020.6 Corridor continuity.** *Fire-resistance-rated corridors* shall be continuous from the point of entry to an *exit*, and shall not be interrupted by intervening rooms. Where the path of egress travel within a *fire-resistance-rated corridor* to the exit includes travel along unenclosed *exit access stairways* or *ramps*, the *fire-resistance rating* shall be continuous for the length of the *stairway* or *ramp* and for the length of the connecting *corridor* on the adjacent floor leading to the *exit*.

**Exceptions:**

1. Foyers, lobbies or reception rooms constructed as required for *corridors* shall not be construed as intervening rooms.
2. Enclosed elevator lobbies as permitted by Item 1 of Section 1016.2 shall not be construed as intervening rooms.

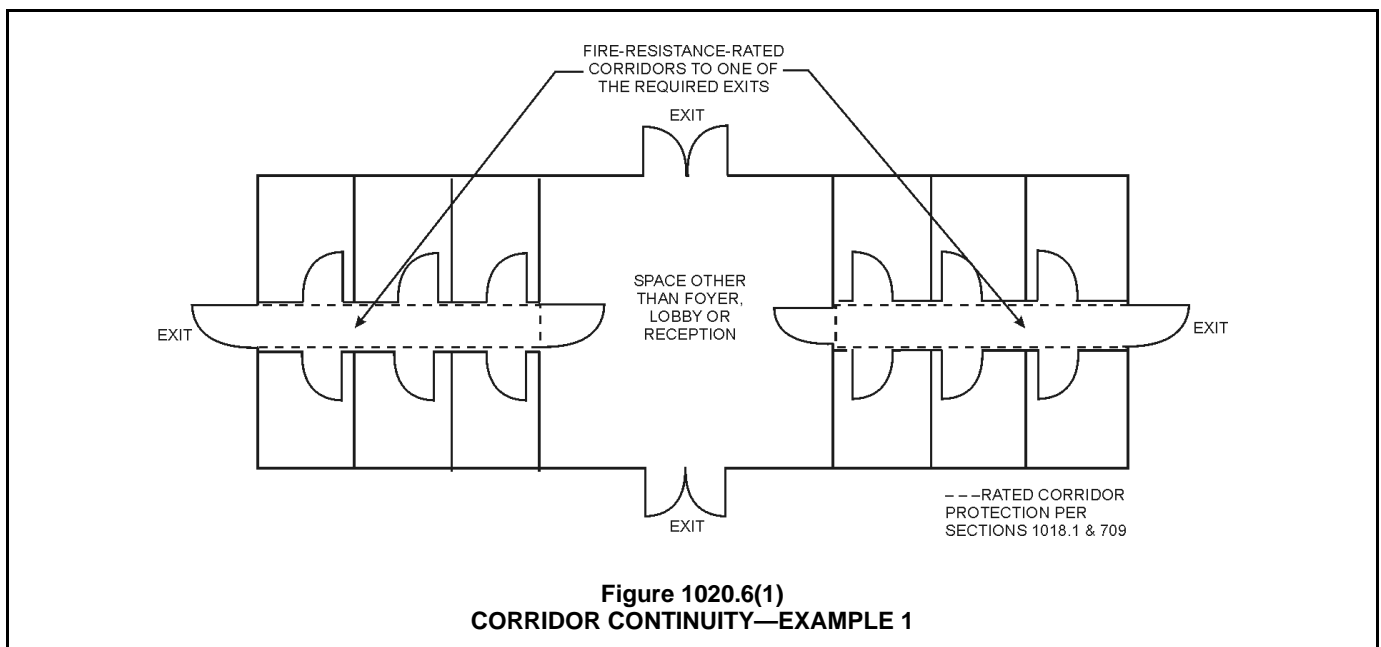
❖ This section requires that where fire protection is offered by a corridor, it is to be continuous from the

point of entry into the corridor to an exit. This is to protect occupants from the accumulation of smoke or fire exposure and to allow for sufficient time to evacuate the building. Where a corridor is served by two or more exits, only one of the exits is required to be accessed directly from the corridor. Other exits may be accessed through intervening spaces in accordance with Section 1016.2, provided that there is an opening protective at the end of the corridor to separate the rated corridor from the intervening rooms. Thus, occupants will always have their protected path to an exit, and at the same time a reasonable degree of design freedom is allowed [see Commentary Figures 1020.6(1) and 1020.6(3)].

When a level is permitted to have unenclosed exit access stairways in accordance with Section 1019.3, the corridor protection is required to continue down the exit access stairway to an enclosure for an interior exit stairway or to an exit door leading to the outside. Since the exit access stairway effectively becomes part of the corridor, doors would not be required at the top and bottom of the open exit access stairway as they are when entering enclosures for exit stairways.

Exception 1 allows a foyer, lobby or reception room to be located on the path of egress from a corridor or as part of the fire-resistance-rated corridor, provided the room has the same fire-resistance-rated walls and doors as required for the corridor. The use of this provision should be viewed as limiting the types of uses that may occur within the protected corridor. Occupied spaces within the corridor should have very limited uses and hazards. Foyers and lobbies are included in this exception based on the low fire hazard of the contents in such rooms [see Commentary Figure 1020.6(2)].

Another consideration is corridor continuity at an elevator opening. When an elevator opens into a cor-

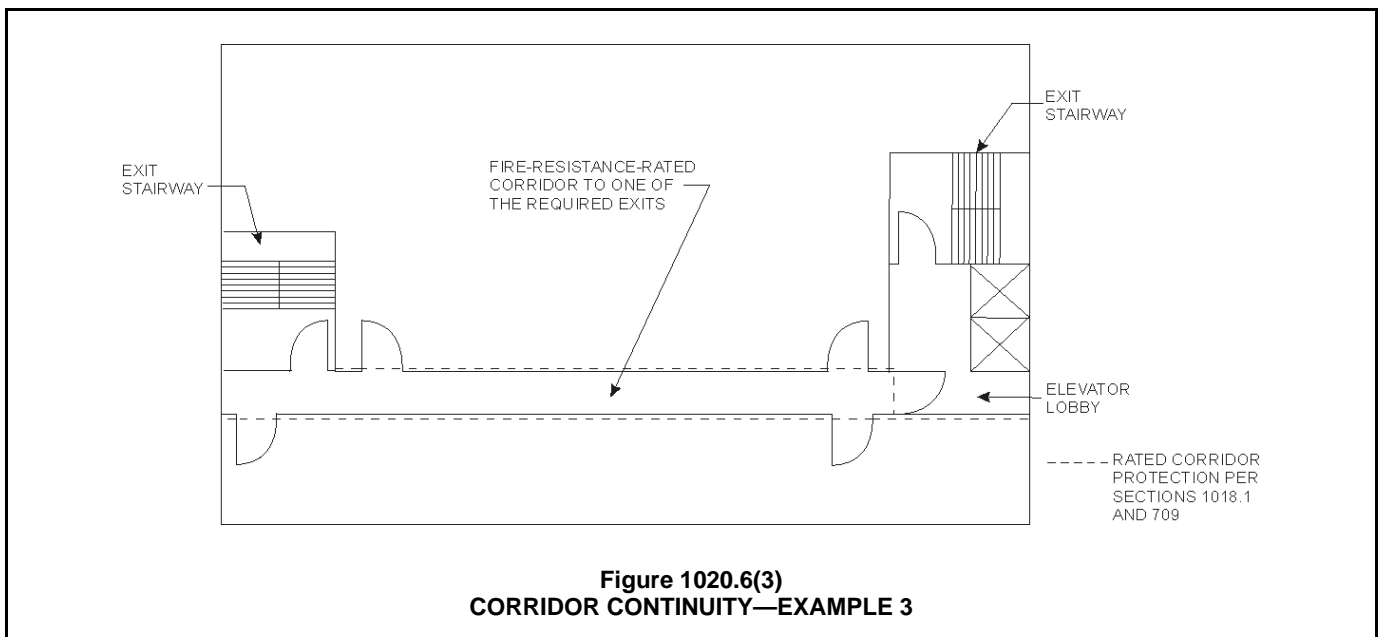
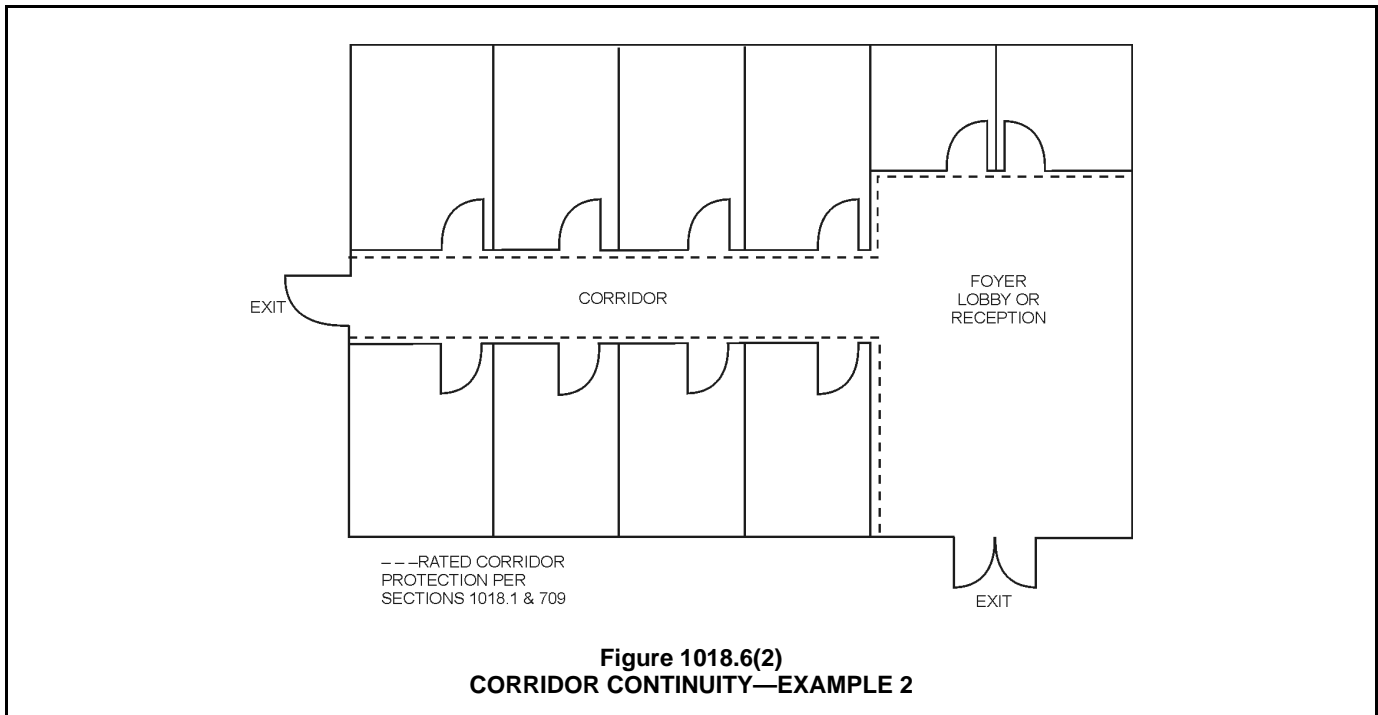


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ridor that is required to be of fire-resistance-rated construction, the opening between the elevator shaft and the corridor must be protected to meet not only the shaft's fire protection rating but also the additional smoke and draft protection requirements necessary to limit the spread of smoke into the corridor. This additional smoke and draft control requirement is found in IBC Section 716.5.3.1. Because elevator hoistway doors do not typically comply as smoke- and draft-control assemblies, they would not be able to open directly into a corridor that is required to have protected openings. The provisions in IBC Sections 713.14 and 3006 waiving the requirements for an ele-

vator lobby do not waive the corridor opening protection requirements. Therefore, to maintain the integrity of the corridor, the elevator hoistway shaft doors opening into such rated corridors will need to be separated from the corridor by one of the following methods of protection:

1. A lobby needs to be provided with the appropriate walls and doors [see Commentary Figure 1020.6(4) and IBC Section 3006.3, Items 1 and 2] to separate the lobby from the corridor.
2. Additional doors must be provided at the hoistway [see Commentary Figure 1020.6(5) and

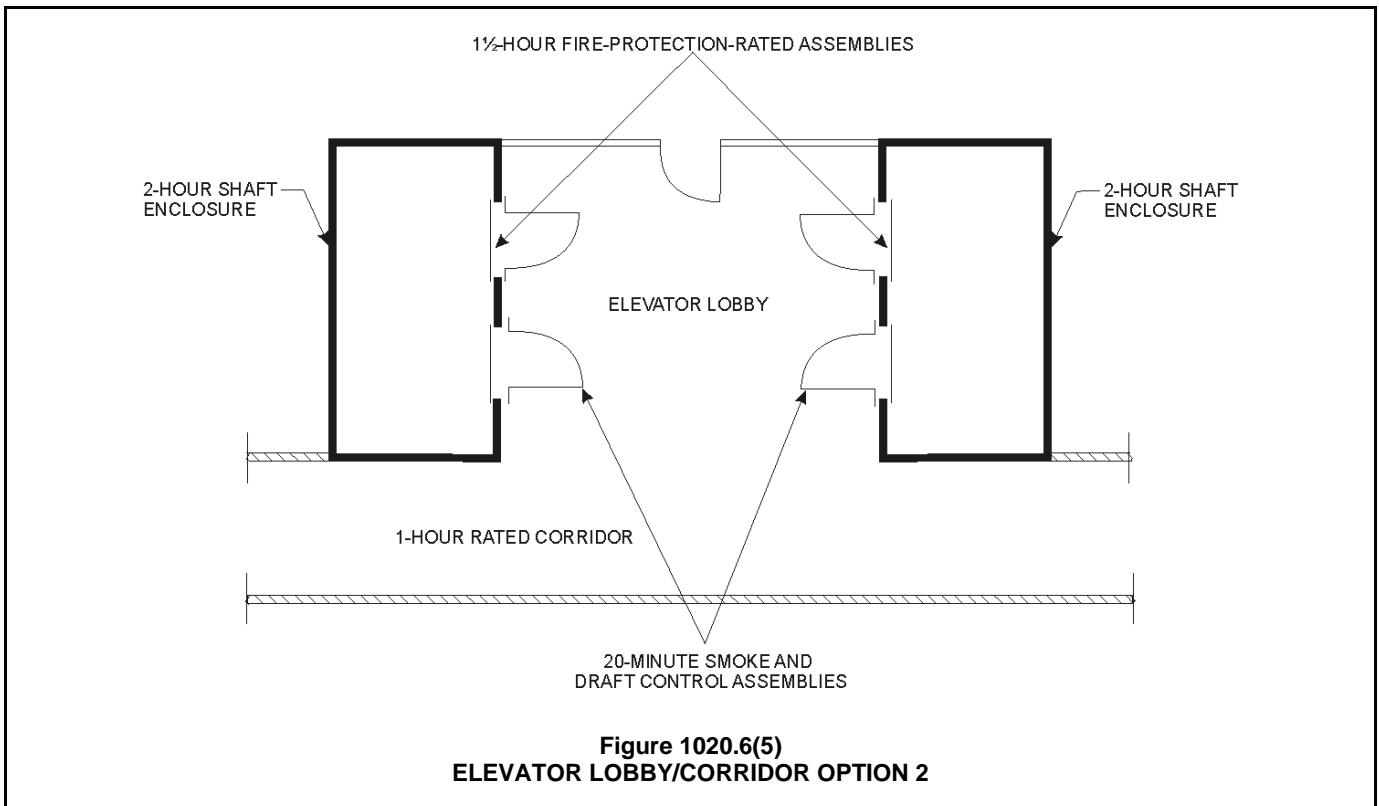
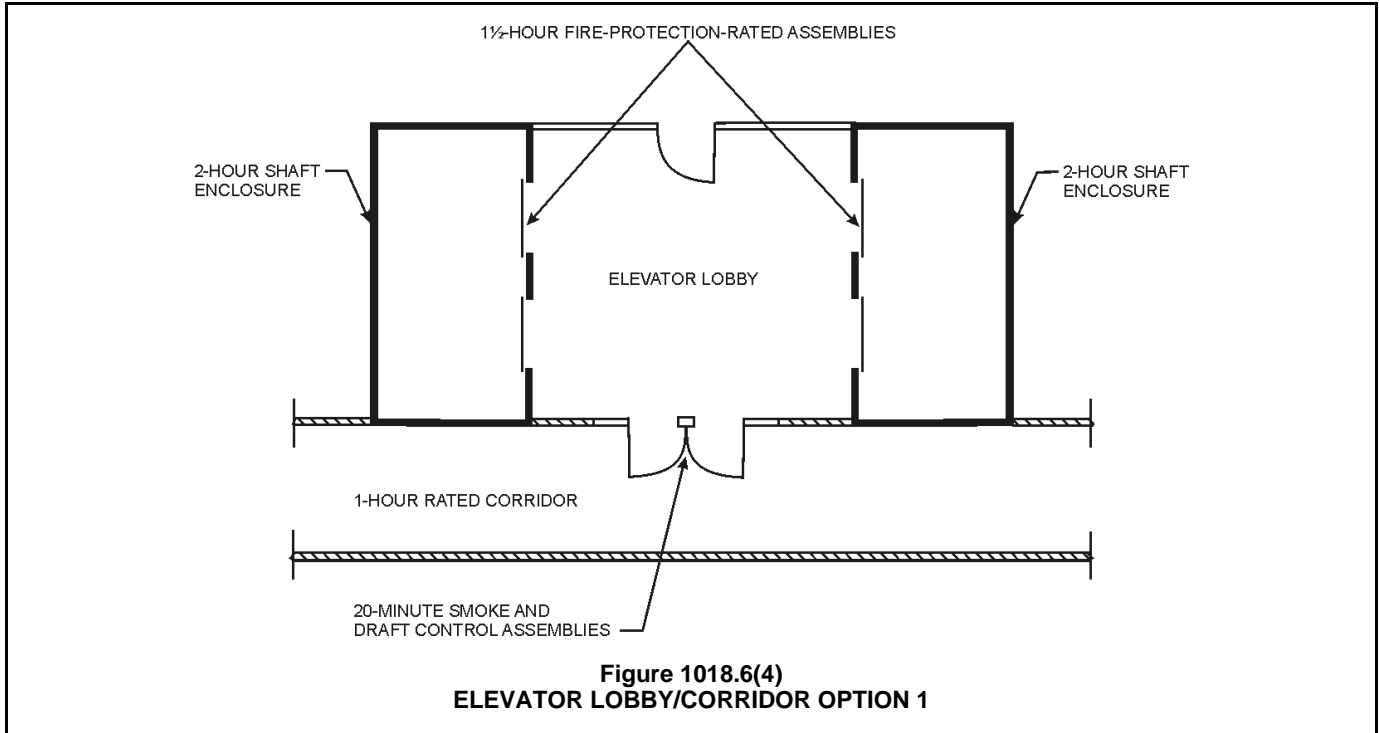


IBC Section 3006.3, Item 3] that will protect the shaft openings the same as required for the corridor doors.

3. An elevator shaft door meeting both the smoke and draft protection requirements for corridor doors in IBC Section 716.5.3.1 and the appropriate fire protection rating of IBC Table 716.5 for the shaft must be provided.

appropriate fire protection rating of IBC Table 716.5 for the shaft must be provided.

4. The corridor must be separated from the lobby [see Commentary Figure 1020.6(6) and IBC Section 3006.3, Items 1 and 2]. Per Exception 2 of Section 1020.6, Option 4 is permitted for cor-



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ridor continuity since the elevator lobby is also not considered an intervening room. Section 1016.2, Item 1, states that at least one end of a fire-resistance-rated corridor leads directly to an exit without going through the lobby. Alternatively, the second means of egress serving the corridor can be an elevator lobby with direct access to an exit [see Commentary Figure 1020.6(3)].

5. The elevator hoistway can be pressurized so that smoke will not move up the shaft (see Section 3006.3, Item 4).

While many elevator hoistway shaft doors are tested and labeled for the 1-hour or 1½-hour fire-resistance rating (see Section 716.5), very few, if any of the doors typically sold in the U.S. will also meet the smoke and draft requirements (see Section 716.5.3.1) that would allow them to open directly into a fire-resistance-rated corridor. Because of this, Items 1, 2 and 4 above will be the general methods for protecting such openings.

For additional explanation of the requirements for elevator lobbies that are adjacent to rated corridors, see Section 3006. For requirements for exit enclosures, see Section 1023.

### SECTION 1021 EGRESS BALCONIES

**1021.1 General.** Balconies used for egress purposes shall conform to the same requirements as *corridors* for minimum

width, required capacity, headroom, dead ends and projections.

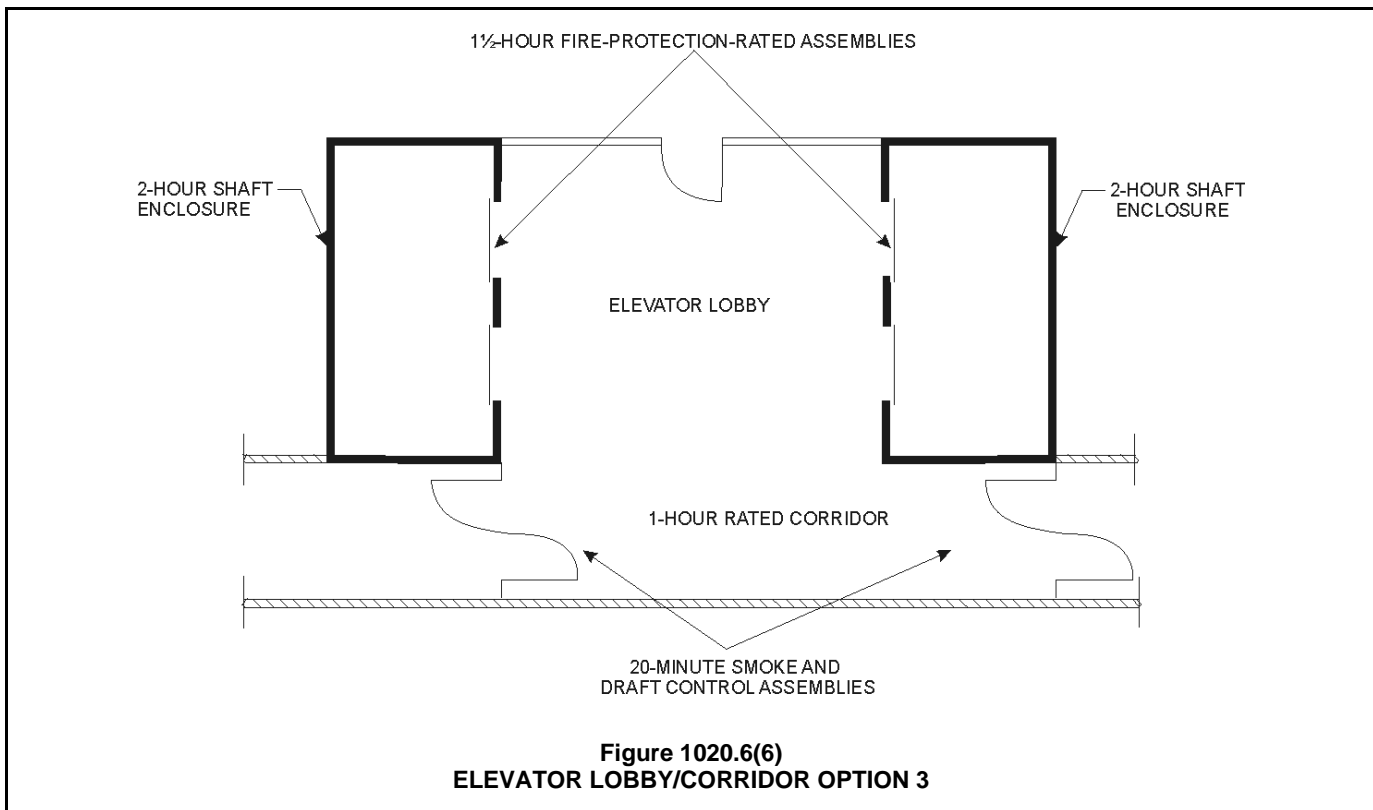
- ❖ This section regulates balconies that are used as an exit access element. Requirements are the same as exit access corridors, except for the enclosure.

Where exterior egress balconies are used in moderate or severe climates, there may also be a concern to protect the egress balcony from accumulations of snow and ice to provide a safe path of egress travel at all times, including winter. Maintenance of the means of egress in the IFC requires an unobstructed path to allow for full instant use in case of a fire or emergency. Typical methods for protecting these egress elements include roof overhangs or canopies, a heated slab and, when approved by the building official, a reliable snow removal maintenance program.

**1021.2 Wall separation.** Exterior egress balconies shall be separated from the interior of the building by walls and opening protectives as required for *corridors*.

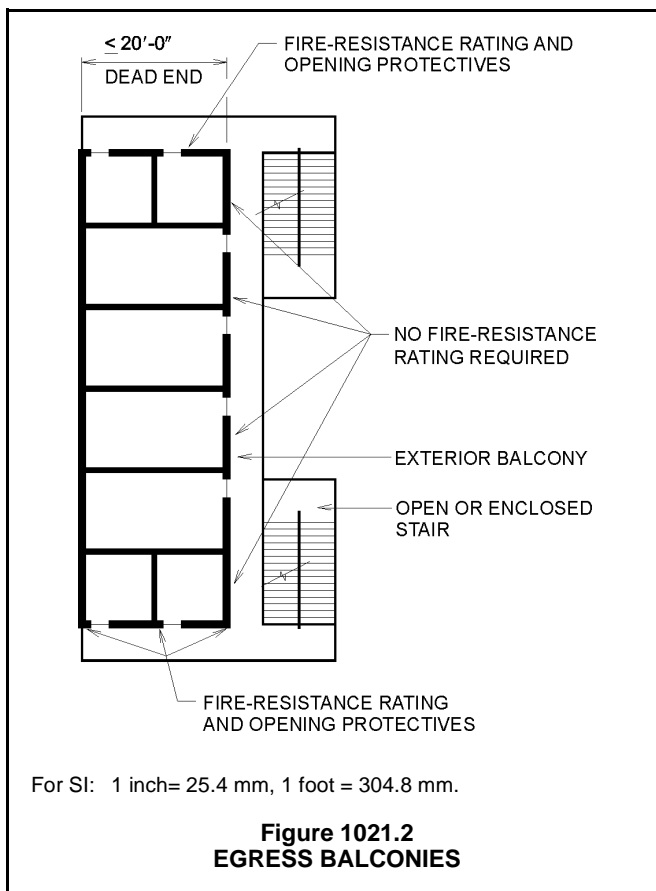
**Exception:** Separation is not required where the exterior egress balcony is served by not less than two *stairways* and a dead-end travel condition does not require travel past an unprotected opening to reach a *stairway*.

- ❖ An exterior exit access balcony has a valuable attribute in that the products of combustion may be freely vented to the open air. In the event of a fire in an adjacent space, the products of combustion would not be expected to build up in the balcony area as would commonly occur in an interior corridor. How-



ever, there is still a concern for the egress of occupants who must use the balcony for exit access, and, consequently, may have to pass the room or space where the fire is located. Therefore, an exterior exit access balcony is required to be separated from interior spaces by fire partitions, as is required for interior corridors. The other provisions of Section 1020 relative to dead ends and opening protectives also apply.

If there are no dead-end conditions that require travel past an unprotected opening and the balcony is provided with at least two stairways, then the wall separating the balcony from the interior spaces need not have a fire-resistance rating (see Commentary Figure 1021.2). Such an arrangement reduces the probability that occupants will need to pass the area with the fire to gain access to an exit.



**1021.3 Openness.** The long side of an egress balcony shall be at least 50 percent open, and the open area above the *guards* shall be so distributed as to minimize the accumulation of smoke or toxic gases.

❖ This section provides an opening requirement that is intended to preclude the rapid buildup of smoke and toxic gases. A minimum of one side of the exterior balcony is required to have a minimum open exterior area of 50 percent of the side area of the balcony. The side openings are to be uniformly distributed along the length of the balcony.

**1021.4 Location.** Exterior egress balconies shall have a minimum *fire separation distance* of 10 feet (3048 mm) measured at right angles from the exterior edge of the egress balcony to the following:

1. Adjacent *lot lines*.
2. Other portions of the building.
3. Other buildings on the same lot unless the adjacent building *exterior walls* and openings are protected in accordance with Section 705 based on *fire separation distance*.

For the purposes of this section, other portions of the building shall be treated as separate buildings.

❖ The location requirements for exterior egress balconies given by this section protect the users of the egress balcony from the effects of a fire in another building on the same lot or an adjacent lot. The separation distance reduces the exposure to heat and smoke. If the egress balcony is closer than specified, then the adjacent buildings' exterior walls and openings are to be protected in accordance with IBC Section 705 so that the users of the egress balcony are protected. The reason for the required distance to a lot line is to provide for a future building that could be built on the adjacent lot. While buildings on the same lot can be considered one building for height and area limitations (see IBC Section 503.1.2), they must be separated by a minimum of 10 feet (3048 mm) if there is a path for exit discharge between them. The purpose of the last sentence is to clarify that an egress balcony needs a minimum 10-foot separation where a building wraps around on itself, such as a U-shaped building. It is not intended that the distance be measured to the imaginary lot line between buildings on the same lot.

Requirements are the same for exterior exit stairways and ramps. For an illustration of how exterior egress balconies and exterior exit stairways work together, see Commentary Figure 1027.5.

## SECTION 1022 EXITS

**1022.1 General.** *Exits* shall comply with Sections 1022 through 1027 and the applicable requirements of Sections 1003 through 1015. An *exit* shall not be used for any purpose that interferes with its function as a *means of egress*. Once a given level of *exit* protection is achieved, such level of protection shall not be reduced until arrival at the *exit discharge*. *Exits* shall be continuous from the point of entry into the *exit* to the *exit discharge*.

❖ This group of sections is applicable to the “exit” portion of the three-part means of egress system. Sections 1003 through 1015 are also applicable to exits. The following sections are covered in this group:

- Section 1022 provides general requirements for exterior exit doorways.

- Section 1023 provides criteria for interior exit stairways and ramps.
- Section 1024 covers horizontal portions of the exit and exit passageways.
- Section 1025 is referenced by the high-rise provisions in IBC Section 403. This section addresses a backup system for means of egress lighting (see Section 1008). “Glow-in-the-dark” stripes identify steps, handrails, obstructions and doorways within the enclosure for interior exit stairways.
- Section 1026 discusses the option of horizontal exits. This type of system is most commonly used for buildings such as hospitals and jails where building evacuation is not always the best option.
- Section 1027 provides criteria for stairways or ramps that are primarily open to the exterior, thus reducing the chance of accumulation of smoke or fumes.

The use of required exterior exit doors, exit stairways, exit passageways and horizontal exits for any purpose other than exiting is prohibited, because it might interfere with use as an exit. This is *not* intended to prohibit a door or stairway being used as part of normal circulation patterns, such as the exit doors also serving as entrances, or using the stairway to move between floors when there is not an emergency. However, these spaces must not include furniture, storage or work space. For example, the use of an exit stairway landing for storage, vending machines, copy machines, displays or any purpose other than for exiting is not permitted. Such a situation could not only lead to obstruction of the path of exit travel, thereby creating a hazard to life safety, but if the contents consist of combustible materials, then the use of the stairway as a means of egress could be jeopardized by fire or smoke in the exit enclosure.

It is recognized that standpipe risers are provided within the stair enclosure and that vertical electrical conduit may be necessary for power or lighting. However, such risers must be located so as not to interfere with the required clear width of the exit. For example, a standpipe riser located in the corner of a stairway will not reduce the required clear radius of the landing. This also applies when the stairway landing is used as an area of refuge. The spaces for wheelchairs must not obstruct the general path of egress travel [see Commentary Figures 1009.3(1) and 1009.3(2)]. Electrical conduit and mechanical equipment are permitted when necessary to serve the exit enclosure.

In existing buildings, sometimes the only viable option for providing access into the space is a platform lift. These platform lifts can be located within the enclosure for the exit (see IEBC Section 410.8.3 and IBC Section 705.1.3). Regulations in ASME A18.1 would limit the potential for any concerns for platform lifts because a fuel load in an exit stairway. However, the plat-

form lift must be located so that it is not an obstruction to the exit pathway. Typically, this is reviewed when the platform lift is in the off and folded position.

Sections 1022 through 1027 apply to all exits but do not apply to elements of the means of egress that are not actually exits, such as exit access stairways, ramps, corridors and passageways or elements of the exit discharge. Once an exit is entered, that same level of protection must be available until the occupants leave the building at the level of exit discharge. For exit discharge options for the enclosure, other than a door leading directly to the outside, see the requirements for exit passageways in Section 1024 or the options permitting usage of a lobby or vestibule in the exceptions to Section 1028.1.

**1022.2 Exterior exit doors.** Buildings or structures used for human occupancy shall have not less than one exterior door that meets the requirements of Section 1010.1.1.

❖ The purpose of this section is to specify that at least one exterior exit door is required to meet the door size requirements in Section 1010.1.1. It is not the intent of this section to specify the number of exit doors required, which is addressed in Section 1006.

**1022.2.1 Detailed requirements.** Exterior *exit* doors shall comply with the applicable requirements of Section 1010.1.

❖ The purpose of this section is simply to provide a cross reference from the exit section to all of the detailed requirements for doors that are included in Section 1010.1 and all of its subsections. For example, the requirements for door operation on exterior exit doors are controlled by Section 1010.1.9.

**1022.2.2 Arrangement.** Exterior *exit* doors shall lead directly to the *exit discharge* or the *public way*.

❖ The exterior exit door is to be the entry point of the exit discharge or lead directly to the public way. When a person reaches the exterior exit door, he or she is directly outside, where smoke and toxic gases are not a health hazard. Additionally, this section will keep exterior doors at other locations, such as to an egress balcony, from being viewed as an exit element.

## SECTION 1023 INTERIOR EXIT STAIRWAYS AND RAMPS

**1023.1 General.** *Interior exit stairways* and *ramps* serving as an *exit* component in a *means of egress* system shall comply with the requirements of this section. *Interior exit stairways* and *ramps* shall be enclosed and lead directly to the exterior of the building or shall be extended to the exterior of the building with an *exit passageway* conforming to the requirements of Section 1024, except as permitted in Section 1028.1. An *interior exit stairway* or *ramp* shall not be used for any purpose other than as a *means of egress* and a circulation path.

❖ The first sentence is a general reference to the rest of the section. Sections 1023.2 through 1023.7 deal

with the construction of the walls and ceiling that enclose the exit stairway or exit ramp. Sections 1023.8 and 1023.9 deal with information required in the enclosure for safe exiting. Section 1023.10 provides criteria for stairways in high-rise or underground buildings where a smokeproof enclosure and pressurization of the stair tower are required (see IBC Sections 403.5.4 and 405.7.2).

Most exit stairways or ramps have an exterior door at the level of exit discharge that leads directly to the outside. From this doorway, there must be a path for exit discharge that leads to the public way; however, there are other options. Exit passageways are considered an extension of the exit enclosure. The stairway enclosure discharges into the exit passageway, which in turn leads to the outside of the building. There are limited allowances for the exit enclosure to discharge through a lobby or vestibule (see Section 1028.1, Exceptions 1 and 2). A stairway enclosure could also discharge through a horizontal exit (see Section 1028.1, Exception 3). The termination requirements are the same as stated in Section 1023.3.

It is important that an exit stairway or ramp not be used for any purpose other than as a means of egress. For example, there is a tendency to use stairway landings for storage purposes. Such a situation obstructs the path of exit travel and if the stored contents consist of combustible materials, the use of the exit stairway as part of the path for a means of egress may be jeopardized, creating a hazard to life safety. It is not the intent of these provisions to prohibit an exit stairway from being used as part of the normal building circulation system. If the tenants or building owner have security concerns that would prompt them to wish to limit stairway access, consult Section 1010.1.9.11.

It is not the intent of this provision to exclude inclined platform lifts in the enclosure for the stairway; however, it is important that when not in operation they do not block access to the exit stairway or handrails. The referenced technical standard, ASME A18.1, basically requires noncombustible elements, so there is not a fire load issue associated with the lifts. Platform lifts are an important option for providing accessibility in a building. IBC Section 1109.7 limits the use of platform lifts in new construction to mainly areas with minimal occupant loads or where elevators and ramps are impracticable. Platform lifts can be part of an accessible means of egress in limited situations (Section 1007.5). IEBC Section 410.8.3 and IBC Section 705.1.3 allow for platform lifts anywhere in existing buildings in order to gain accessibility for persons with mobility impairments. The industry is currently working on different options to address the concern that the lift may be in operation during an event that requires evacuation.

**1023.2 Construction.** Enclosures for *interior exit stairways* and *ramps* shall be constructed as *fire barriers* in accordance with Section 707 or *horizontal assemblies* constructed in

accordance with Section 711, or both. *Interior exit stairway* and *ramp* enclosures shall have a *fire-resistance rating* of not less than 2 hours where connecting four stories or more and not less than 1 hour where connecting less than four stories. The number of stories connected by the *interior exit stairways* or *ramps* shall include any *basements*, but not any *mezzanines*. *Interior exit stairways* and *ramps* shall have a *fire-resistance rating* not less than the floor assembly penetrated, but need not exceed 2 hours.

**Exceptions:**

1. *Interior exit stairways* and *ramps* in Group I-3 occupancies in accordance with the provisions of Section 408.3.8.
  2. *Interior exit stairways* within an *atrium* enclosed in accordance with Section 404.6.
- ❖ This section requires that all interior exit stairways or ramps are to be enclosed with rated walls (i.e., fire barriers) and floor/ceiling assemblies (i.e., horizontal assemblies). The fire-resistance rating required depends on the number of connected stories and the required fire-resistance rating of the penetrated floors. The minimum fire-resistance rating of an enclosure for an exit stairway or ramp is at least 1 hour. The fire-resistance rating of the enclosure must be increased to 2 hours if the stairway or ramp connects four or more stories or if it penetrates a floor system with a fire-resistance rating of 2 hours or more (see Table 602 for Type I construction). Note that the criteria are based on the number of stories connected by the stairway or ramp and not the height of the building. Therefore, a building that has three stories located entirely above the grade plane and a basement would require an enclosure with a 2-hour fire-resistance rating if the stairway or ramp connects all four stories. Where the floor construction penetrated by the enclosure has a fire-resistance rating, the enclosure must have the same minimum rating. For example, an enclosure that penetrates a 2-hour floor assembly must have a minimum fire-resistance rating of 2 hours, regardless of the number of stories the enclosure connects. The fire-resistance rating of an enclosure need never exceed 2 hours. If the floor assembly penetrated requires a minimum 3-hour fire-resistance rating, the enclosure rating is only required to be 2-hour fire-resistance rated. All linear voids at joints between fire-resistance-rated wall and floor/ceiling assemblies and where an enclosure would intersect with an exterior wall must be filled so that the integrity of the enclosure is maintained (see Section 715). The fire-resistance-rated requirements for enclosures for exit stairways and ramps are consistent with those for shaft enclosures and enclosures for exit access stairways and ramps.

The enclosure is needed because an exit stairway or ramp penetrates the floor/ceiling assemblies between the levels, thus creating a vertical opening or shaft. In cases of fire, a vertical opening may act as a chimney, causing smoke, hot gases and light-burning products to flow upward (buoyant force). If an opening

is unprotected, these products of combustion will be forced by positive pressure differentials to spread horizontally into the building spaces. There are exceptions for shaft protection around stairways and ramps that are not part of a required means of egress in IBC Section 712 or exit access stairways as permitted in Section 1019.3.

The enclosure of interior stairways or ramps with construction having a fire-resistance rating is intended to prevent the spread of fire from floor to floor. Another important purpose is to provide a safe path of travel for the building occupants and to serve as a protected means of access to the fire floor by fire department personnel. For this reason, Sections 1023.4 through 1023.6 limit the penetrations and openings permitted in the enclosure for an exit stairway or ramp.

For travel distance measurements at the exit stairways, see the commentary to Section 1017.3. While not specifically mentioned as an exception, Section 1027 for exterior exit stairways is considered to provide an equivalent level of protection to enclosed interior stairways.

Per Exception 1, because of security needs in detention facilities, one of the exit stairways is permitted to be glazed in a manner similar to atrium enclosures. Specific limitations and requirements are discussed in IBC Section 408.3.8. Exit access stairways within housing units are addressed in IBC Sections 408.5.1 and Section 1019.4 of the code.

Exception 2 is in consideration of an increased level of safety in an atrium. IBC Section 404 for atriums requires the space to be enclosed by a 1-hour passive enclosure and also protected by various active systems including fire suppression and smoke control features. The natural configuration of an atrium affords building occupants immediate views of the entire egress to the bottom of the atrium.

**1023.3 Termination.** *Interior exit stairways and ramps shall terminate at an exit discharge or a public way.*

**Exception:** A combination of *interior exit stairways, interior exit ramps and exit passageways*, constructed in accordance with Sections 1023.2, 1023.3.1 and 1024, respectively, and forming a continuous protected enclosure, shall be permitted to extend an *interior exit stairway or ramp* to the *exit discharge or a public way*.

- ❖ The intent of this section is to provide safety in all portions of the exit by requiring continuity of the fire protection characteristics of the enclosure for the exit stairway. Exit passageways (see Section 1024) are a continuation of the enclosure for the exit stairway. This would include, but not be limited to, the fire-resistance rating of the exit enclosure walls and the opening protection rating of the doors. While an exit passageway is most commonly found on the level of exit discharge as a means to connect a stairway enclosure to the exterior, in buildings that step back in footprint as the rise, the stairways may not be totally vertical shafts, but move out as they move down to keep the required separation distance. Exit

passageways can be at any level to connect the stair towers. There are special exit signage considerations for this particular issue in Section 1013.1 (see Commentary Figure 1013.1).

Section 1028.1 would allow for an alternative for direct access to the outside via an intervening lobby or vestibule.

Horizontal exits (see Section 1026), while not providing direct access to the outside of the structure, do move occupants to another “building” by moving through a fire wall (see Sections 1026 and 1028.1, Exception 3) into a refuge area protected by fire barriers and horizontal assemblies. Horizontal exits are commonly used in hospitals and jails for a defend-in-place type of protection.

**1023.3.1 Extension.** Where *interior exit stairways and ramps* are extended to an *exit discharge* or a *public way* by an *exit passageway*, the *interior exit stairway and ramp* shall be separated from the *exit passageway* by a *fire barrier* constructed in accordance with Section 707 or a *horizontal assembly* constructed in accordance with Section 711, or both. The *fire-resistance rating* shall be not less than that required for the *interior exit stairway and ramp*. A *fire door* assembly complying with Section 716.5 shall be installed in the *fire barrier* to provide a *means of egress* from the *interior exit stairway and ramp* to the *exit passageway*. Openings in the *fire barrier* other than the *fire door* assembly are prohibited. Penetrations of the *fire barrier* are prohibited.

**Exceptions:**

1. Penetrations of the *fire barrier* in accordance with Section 1023.5 shall be permitted.
  2. Separation between an *interior exit stairway or ramp* and the *exit passageway* extension shall not be required where there are no openings into the *exit passageway* extension.
- ❖ Once a person enters the enclosure surrounding an exit stairway, that same level of protection should be provided to them until they can leave the building. When an enclosure for an exit stairway connects to an exit passageway, either at the ground level or at an intermediate transition floor, the exit passageway must provide the same level of protection as the enclosure for the exit stairway, including fire-resistance of the walls, floor, ceiling and supporting construction and protection of any openings. At the junction between the enclosure for the exit stairway and the exit passageway, there must be both a rated fire barrier and a fire door. This has the additional benefit of preventing any smoke that may migrate into the exit passageway from also moving up the exit stairway or ramp. Permitted penetrations for the exit passageway are the same as those limitations set for the enclosure for the exit stairway. See Sections 1013.1 and 1025 for egress markings and signage within these types of spaces.

For the situation when an exit stairway is constructed as a smokeproof enclosure or a pressurized stairway, see Section 1023.10.1.

Exception 1—The penetrations for the exit passageway are allowed to be the same as permitted for the stairway enclosure.

Exception 2—The purpose in having a door at this interface in the existing requirement is to prevent smoke from a possible open door or other penetration in the passageway from traveling up the exit enclosure. This is prevented if there are no openings or penetrations in the exit passageway. Then the exit passageway is horizontal offset of the exit enclosure and does not propose the same hazard. Egress can proceed faster if there are no intermediate doors contained at the enclosure transitions.

**1023.4 Openings.** *Interior exit stairway and ramp* opening protectives shall be in accordance with the requirements of Section 716.

Openings in *interior exit stairways* and *ramps* other than unprotected exterior openings shall be limited to those necessary for *exit access* to the enclosure from normally occupied spaces and for egress from the enclosure.

Elevators shall not open into *interior exit stairways* and *ramps*.

❖ In order for fire doors to be effective, they must be in the closed position; therefore, the preferred arrangement is to install self-closing doors. Recognizing that operational practices often require doors to be open for an extended period of time, automatic-closing doors are permitted as long as this opening will not pose a threat to occupant safety and the doors will be self-latching. Automatic-closing devices enable the opening to be protected during a fire condition. The basic requirement for closing devices and specific requirements for automatic-closing and self-closing devices are given in NFPA 80. Automatic-closing doors that are provided at protected openings in exits are also required to close on the actuation of smoke detectors or loss of power to the smoke detectors (see Section 716.5.9.3).

The only openings that are permitted in fire-resistance-rated enclosures for exit stairways or ramps are doors that lead from normally occupied spaces into the enclosure and doors leading out of the enclosure to the outside. This restriction on openings essentially prohibits the use of windows in an exit enclosure except for those exterior windows that are not exposed to any hazards. This requirement is not intended to prohibit windows or other openings in the exterior walls of the exit enclosure. The verbiage “unprotected exterior openings” includes windows or doors not required to be protected by either IBC Section 705.8 or Section 1023.7 of the code. The only exception would be window assemblies that have been tested as wall assemblies in accordance with ASTM E119 or UL 263. The objective of this provision is to minimize the possibility of fire spreading into an enclosure and endangering the occupants or even preventing the use of the exit at a time when it is most needed. The limitation on openings applies regardless of the fire protection rating of the opening protective.

The limitation on openings from normally occupied areas is intended to reduce the probability of a fire occurring in an unoccupied area, such as a storage closet, which has an opening into the stairway, thereby possibly resulting in fire spread into the stairway. Other spaces that are not normally occupied include, but are not limited to, toilet rooms, electrical/mechanical equipment rooms and janitorial closets. For connection between the vertical exit enclosure and an exit passageway, see Section 1023.3.1.

Elevators may not open into exit enclosures. The difficulty is to have elevator doors that can meet the opening protectives for a fire barrier, but still operate effectively as elevator doors. For additional information on elevator lobbies and doors, see the commentary for IBC Section 713.14, Section 1020.6 of the code and IBC Section 3006.

These opening limitations are very similar to those required for an exit passageway (see Section 1024.5).

**1023.5 Penetrations.** Penetrations into or through *interior exit stairways* and *ramps* are prohibited except for equipment and ductwork necessary for independent ventilation or pressurization, sprinkler piping, standpipes, electrical raceway for fire department communication systems and electrical raceway serving the *interior exit stairway* and *ramp* and terminating at a steel box not exceeding 16 square inches (0.010 m<sup>2</sup>). Such penetrations shall be protected in accordance with Section 714. There shall not be penetrations or communication openings, whether protected or not, between adjacent *interior exit stairways* and *ramps*.

**Exception:** Membrane penetrations shall be permitted on the outside of the *interior exit stairway* and *ramp*. Such penetrations shall be protected in accordance with Section 714.3.2.

❖ This section specifically lists the items that are allowed to penetrate the walls and ceiling of the enclosure for the exit stairway. This is consistent for all types of enclosures for exits, including interior exit stairways or interior exit ramps and exit passageways (see Section 1024.6). In general, only portions of the building service systems that serve the enclosure are allowed to penetrate the enclosure. As indicated in the commentary to Section 1022.1, standpipe systems are commonly located in the exit stair enclosures. If two exit enclosures are adjacent to one another, there must be no penetrations between them, thereby limiting the chances of smoke being in both stairwells.

IBC Section 714 addresses through penetrations and membrane penetrations for fire-resistance-rated wall and floor/ceiling assemblies. The intent is to maintain the integrity of the enclosure for the exit access stairway. This section and Section 1023.6 are meant to work together. Penetrations in exterior walls are addressed in Section 1023.7.

The exception allows for electrical boxes, “Exit” signs or fire alarm pull stations to be installed on the outside of the enclosure, provided that the boxes are installed so that the required fire-resistance rating is not reduced (see IBC Section 714.3.2).

**1023.6 Ventilation.** Equipment and ductwork for *interior exit stairway* and *ramp* ventilation as permitted by Section 1023.5 shall comply with one of the following items:

1. Such equipment and ductwork shall be located exterior to the building and shall be directly connected to the *interior exit stairway* and *ramp* by ductwork enclosed in construction as required for shafts.
2. Where such equipment and ductwork is located within the *interior exit stairway* and *ramp*, the intake air shall be taken directly from the outdoors and the exhaust air shall be discharged directly to the outdoors, or such air shall be conveyed through ducts enclosed in construction as required for shafts.
3. Where located within the building, such equipment and ductwork shall be separated from the remainder of the building, including other mechanical equipment, with construction as required for shafts.

In each case, openings into the *fire-resistance-rated* construction shall be limited to those needed for maintenance and operation and shall be protected by opening protectives in accordance with Section 716 for shaft enclosures.

The *interior exit stairway* and *ramp* ventilation systems shall be independent of other building ventilation systems.

❖ The purpose of the requirements for ventilation system equipment and ductwork is to maintain the fire resistance of the enclosure for the exit stairway. The ventilation system serving the enclosure is to be independent of other building systems to prevent smoke in the enclosure from traveling to other areas of the building. This section and Section 1023.5 are meant to work together. Where ductwork penetrates the outside wall, if it is not required to be rated by Section 1023.7, then the duct does not require a fire and smoke damper. If the ductwork serving the shaft does penetrate a rated wall or rated floor/ceiling assembly, a fire and smoke damper would be required by IBC Section 717.5.3. Openings required for access to the ventilation system for maintenance and operation shall be protected in accordance with IBC Section 716.

**1023.7 Interior exit stairway and ramp exterior walls.**

*Exterior walls* of the *interior exit stairway* or *ramp* shall comply with the requirements of Section 705 for *exterior walls*. Where nonrated walls or unprotected openings enclose the exterior of the *stairway* or *ramps* and the walls or openings are exposed by other parts of the building at an angle of less than 180 degrees (3.14 rad), the building *exterior walls* within 10 feet (3048 mm) horizontally of a nonrated wall or unprotected opening shall have a *fire-resistance rating* of not less than 1 hour. Openings within such *exterior walls* shall be protected by opening protectives having a *fire protection rating* of not less than  $\frac{3}{4}$  hour. This construction shall extend vertically from the ground to a point 10 feet (3048 mm) above the topmost landing of the *stairway* or *ramp*, or to the roof line, whichever is lower.

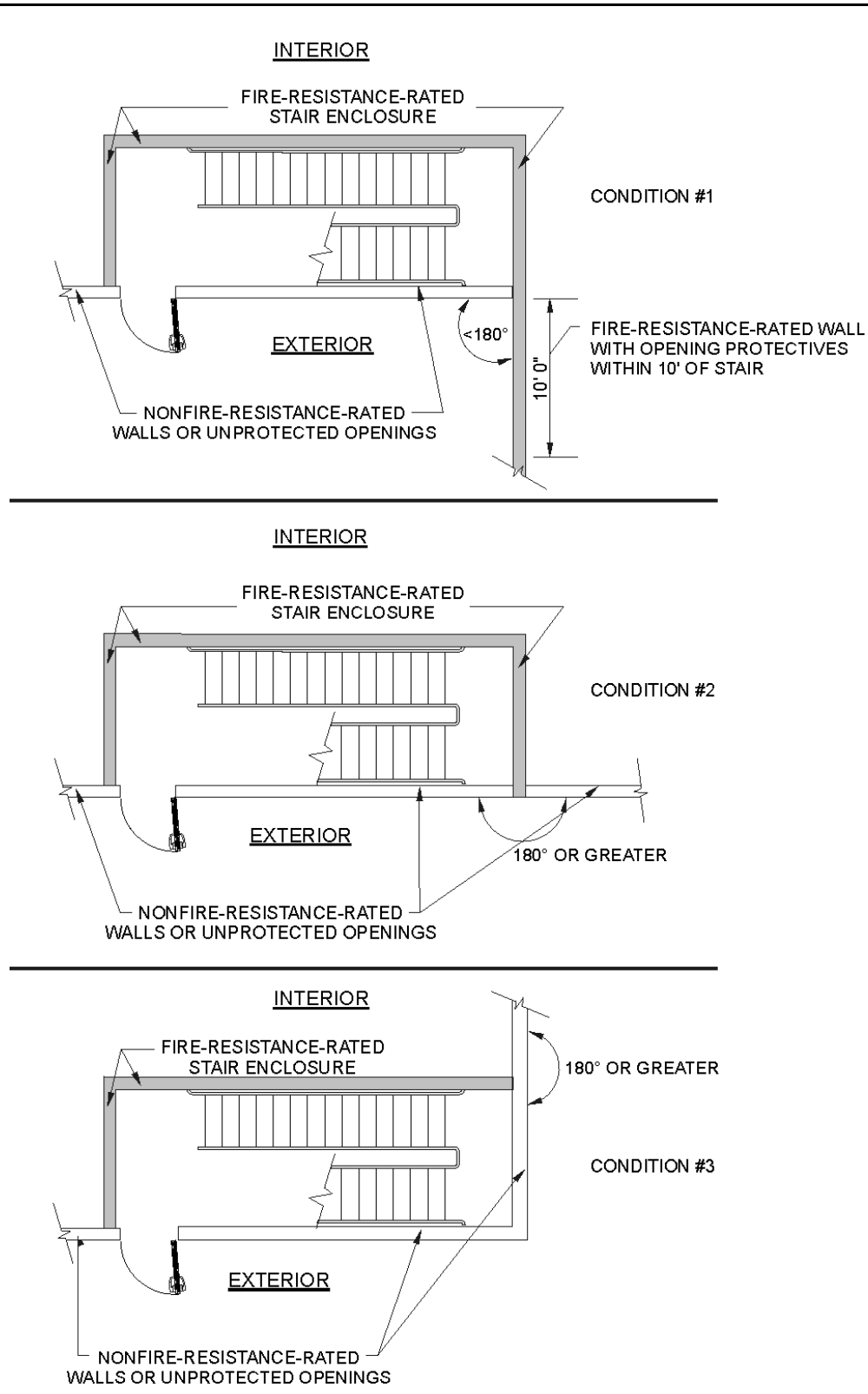
❖ This section does not require exterior walls of an enclosure for an exit stairway or ramp to have the

same fire-resistance rating as the interior walls. IBC Table 602 and IBC Section 705 establish when exterior walls are required to be rated and openings limited due to adjacent buildings or lot lines. This exposure is different from exterior load-bearing walls that are required to be rated because of the type of construction per IBC Table 601. What is unique to exterior walls at exit stairways is the need to stop fires from burning through an exterior wall adjacent to the enclosure, which may then jeopardize the occupant's ability to continue to use that exit stairway. Essentially, there are two alternatives where an exposure hazard exists: 1. Provide protection to the stairway by having a fire-resistance rating on its exterior wall; or 2. Provide a fire-resistance rating to the walls adjacent to the stairway. The ratings apply for a distance of 10 feet (3048 mm) measured horizontally and vertically from the stairway enclosure where those walls are at an angle of less than 180 degrees (3.14 rad) from the exterior wall portion of the enclosure [see Condition 1 in Commentary Figure 1023.7(1)]. When the adjacent exterior wall is protected in lieu of the stairway enclosure wall, the protection is to extend from the ground to a level of 10 feet (3048 mm) above the highest landing of the stairway. However, the protection is not required to extend beyond the normal roof line of the building.

The 180-degree (3.14 rad) angle criterion is based on the scenario where the exterior wall of the stair enclosure is in the same plane and flush with the exterior wall of the building [see Conditions 2 and 3 in Commentary Figure 1023.7(1)]. In this scenario, heat or fire would need to travel 180 degrees (3.14 rad) around in order to impinge on the stair. Based on studies of existing buildings, this 180-degree (3.14 rad) spread of fire does not appear to be a problem. This criterion is only applicable when the angle between the walls is 180 degrees (3.14 rad) or less.

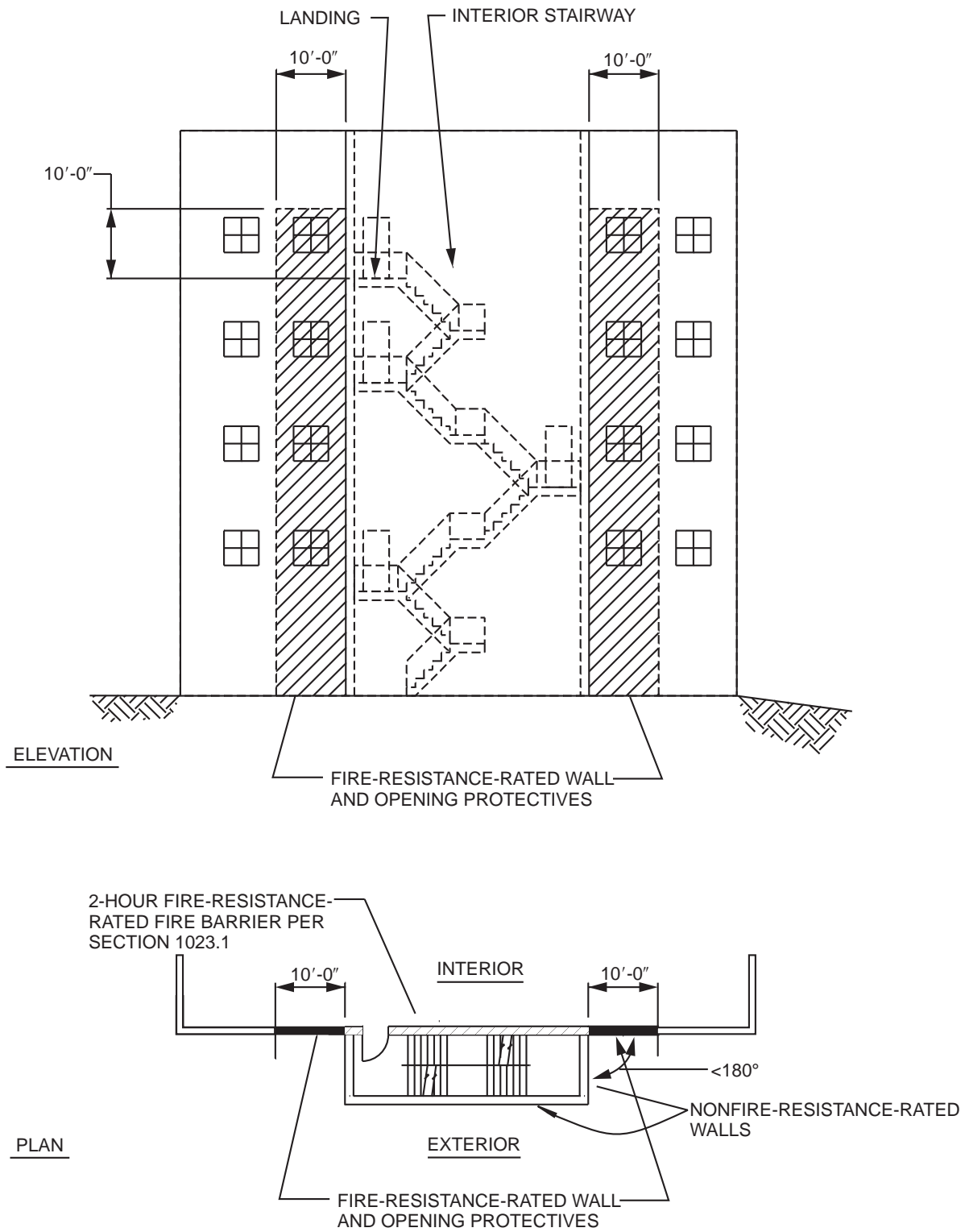
As the fire exposure on the exterior is different than can be expected on the interior, the fire-resistance rating of the exterior wall is not required to exceed 1 hour, regardless of whether it is the stairway enclosure wall or the adjacent exterior wall, unless the exterior wall is required by other sections of the code to have a higher fire-resistance rating (see IBC Tables 601 and 602). The fire protection rating on any openings in the exterior wall of a stairway enclosure or adjacent exterior wall within 180 degrees (3.14 rad) is to be a minimum of  $\frac{3}{4}$  hour [see Commentary Figure 1023.7(2)].

In a situation where the upper levels are smaller than lower levels, an interior stairway can end up having an exterior wall when it moves above the roof of the lower levels. In this situation, the question is the rating requirements for the exterior wall of the stairway over the roof. Therefore, the exterior wall of the stairway must meet the vertical opening provisions in IBC Section 705.8.6.



For SI: 1 foot = 304.8 mm, 1 degree = 0.01745 rad.

**Figure 1023.7(1)**  
**EXAMPLES OF EXTERIOR WALL PROTECTIVES**



For SI: 1 foot = 304.8 mm, 1 degree = 0.01745 rad.

**Figure 1023.7(2)**  
**EXTERIOR WALL PROTECTION**

**1023.8 Discharge identification.** An *interior exit stairway* and *ramp* shall not continue below its *level of exit discharge* unless an *approved* barrier is provided at the *level of exit discharge* to prevent persons from unintentionally continuing into levels below. Directional exit signs shall be provided as specified in Section 1013.

❖ So that building occupants using an exit stairway during an emergency situation will be prevented from going past the level of exit discharge, the run of the stairway is to be interrupted by a partition, door, gate or other approved means. These devices help the users of the stairway to recognize when they have reached the point that is the level of exit discharge. Exit signs, including raised letters and braille, are to be provided for occupant guidance at the door leading to the way out (i.e., directly to the exterior, or via an exit passageway, lobby or vestibule). Furthermore, signs are to be placed at each floor landing in all interior exit stairways connecting more than three floor levels, designating the level or story of the landings in accordance with Section 1023.9.

The code does not specify the type of material or construction of the barrier used to identify the level of exit discharge. The key issues to be considered in the selection and approval of the type of barrier to be used are: 1. Whether the barrier provides a visible and physical means of alerting occupants who are exiting under emergency conditions that they have reached the level of exit discharge; and 2. Whether the barrier is constructed of materials that are permitted by the construction type of the building. In an emergency situation, some occupants are likely to

come in contact with the barrier during exiting before realizing that they are at the level of exit discharge. Therefore, the barrier should be constructed in a manner that is substantial enough to withstand the anticipated physical contact, such as pushing or shoving. It would be reasonable, as a minimum, to design the barrier to withstand the structural load requirements of IBC Section 1607.5 for interior walls and partitions. The barrier could be opaque (such as gypsum wallboard and stud framing) or not (such as a wire grid-type material).

The use of signage only or relatively insubstantial barriers, such as ropes or chains strung across the opening, is typically not sufficient to prevent occupants from attempting to continue past the level of exit discharge during an emergency.

Commentary Figure 1023.8 is an example of one method of discharge identification.

**1023.9 Stairway identification signs.** A sign shall be provided at each floor landing in an *interior exit stairway* and *ramp* connecting more than three stories designating the floor level, the terminus of the top and bottom of the *interior exit stairway* and *ramp* and the identification of the *stairway* or *ramp*. The signage shall also state the story of, and the direction to, the *exit discharge* and the availability of roof access from the *interior exit stairway* and *ramp* for the fire department. The sign shall be located 5 feet (1524 mm) above the floor landing in a position that is readily visible when the doors are in the open and closed positions. In addition to the *stairway* identification sign, a floor-level sign in visual characters, raised characters and braille complying with ICC A117.1 shall be located at each floor-level landing adjacent to



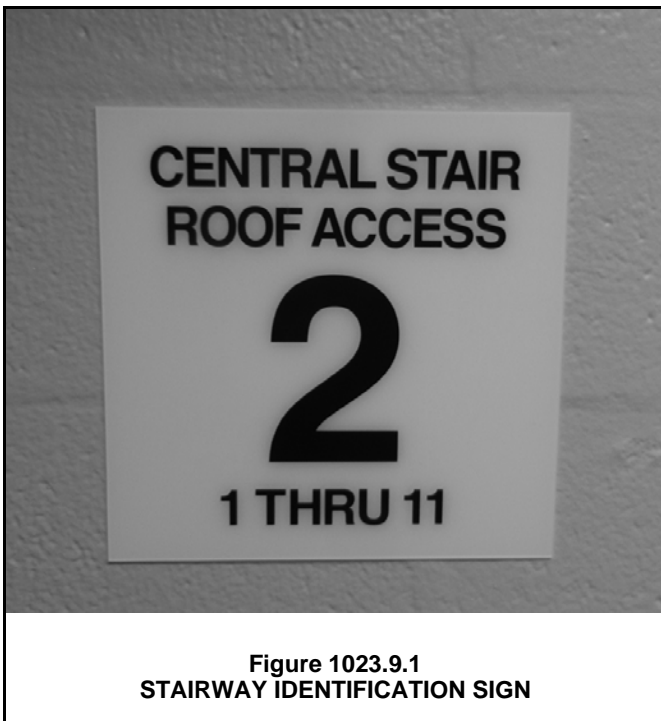
**Figure 1023.8**  
**EXAMPLE OF A STAIRWAY BARRIER AT THE LEVEL OF EXIT DISCHARGE**

the door leading from the *interior exit stairway* and *ramp* into the *corridor* to identify the floor level.

❖ This section discusses two distinct sign requirements that have totally different purposes.

Signs are to be placed at each floor landing in all exit stairways connecting more than three stories. The signs are to designate the level or story of the landings above or below the level of exit discharge. The purpose is to inform the occupants of their location with respect to the level of exit discharge as they use the stairway to leave the building. More importantly, it allows the fire service to locate and gain quick access to the fire floor. At each level, the direction to the exit discharge is required to be indicated. The identification of the level that is the exit discharge is also to be indicated at each level. The identification of the roof access availability is for the fire department (see Commentary Figure 1023.9.1). Roof access is required by Section 1011.13. For visibility, the signs are required to be located approximately 5 feet (1524 mm) above the floor surface and to be visible when the stairway door is open. The need to designate levels remaining to reach the level of exit discharge may mean that the numbering is other than the normal designation used by building management. For example, a designation of P1, P2, P3, etc., would not be acceptable for stairways in the basement parking garage, since in themselves they do not designate the floor level below the level of exit discharge.

To aid people with vision impairments, the floor designation must also be available in visual and raised letters and braille at each door. The intent is to let persons with vision impairments be able to find out what floor they are on without leaving the stairway



enclosure. Visual and raised letters and braille signage indicating the door leading to the exterior is covered in Section 1013.4.

**1023.9.1 Signage requirements.** *Stairway* identification signs shall comply with all of the following requirements:

1. The signs shall be a minimum size of 18 inches (457 mm) by 12 inches (305 mm).
2. The letters designating the identification of the *interior exit stairway* and *ramp* shall be not less than 1½ inches (38 mm) in height.
3. The number designating the floor level shall be not less than 5 inches (127 mm) in height and located in the center of the sign.
4. Other lettering and numbers shall be not less than 1 inch (25 mm) in height.
5. Characters and their background shall have a nonglare finish. Characters shall contrast with their background, with either light characters on a dark background or dark characters on a light background.
6. Where signs required by Section 1023.9 are installed in the *interior exit stairways* and *ramps* of buildings subject to Section 1025, the signs shall be made of the same materials as required by Section 1025.4.

❖ The requirements for stairway identification signage will provide for a consistent approach. The intent is to make signs visible and immediately recognizable to occupants and emergency responders using the stairway (see Commentary Figure 1023.9.1).

In addition, if the building is a high-rise and luminous egress path markings are required (see Section 1025.1), the stairway identification signage must also be self-luminous or photoluminescent. In order to also meet the contrast requirements in Item 5, typically the sign will have dark letters on a glow-in-the-dark background.

**1023.10 Elevator lobby identification signs.** At landings in *interior exit stairways* where two or more doors lead to the floor level, any door with direct access to an enclosed elevator lobby shall be identified by signage located on the door or directly adjacent to the door stating “Elevator Lobby.” Signage shall be in accordance with Section 1023.9.1, Items 4, 5 and 6.

❖ This section is mainly related to fire service access elevators required in IBC Section 403.6.1 for a building with an occupied floor more than 120 feet (3048 mm) above the street. The elevator lobby is required to have direct access to an exit stairway (see IBC Section 3007.6.1). In addition, that same exit enclosure has to have access to the floor without going back through the elevator lobby (see IBC Section 3007.9.1). This leads to two doors at each floor landing. Elevator lobby signs identify the correct door through which fire fighters should access the floor so that lobby smoke protection is maintained.

Since typically the fire service access elevators will use the same lobby as the occupant evacuation elevators (when provided), this signage would effectively be

required for the doors in the stairway enclosure that lead to occupant evacuation elevator lobbies as well.

**1023.11 Smokeproof enclosures.** Where required by Section 403.5.4 or 405.7.2, *interior exit stairways* and *ramps* shall be *smokeproof enclosures* in accordance with Section 909.20.

❖ While smokeproof enclosures and pressurized stairways for exiting can, at the designer's option, be used in buildings of any occupancy, height or area, this section specifically requires smokeproof enclosures or pressurized stairways to be provided when either of two conditions occur.

The first condition requires all exit stairways in high-rise buildings [i.e., buildings with floor levels higher than 75 feet (22 860 mm) above the level of exit discharge (see IBC Section 403.5.4)] to be smokeproof enclosures or pressurized stairways. The reason for this provision is that in very tall buildings, often during fire emergencies, total and immediate evacuation of the occupants cannot be readily accomplished. In such situations, exit stairways become places of safety for the occupants and must be adequately protected with smokeproof enclosures or pressurization to provide a safe egress environment. In order to provide this safe environment, the enclosure must be constructed to resist the migration of smoke caused by the "stack effect." Stack effect occurs in tall enclosures such as chimneys, when a fluid such as smoke, which is less dense than the ambient air, is introduced into the enclosure. The smoke will rise because of the effects of buoyancy and will induce additional flow into the enclosure through openings of any size at the lower levels.

The second condition applies for underground buildings [i.e., when an occupiable floor level is located more than 30 feet (9144 mm) below the level of exit discharge (see IBC Section 405.7.2)]. Stairways serving those levels are also required to be protected by smokeproof enclosures or pressurization because underground portions of a building present unique problems in providing not only for life safety but also access for fire-fighting purposes. The choice of a 30-foot (9144 mm) threshold for this requirement is intended to provide a reasonable limitation on vertical travel distance before the requirement applies.

Detailed system requirements for a smokeproof enclosure or pressurization are in Section 909.20. Note that IBC Sections 403 and 405 each have exceptions for specific building types that are not to be regulated by those sections. Likewise, the requirements of this section do not apply to buildings identified in those exceptions.

**1023.11.1 Termination and extension.** A *smokeproof enclosure* shall terminate at an *exit discharge* or a *public way*. The *smokeproof enclosure* shall be permitted to be extended by an *exit passageway* in accordance with Section 1023.3. The *exit passageway* shall be without openings other than the *fire door assembly* required by Section 1023.3.1 and those necessary for egress from the *exit passageway*. The *exit passageway* shall be separated from the remainder of the building by

2-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

**Exceptions:**

1. Openings in the *exit passageway* serving a *smokeproof enclosure* are permitted where the *exit passageway* is protected and pressurized in the same manner as the *smokeproof enclosure*, and openings are protected as required for access from other floors.
2. The *fire barrier* separating the *smokeproof enclosure* from the *exit passageway* is not required, provided the *exit passageway* is protected and pressurized in the same manner as the *smokeproof enclosure*.
3. A *smokeproof enclosure* shall be permitted to egress through areas on the *level of exit discharge* or vestibules as permitted by Section 1028.

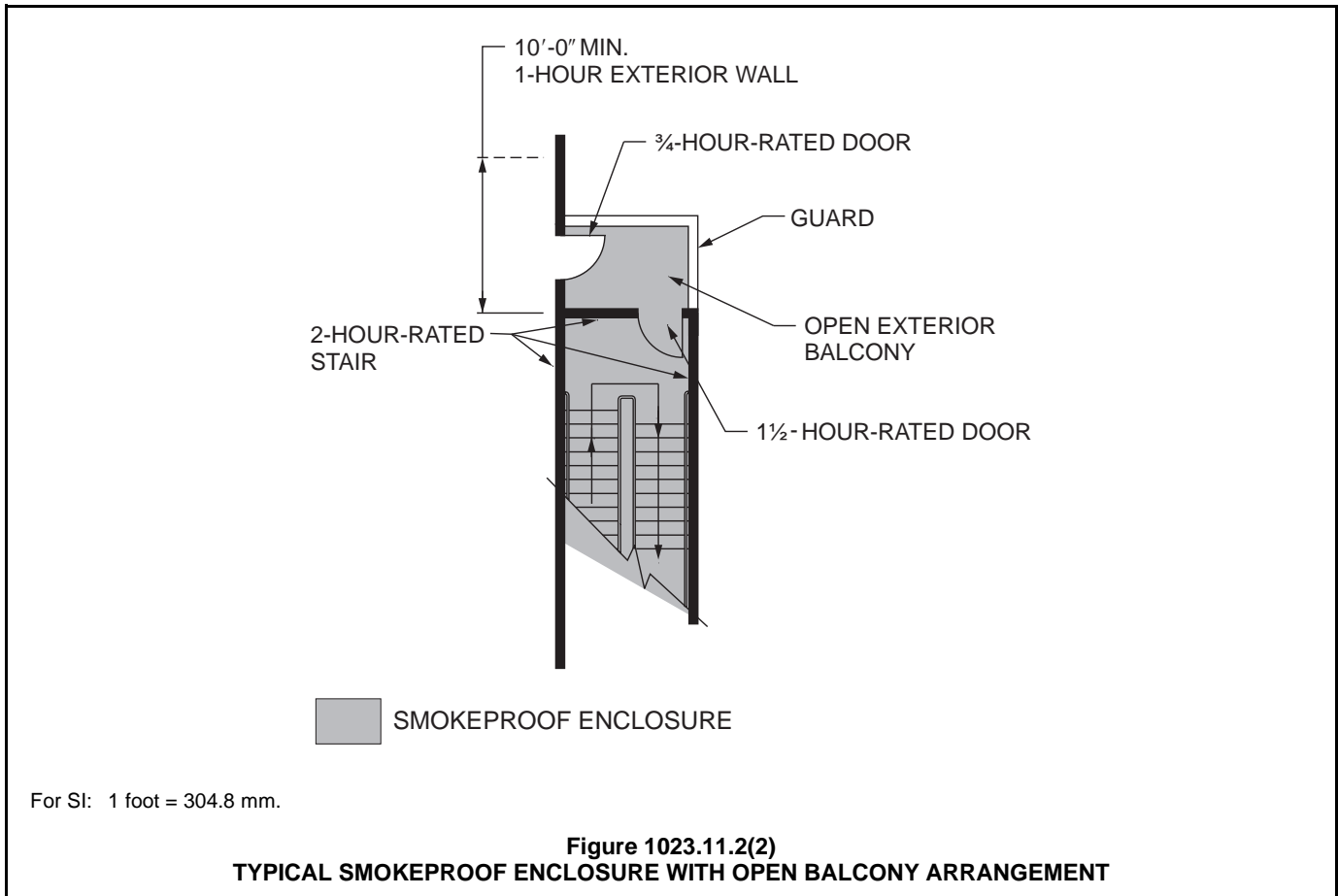
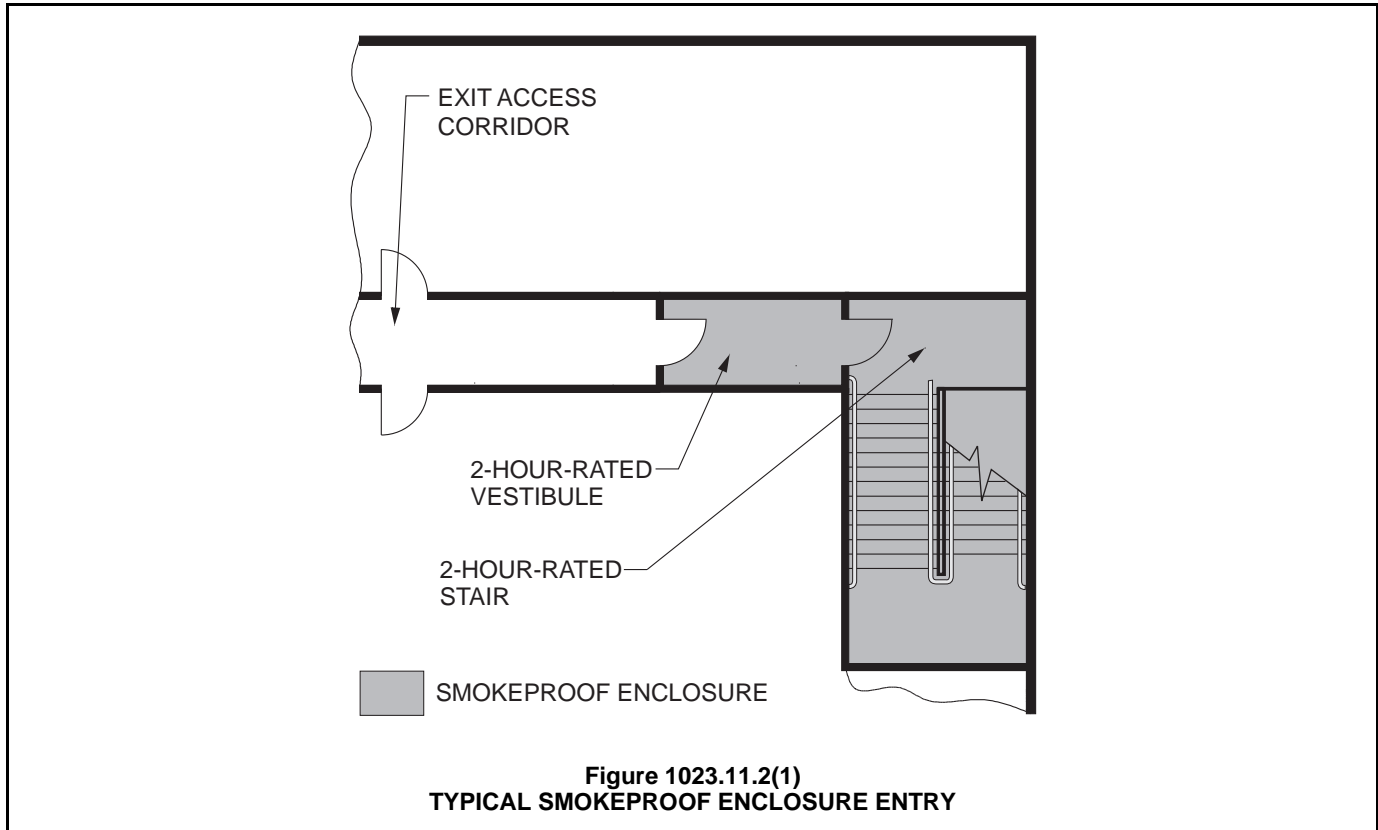
❖ The walls forming the smokeproof enclosure, which includes the stairway shaft and the vestibules, must be fire barriers having a fire-resistance rating of at least 2 hours. This level of fire endurance is specified because exit stairways in high-rise buildings serve as principal components of the egress system and as the source of fire service access to the fire floor. This supersedes any allowed reduction of enclosure rating, even if the stair from the level that is more than 30 feet (9144 mm) below exit discharge connects three stories or less. A pressurized stairway is a special case of a smokeproof enclosure; therefore, the requirements would be the same.

The first exception applies to openings in the exit passageway that are permitted, provided the exit passageway is protected and pressurized. If the exit stairway enclosure is connected to an exit passageway, Exception 2 allows the elimination of a door between, since this would interfere with the pressurization of the stairway and passageway as a combined exit system. In accordance with Exception 3, 50 percent of the stairways in smokeproof enclosures or pressurized stairways can use the exit discharge exceptions in Section 1028 to egress through a lobby or vestibule.

**1023.11.2 Enclosure access.** Access to the *stairway* or *ramp* within a *smokeproof enclosure* shall be by way of a vestibule or an open exterior balcony.

**Exception:** Access is not required by way of a vestibule or exterior balcony for *stairways* and *ramps* using the pressurization alternative complying with Section 909.20.5.

❖ See Commentary Figures 1023.11.2(1) and 1023.11.2(2) for illustrations of access to the smokeproof stairway or ramp by way of a vestibule or an exterior balcony. The purpose of this requirement is to keep the enclosure clear of smoke. Where a pressurized stairway is used, these elements are not necessary.



## SECTION 1024 EXIT PASSAGEWAYS

**1024.1 Exit passageways.** *Exit passageways* serving as an exit component in a *means of egress* system shall comply with the requirements of this section. An *exit passageway* shall not be used for any purpose other than as a *means of egress* and a *circulation path*.

❖ This section provides acceptable methods of continuing the protected path of travel for building occupants. The building designer or owner is given different options for achieving this protected path of travel. See Commentary Figure 1024.1 for an illustration of an exit passageway arrangement. In the case of office buildings or similar structures, the exit stairways are often located at the central core or in line with the centrally located exit access corridors. Exit passageways may be used to connect the exit stair to the exterior exit door or to connect enclosures for exit stairways that are not vertically continuous. Such an arrangement provides great flexibility in the design use of the building. Without an exit passageway at the grade floor or the level of exit discharge, the occupants of the upper floors or basement levels would have to leave the safety of the exit stairway to travel to the exterior doors. Such a reduction of protection is not acceptable (see Section 1028 for exit discharge alternatives).

Exit passageways may also be used on their own in locations not connected with an enclosure for an exit stairway. The exit passageway is often used as a protected horizontal exit path, such as in a mall or unlimited area building. Sometimes on large floor plans, an exit passageway may be used to extend an exit into areas that would not otherwise be able to meet the travel distance requirements. Like exit stairways, there is no travel distance limitation within an exit passageway.

**1024.2 Width.** The required capacity of *exit passageways* shall be determined as specified in Section 1005.1 but the minimum width shall be not less than 44 inches (1118 mm), except that *exit passageways* serving an occupant load of less than 50 shall be not less than 36 inches (914 mm) in width. The minimum width or required capacity of *exit passageways* shall be unobstructed.

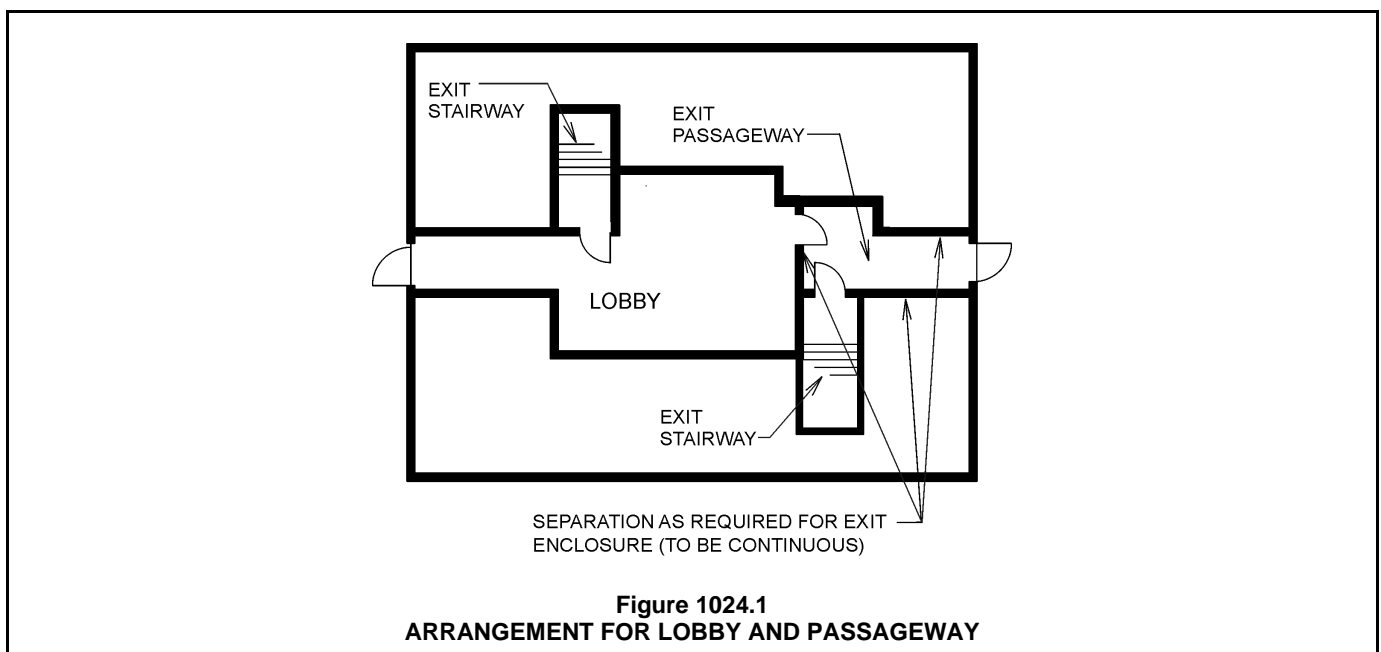
**Exception:** Encroachments complying with Section 1005.7.

❖ The width of an exit passageway is to be determined in accordance with Section 1005.1, based on the number of occupants served in the same manner as for corridors. The greater of the minimum required width or the width determined based on occupancy is to be used. In situations where the exit passageway also serves as an exit access corridor for the first floor, the corridor width must comply with the stricter requirement.

A cross reference back to Section 1005.7 from the exceptions for encroachments in the required width in aisles (see Section 1011.1), corridors (see Section 1020.3), exit passageways (see Section 1024.2) and exit courts (see Section 1028.4.1) reinforces the fact that the protrusion limits provision is generally applicable for these types of confined routes.

**1024.3 Construction.** *Exit passageway* enclosures shall have walls, floors and ceilings of not less than a 1-hour *fire-resistance rating*, and not less than that required for any connecting *interior exit stairway* or *ramp*. *Exit passageways* shall be constructed as *fire barriers* in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

❖ The entire exit passageway enclosure is to be fire-resistance rated as specified. The floors and ceilings are required to be rated in addition to the walls. When used separately, a minimum 1-hour fire-resistance



rating is required. Where extending an enclosure for an exit stairway, the rating must not be less than the enclosure for the exit stairway so that the degree of protection is kept at the same level. Remember that if the exit passageway extends over a lower level, such as a basement, all supporting construction is to have the same fire-resistance rating as the elements supported in accordance with the continuity requirements for fire barriers and horizontal assemblies (see IBC Sections 707.5 and 711.2.3). The continuity requirements would also be a concern for the rated ceiling of the exit passageway. An alternative for the ceiling of the exit passageway could be a top-of-shaft enclosure (see IBC Section 713.12).

**1024.4 Termination.** *Exit passageways on the level of exit discharge shall terminate at an exit discharge. Exit passageways on other levels shall terminate at an exit.*

❖ This is consistent with the exit continuity and enclosure requirements in Section 1023.3. Section 1023.3 has an exception that allows for combinations of interior exit stairways and ramps with the exit passageway. The intent of this section is to provide safety in all portions of the exit by requiring continuity of the fire protection characteristics of the enclosure for the exit stairway in combination with an exit passageway. This would include, but not be limited to, the fire-resistance rating of the enclosure walls for the exit stairways and the opening protection rating of the doors. When an exit passageway is supported by the structure, the supporting construction must be fire-resistance rated equal to the walls and floors of the passageway being supported.

Section 1028.1, Exceptions 1 and 2, allow for an alternative for direct access to the outside via an intervening lobby or vestibule.

Horizontal exits, while not providing direct access to the outside of the structure, do move occupants to another “building” by moving through a fire wall (see Sections 1026 and 1028.1, Exception 3) into a refuge area protected by fire barriers and horizontal assemblies. Horizontal exits are commonly used in hospitals and jails for a defend-in-place type of protection.

An exit passageway may be used to move between vertical enclosures for exit stairways. This may occur when a building is shaped like a wedding cake, so the stairway towers move outward as the building gets larger toward grade level. If this situation happens, it is very important to let occupants know how to proceed. See Section 1013.1 for exit signage requirements for within the exit passageways.

**1024.5 Openings.** *Exit passageway opening protectives shall be in accordance with the requirements of Section 716.*

Except as permitted in Section 402.8.7, openings in *exit passageways* other than unprotected exterior openings shall be limited to those necessary for *exit access* to the *exit passageway* from normally occupied spaces and for egress from the *exit passageway*.

Where an *interior exit stairway* or *ramp* is extended to an *exit discharge* or a *public way* by an *exit passageway*, the *exit passageway* shall comply with Section 1023.3.1.

Elevators shall not open into an *exit passageway*.

❖ In order for fire doors to be effective, they must be in the closed position; therefore, the preferred arrangement is to install self-closing doors. Recognizing that operational practices often require doors to be open for an extended period of time, automatic-closing doors are permitted as long as this opening will not pose a threat to occupant safety and the doors will be self-latching. Automatic-closing devices enable the opening to be protected during a fire condition. The basic requirement for closing devices and specific requirements for automatic-closing and self-closing devices are given in NFPA 80. Automatic-closing doors that protect openings into exits are also required to close on the actuation of smoke detectors or loss of power to the smoke detectors (see Section 716.5.9.3).

The requirements for exit passageways are very similar to those required for enclosures for interior exit stairways (see Section 1023.4). The only openings that are permitted in fire-resistance-rated exit passageways are doors that lead from normally occupied spaces, from the enclosure for the exit stairway and to the outside. This restriction on openings essentially prohibits the use of windows in an exit passageway except for those exterior windows that are not exposed to any hazards. This requirement is not intended to prohibit windows or other openings in the exterior walls of the exit enclosure. The verbiage “unprotected exterior openings” includes windows or doors not required to be protected by either IBC Section 705.8 or Section 1023.7 of the code. The only exception would be window assemblies that have been tested as wall assemblies in accordance with ASTM E119 and UL 263. The objective of this provision is to minimize the possibility of fire spreading into an exit passageway and endangering the occupants or even preventing the use of the exit at a time when it is most needed. The limitation on openings applies regardless of the fire protection rating of the opening protective. The limitation on openings from normally occupied areas is intended to reduce the probability of a fire occurring in an unoccupied area, such as a storage closet, that has an opening into the exit passageway, thereby resulting in smoke spreading into the exit passageway. Other spaces that are not normally occupied include, but are not limited to, toilet rooms, electrical/mechanical equipment rooms and janitorial closets. Note that exit passageways prohibit elevators from opening directly into the passageway. There are some exceptions for these unoccupied spaces in exit passageways in covered malls (see IBC Section 402.4.6).

The third paragraph addresses when the vertical enclosure for an exit stairway or ramp transitions to

the exit passageway. While the exit passageway is an extension of the protection offered by the vertical exit, there must still be a door (i.e., opening protective) between the bottom of the stairway or ramp enclosure and the exit passageway. This is to prevent any smoke that may migrate into the exit passageway from also moving up the exit stairway or ramp. This door is not required if the exit stairway and exit passageway are protected by pressurization (see Section 1023.10.1).

Elevators may not open into exit passageways. The difficulty is to have elevator doors that can meet the opening protectives for a fire barrier, but still operate effectively. For additional information on elevator lobbies and doors, see the commentary to IBC Sections 713.14 and 1020.6.

These opening limitations are very similar to those required for an exit enclosure (see Section 1023.3).

**1024.6 Penetrations.** Penetrations into or through an *exit passageway* are prohibited except for equipment and ductwork necessary for independent pressurization, sprinkler piping, standpipes, electrical raceway for fire department communication and electrical raceway serving the *exit passageway* and terminating at a steel box not exceeding 16 square inches (0.010 m<sup>2</sup>). Such penetrations shall be protected in accordance with Section 714. There shall not be penetrations or communicating openings, whether protected or not, between adjacent *exit passageways*.

**Exception:** Membrane penetrations shall be permitted on the outside of the *exit passageway*. Such penetrations shall be protected in accordance with Section 714.3.2.

❖ This section specifically lists the items that are allowed to penetrate an exit passageway. This is consistent for all types of exit enclosures, including enclosures for exit stairways or ramps (see Section 1023.5) and exit passageways. In general, only portions of the building service systems that serve the exit passageways are allowed to penetrate the exit passageway. IBC Section 714 addresses through penetrations and membrane penetrations for fire-resistance-rated wall and floor/ceiling assemblies. The intent is to maintain the integrity of the enclosure for the exit access stairway. If the ductwork serving the exit passageway penetrates a rated wall or floor/ceiling assembly, a fire and smoke damper is required by IBC Section 717.5.3. This requirement is not intended to prohibit windows in the exterior walls of exit passageways that are not required to be rated.

The exception allows for electrical boxes or fire alarm pull stations to be installed on the outside of the enclosure, provided that the boxes are installed so that the required fire-resistance rating is not reduced (see IBC Section 714.3.2).

**1024.7 Ventilation.** Equipment and ductwork for *exit passageway* ventilation as permitted by Section 1024.6 shall comply with one of the following:

1. The equipment and ductwork shall be located exterior to the building and shall be directly connected to the

*exit passageway* by ductwork enclosed in construction as required for shafts.

2. Where the equipment and ductwork is located within the *exit passageway*, the intake air shall be taken directly from the outdoors and the exhaust air shall be discharged directly to the outdoors, or the air shall be conveyed through ducts enclosed in construction as required for shafts.
3. Where located within the building, the equipment and ductwork shall be separated from the remainder of the building, including other mechanical equipment, with construction as required for shafts.

In each case, openings into the fire-resistance-rated construction shall be limited to those needed for maintenance and operation and shall be protected by opening protectives in accordance with Section 716 for shaft enclosures.

*Exit passageway* ventilation systems shall be independent of other building ventilation systems.

❖ As a continuation of an exit stairway enclosure, an exit passageway has the same considerations for protection. While an exit passageway may look like a regular hallway, it is important that it be maintained as free of smoke as the exit stairway. See the commentary to Section 1023.6.

## SECTION 1025 LUMINOUS EGRESS PATH MARKINGS

**1025.1 General.** *Approved* luminous egress path markings delineating the exit path shall be provided in *high-rise buildings* of Group A, B, E, I, M, and R-1 occupancies in accordance with Sections 1025.1 through 1025.5.

**Exception:** Luminous egress path markings shall not be required on the *level of exit discharge* in lobbies that serve as part of the exit path in accordance with Section 1028.1, Exception 1.

❖ Improved safety for individuals negotiating stairs during egress of a high-rise building is provided by improving the visibility of stair treads and handrails under emergency conditions. A second source of emergency power for exit illumination, exit signs and stair shaft pressurization systems in smokeproof enclosures is currently mandated for high-rise buildings. In the event of an emergency that disconnects utility power, the emergency power source should engage, causing the stair shaft to be illuminated and kept smoke free by the pressurization system. Unfortunately, such systems can fail under demand conditions. The provisions of Section 1025 add an additional level of safety to the egress path by requiring the installation of photoluminescent or self-illuminating marking systems that do not require electrical power and its associated wiring and circuits. An additional means for ensuring that occupants can safely egress a building via exit stairways is now available even if the emergency power supply and system fails to operate. The groups indicated have a high anti-

pated occupant load or occupants may not be as familiar with the space. Note that the provisions only require these markings within the enclosure for the exit stairway, exit ramp and the exit passageway used for enclosure continuation. The markings are not required before reaching the exit (i.e., exit access) or after leaving the exit (i.e., exit discharge).

The exception indicates that if the exit stairway enclosure discharges through the lobby (see Section 1028.1, Exception 1), the egress markings would not be required outside the stairway enclosure for the portion from the stairway enclosure to the door leading to the outside. If the exit stairway discharges through an exit passageway, the exit path markings must continue to the door leading to the outside. The current text is silent for the options of vestibules and horizontal exits, but since Sections 1025.1 through 1025.5 only address within the enclosure for the exit, and not the exit discharge, exit path markings in the vestibule or after the horizontal exit are not required.

**1025.2 Markings within exit components.** Egress path markings shall be provided in *interior exit stairways*, *interior exit ramps* and *exit passageways*, in accordance with Sections 1025.2.1 through 1025.2.6.

❖ Luminous egress path markings are required inside the enclosure for exit stairways or ramps for all floors. If the stairway connects to an exit passageway as part of the travel down to the level of exit discharge or on the level of exit discharge, the path markings must also be continued in the exit passageway.

The subsections include marking the tread nosings, the surrounding edges of landings and any exit passageways, handrails and any protruding objects within the protected enclosure.

All exit path markings are required to be solid and continuous stripes. A key requirement for marking systems is that their design must be uniform. The placement and dimensions of markings must be consistent along the entire exit stairway. By specifying a standard marking dimension, the requirements will ensure that the marking is visible during dark conditions and provides consistent and standard application in the design and enforcement of exit path markings. Markings installed on stair steps, perimeter demarcation lines and handrails must have a minimum width of 1 inch (25 mm). For stair steps and perimeter demarcation lines, their maximum width cannot exceed 2 inches (51 mm). The provisions for stair steps, perimeter demarcation lines and handrails allow the width of the marking to be reduced to less than 1 inch (25 mm) when marking stripes are listed in accordance with UL 1994.

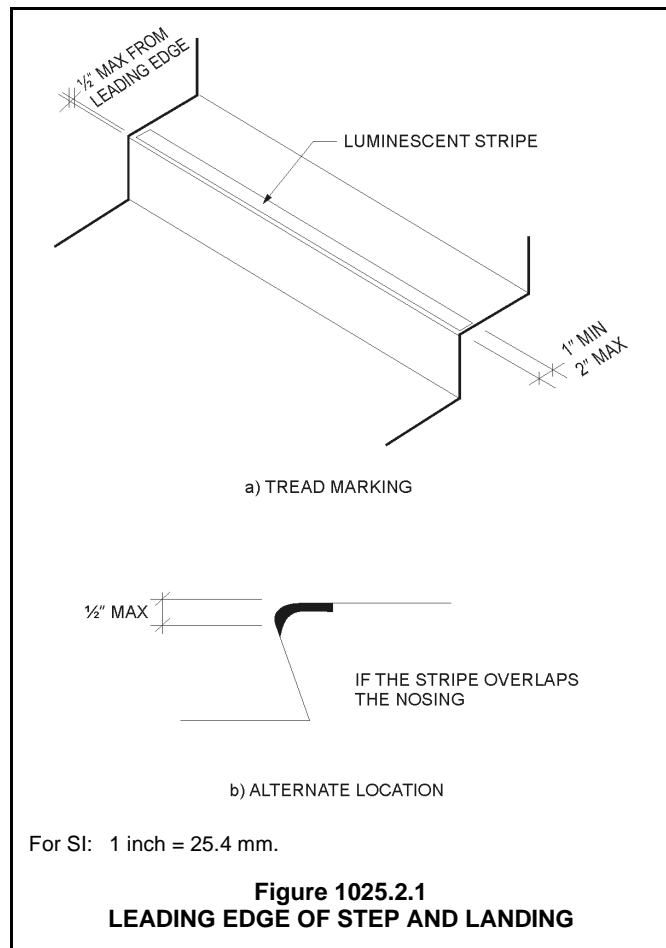
**1025.2.1 Steps.** A solid and continuous stripe shall be applied to the horizontal leading edge of each step and shall extend for the full length of the step. Outlining stripes shall have a minimum horizontal width of 1 inch (25 mm) and a maximum width of 2 inches (51 mm). The leading edge of the stripe shall be placed not more than 1/2 inch (12.7 mm) from the leading edge of the step and the stripe shall not overlap

the leading edge of the step by not more than 1/2 inch (12.7 mm) down the vertical face of the step.

**Exception:** The minimum width of 1 inch (25 mm) shall not apply to outlining stripes listed in accordance with UL 1994.

❖ Luminous stripes are required the full width of the stairway on all tread nosings and along the leading edge of stair landings. These demarcation lines serve to identify the transition from the stair steps to the landing, which is important to minimize the risk of a fall inside of a stairway enclosure that is not illuminated. In order to clearly identify the leading edge of the step, the front edge of the stripe must be within 1/2 inch (13 mm) plus or minus of the leading edge of the tread (see Commentary Figure 1025.2.1).

The code does not specify any minimum slip-resistance requirements for luminous products installed on walking surfaces. However, Section 1003.4 requires all walking surfaces for means of egress to be slip resistant. Persons with vision impairments often rely on high-contrast elements to delineate changes in elevation such as that required in Sections 1011.5.4 and 1029.13.2.2. In medium light conditions, the luminous materials may be hard to discern. Luminous materials installed adjacent to dark contrasting materials may help with both situations.



For SI: 1 inch = 25.4 mm.

**Figure 1025.2.1  
LEADING EDGE OF STEP AND LANDING**

The provisions for stair steps, perimeter demarcation lines and handrails allow the width of the marking to be reduced to less than 1 inch (25 mm) when marking stripes are listed in accordance with UL 1994.

**1025.2.2 Landings.** The leading edge of landings shall be marked with a stripe consistent with the dimensional requirements for steps.

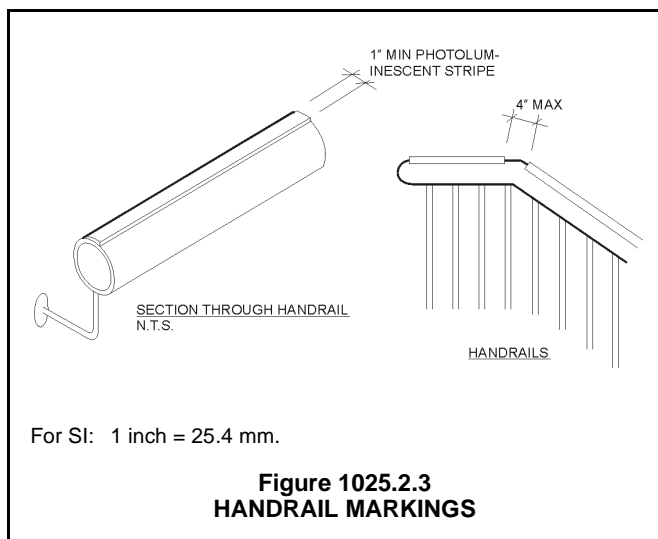
- ❖ The edge of the landing at the top of the steps must be marked in the same manner as the tread nosing so that a person can tell where the steps start. See the commentary to Section 1025.2.1 and Commentary Figure 1025.2.1.

**1025.2.3 Handrails.** *Handrails* and handrail extensions shall be marked with a solid and continuous stripe having a minimum width of 1 inch (25 mm). The stripe shall be placed on the top surface of the *handrail* for the entire length of the *handrail*, including extensions and newel post caps. Where *handrails* or handrail extensions bend or turn corners, the stripe shall not have a gap of more than 4 inches (102 mm).

**Exception:** The minimum width of 1 inch (25 mm) shall not apply to outlining stripes listed in accordance with UL 1994.

- ❖ The handrail must have a glow-in-the-dark stripe down the entire length. The 1-inch (25 mm) minimum width stripe must be on the top of the handrail so it can charge and maximize its visibility in the dark. Bends or turns may result in a break in the marking, which must not be more than 4 inches (102 mm) maximum (see Commentary Figure 1025.2.3).

The provisions for stair steps, perimeter demarcation lines and handrails allow the width of the marking to be reduced to less than 1 inch (25 mm) when marking stripes are listed in accordance with UL 1994.



**Figure 1025.2.3  
HANDRAIL MARKINGS**

**1025.2.4 Perimeter demarcation lines.** Stair landings and other floor areas within *interior exit stairways*, *interior exit ramps* and *exit passageways*, with the exception of the sides of steps, shall be provided with solid and continuous demar-

cation lines on the floor or on the walls or a combination of both. The stripes shall be 1 to 2 inches (25 mm to 51 mm) wide with interruptions not exceeding 4 inches (102 mm).

**Exception:** The minimum width of 1 inch (25 mm) shall not apply to outlining stripes listed in accordance with UL 1994.

- ❖ In addition to the leading edge of the landing, the landing must have a luminous stripe all the way around the edge. If the enclosure includes any type of exit passageway, that corridor must also have a perimeter stripe. The stripe can be on the floor or on the wall at baseboard height (see Sections 1025.2.4.1 and 1025.2.4.2).

The provisions for stair steps, perimeter demarcation lines and handrails allow the width of the marking to be reduced to less than 1 inch (25 mm) when marking stripes are listed in accordance with UL 1994.

**1025.2.4.1 Floor-mounted demarcation lines.** Perimeter demarcation lines shall be placed within 4 inches (102 mm) of the wall and shall extend to within 2 inches (51 mm) of the markings on the leading edge of landings. The demarcation lines shall continue across the floor in front of all doors.

**Exception:** Demarcation lines shall not extend in front of *exit discharge* doors that lead out of an *exit* and through which occupants must travel to complete the exit path.

- ❖ Luminous stripes shall extend all the way around any stair landings. This section specifies the option of stripes on the floor (see Commentary Figure 1025.2.4.1). On a typical landing, the stripe will extend across the front of the door, indicating to someone moving down the stairway that they should continue (see Commentary Figure 1025.2.4.3). At the level of exit discharge the occupant has a different visual cue. The line should not extend in front of the door leading to the exterior (see Commentary Figure 1025.2.6). This should allow people to understand which door they need to move through to get to safety.

**1025.2.4.2 Wall-mounted demarcation lines.** Perimeter demarcation lines shall be placed on the wall with the bottom edge of the stripe not more than 4 inches (102 mm) above the finished floor. At the top or bottom of the *stairs*, demarcation lines shall drop vertically to the floor within 2 inches (51 mm) of the step or landing edge. Demarcation lines on walls shall transition vertically to the floor and then extend across the floor where a line on the floor is the only practical method of outlining the path. Where the wall line is broken by a door, demarcation lines on walls shall continue across the face of the door or transition to the floor and extend across the floor in front of such door.

**Exception:** Demarcation lines shall not extend in front of *exit discharge* doors that lead out of an *exit* and through which occupants must travel to complete the exit path.

- ❖ Luminous stripes that surround the stairway landings can be on the floor or on the wall. This section specifies the option of stripes on the wall (see Commen-

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tary Figure 1025.2.4.2). See the commentary to Sections 1025.2.4 and 1025.2.4.1.

**1025.2.4.3 Transition.** Where a wall-mounted demarcation line transitions to a floor-mounted demarcation line, or vice versa, the wall-mounted demarcation line shall drop vertically to the floor to meet a complimentary extension of the floor-mounted demarcation line, thus forming a continuous marking.

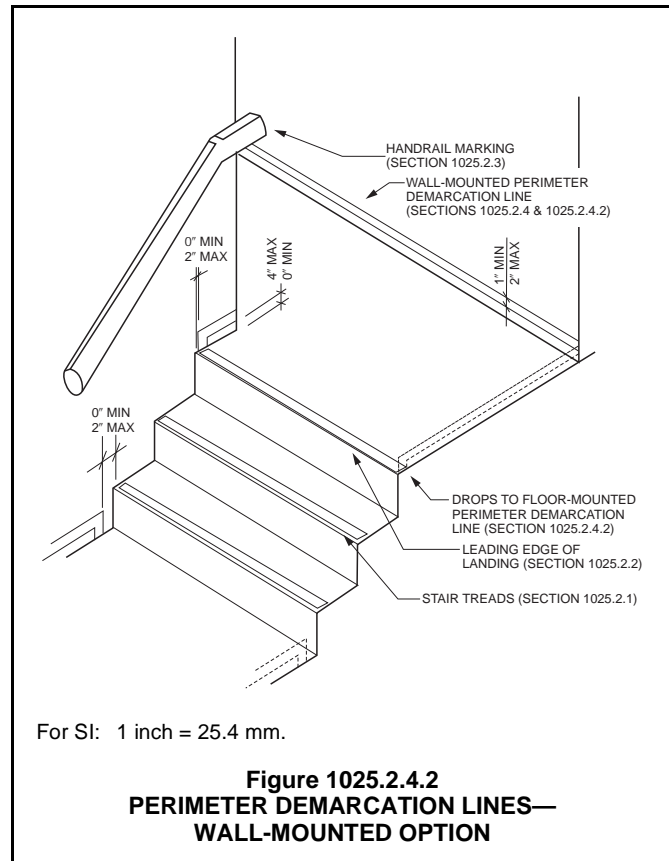
❖ While the luminous perimeter stripes on a landing can be on either the wall or the floor, when they transition from one to another, the lines should appear continuous. See Section 1025.2.4.2 for special requirements for when the wall perimeter marking transitions to the floor stripe indicating the leading edge of the landing.

When perimeter lines cross a door frame, the lines can transition or stay on the same plain (see Commentary Figure 1025.2.4.3).

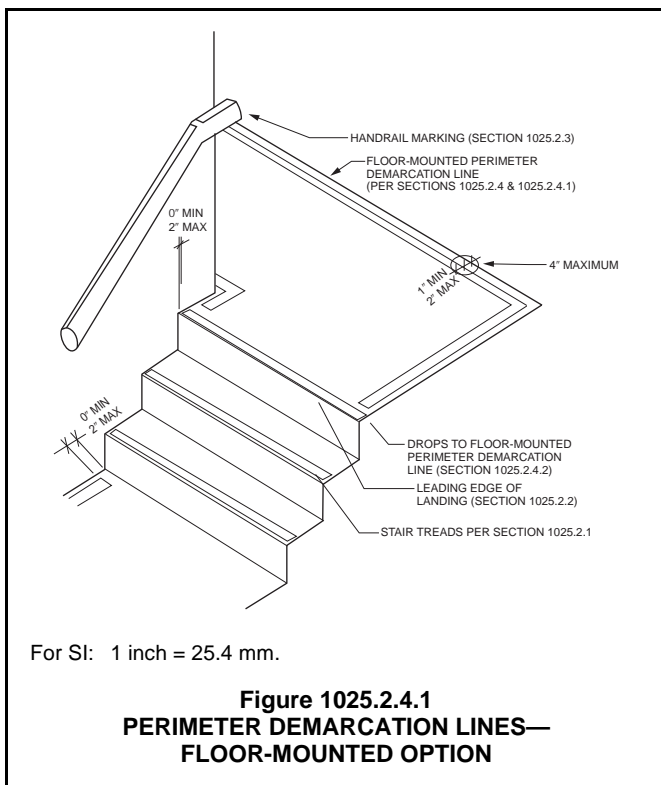
**1025.2.5 Obstacles.** Obstacles at or below 6 feet 6 inches (1981 mm) in height and projecting more than 4 inches (102 mm) into the egress path shall be outlined with markings not less than 1 inch (25 mm) in width comprised of a pattern of alternating equal bands, of luminous material and black, with the alternating bands not more than 2 inches (51 mm) thick and angled at 45 degrees (0.79 rad). Obstacles shall include, but are not limited to, standpipes, hose cabinets, wall projections and restricted height areas. However, such markings shall not conceal any required information or indicators including but not limited to instructions to occupants for the use of standpipes.

❖ Any obstacles within the stairway must be marked with a dashed line of diagonal slashes (see Commentary Figure 1025.2.5). The markings of obstacles are

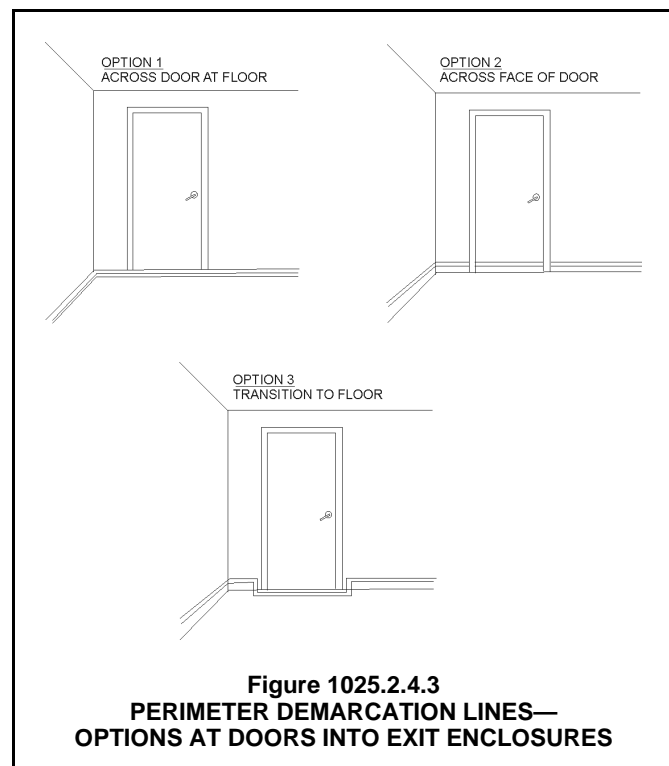
consistent with the intent of protruding object provisions in Section 1003.3. However, there is a difference in the height of 6 feet, 6 inches (1981 mm) instead of 6 feet, 8 inches (2032 mm). Items permit-



**Figure 1025.2.4.2  
PERIMETER DEMARCATION LINES—  
WALL-MOUNTED OPTION**



**Figure 1025.2.4.1  
PERIMETER DEMARCATION LINES—  
FLOOR-MOUNTED OPTION**



**Figure 1025.2.4.3  
PERIMETER DEMARCATION LINES—  
OPTIONS AT DOORS INTO EXIT ENCLOSURES**

ted within the enclosures for exit stairways are limited by Sections 1023.2 and 1023.5.

**1025.2.6 Doors within the exit path.** Doors through which occupants must pass in order to complete the exit path shall be provided with markings complying with Sections 1025.2.6.1 through 1025.2.6.3.

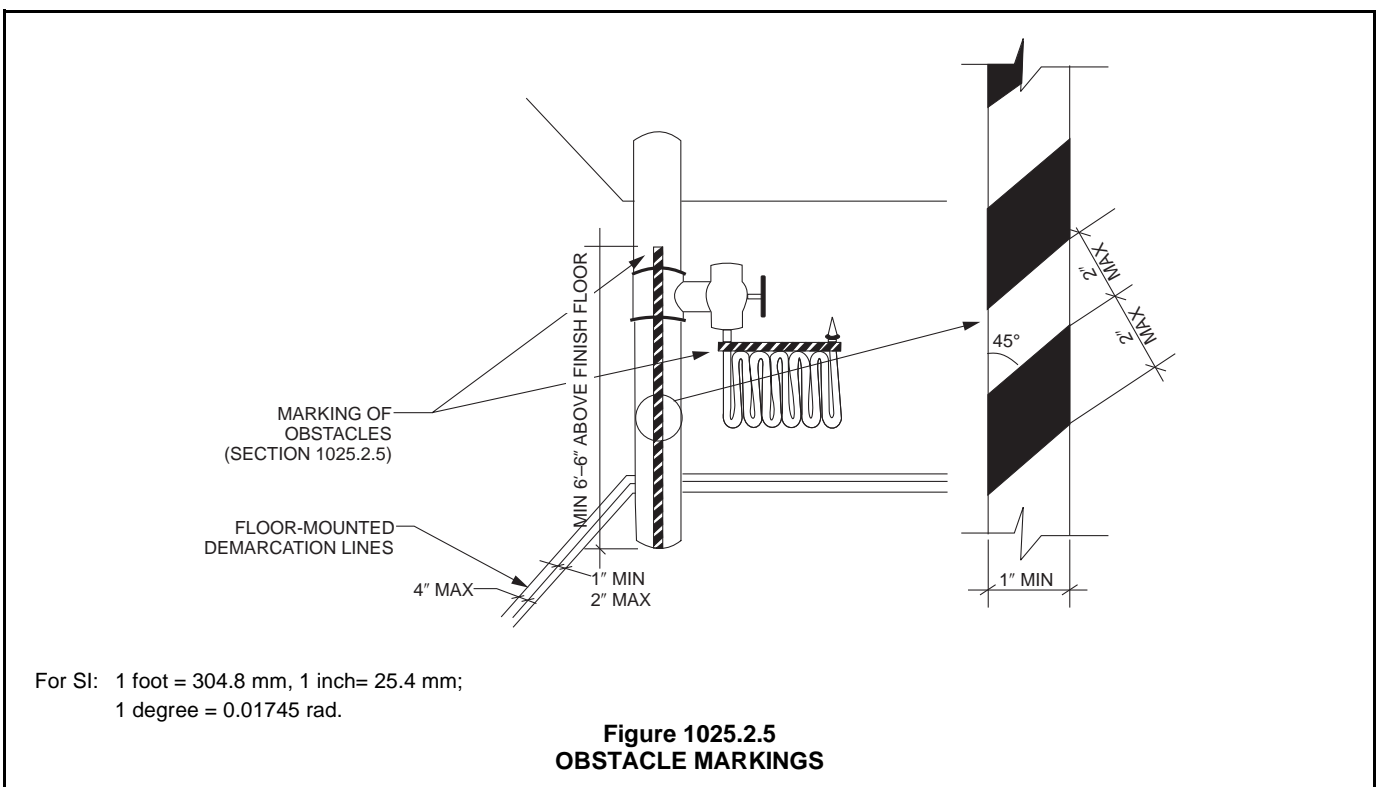
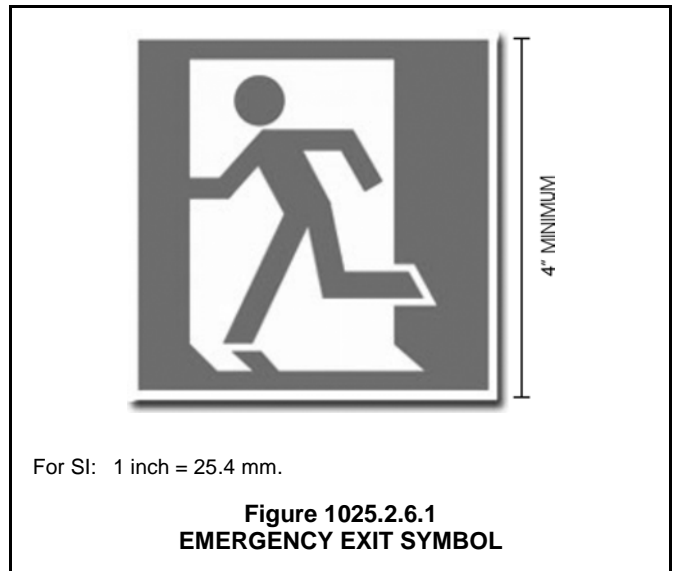
- ❖ Doors within an enclosure for an exit stairway can:
  - Lead directly to the exterior.
  - Pass through a horizontal exit (Section 1028.1, Exception 3).
  - Lead to an exit passageway on the level of exit discharge, to a lobby or vestibule at the level of exit discharge (Section 1028.1, Exceptions 2 and 3).
  - Lead to an exit passageway on a transition level.

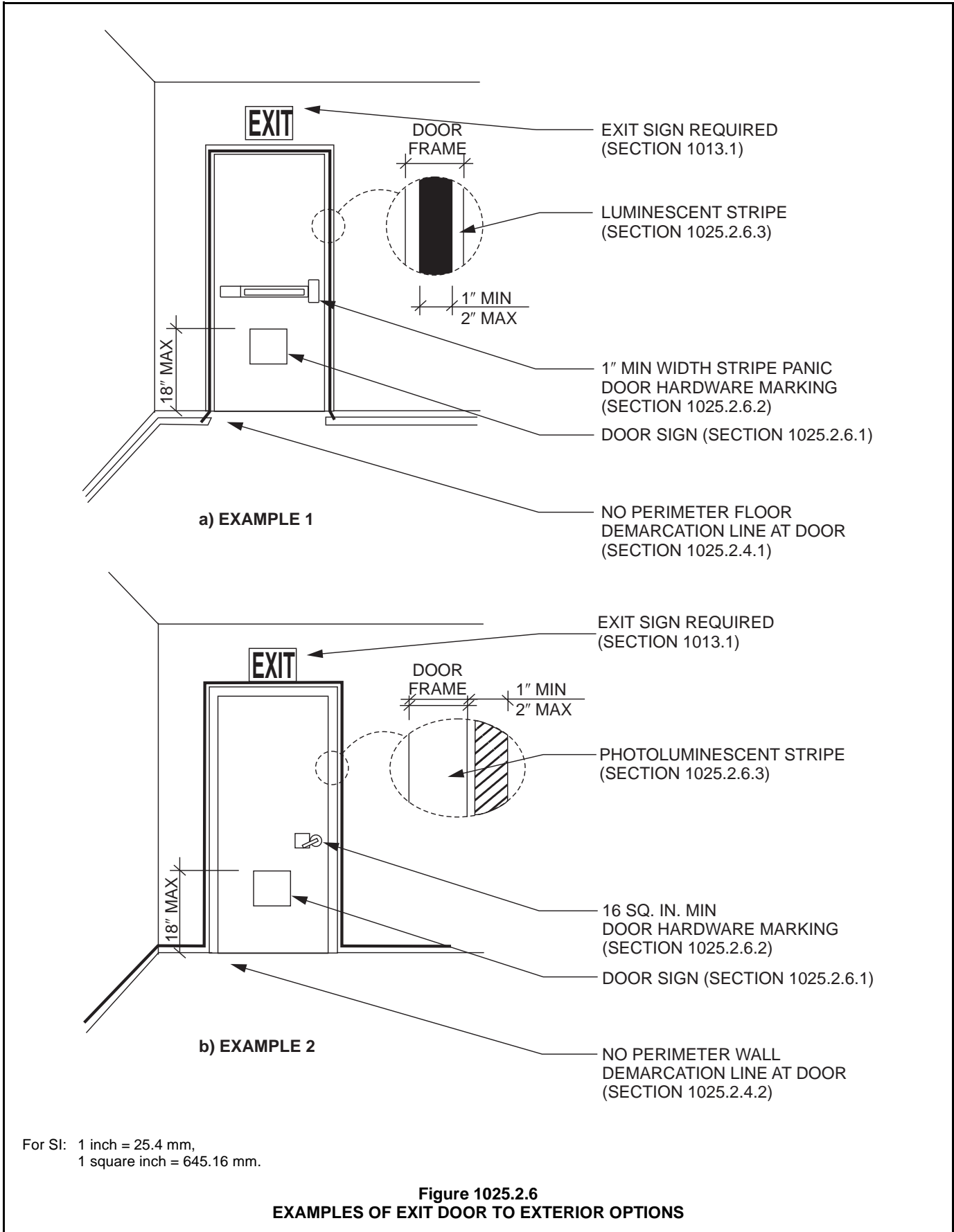
Doors at these locations should be marked as indicated in the following three subsections. Combined with the landing markings not extending across the bottom of this door, this will provide several visual cues to indicate that this is the door to continue through to get out of the building (see Commentary Figure 1025.2.6).

The NIST egress study of the World Trade Center indicated that transition floors can cause delays in egress because people hesitate when it is unclear about which way they should continue. Effectively marking these doors in four different ways will decrease that hazard. Which doors to mark is consistent with the exit sign requirements within exit enclosures in Section 1013.1.

**1025.2.6.1 Emergency exit symbol.** The doors shall be identified by a low-location luminous emergency exit symbol complying with NFPA 170. The exit symbol shall be not less than 4 inches (102 mm) in height and shall be mounted on the door, centered horizontally, with the top of the symbol not higher than 18 inches (457 mm) above the finished floor.

- ❖ The door shall include a low luminous level exit symbol within 18 inches (457 mm) of the floor. For an example of the emergency exit symbol, see Commentary Figure 1025.2.6.1. The sign on the door can be just this symbol or it can also contain additional information such as a directional arrow or "EXIT."





**1025.2.6.2 Door hardware markings.** Door hardware shall be marked with not less than 16 square inches (406 mm<sup>2</sup>) of luminous material. This marking shall be located behind, immediately adjacent to, or on the door handle or escutcheon. Where a panic bar is installed, such material shall not be less than 1 inch (25 mm) wide for the entire length of the actuating bar or touchpad.

❖ Door hardware locations must be clearly visible. If a panic bar is used, a luminous stripe with a minimum width of 1 inch (25 mm) should be provided down the entire length of the activation bar/paddle [see Commentary Figure 1025.2.6, Example 1]. If lever hardware is used, a donut, square or rectangle with a minimum area of 16 square inches (10 322 mm<sup>2</sup>) should be provided behind the hardware [see Commentary Figure 1025.2.6, Example 2]. There is also the option of marking the door handle itself, but it would be difficult to get 16 square inches (10 322 mm<sup>2</sup>) of visible surface area. Plus, over time, a finish on the hardware has a greater chance of wearing off with normal use. The language allows the designer the freedom to decide (with wear and hardware options) which configuration would give the best results.

**1025.2.6.3 Door frame markings.** The top and sides of the door frame shall be marked with a solid and continuous 1-inch- to 2-inch-wide (25 mm to 51 mm) stripe. Where the door molding does not provide sufficient flat surface on which to locate the stripe, the stripe shall be permitted to be located on the wall surrounding the frame.

❖ Doors must be marked along the sides and top with stripes similar to those provided on the stair nosing. Door frames come in a variety of shapes. If there is not space on the door for the marking stripe, the stripe can be around the perimeter of the door [see Commentary Figure 1025.2.6, Examples 1 and 2].

**1025.3 Uniformity.** Placement and dimensions of markings shall be consistent and uniform throughout the same enclosure.

❖ All exit path markings are required to be solid and have continuous stripes. A key requirement for marking systems is that their design must be uniform. The placement and dimensions of markings must be consistent for the path of travel along the exit stairway. By specifying a standard marking dimension, the requirements will ensure that the marking is visible during dark conditions and provides consistent and standard application in the design and enforcement of exit path markings. Markings installed on stair steps, perimeter demarcation lines and handrails must have a minimum width of 1 inch (25 mm). For stair steps and perimeter demarcation lines, their maximum width cannot exceed 2 inches (51 mm). The provisions for stair steps, perimeter demarcation lines and handrails allow the width of the marking to be reduced to less than 1 inch (25 mm) when marking stripes are listed in accordance with UL 1994.

**1025.4 Self-luminous and photoluminescent.** Luminous egress path markings shall be permitted to be made of any material, including paint, provided that an electrical charge is not required to maintain the required luminance. Such materials shall include, but not be limited to, *self-luminous* materials and *photoluminescent* materials. Materials shall comply with either of the following standards:

1. UL 1994.
2. ASTM E2072, except that the charging source shall be 1 footcandle (11 lux) of fluorescent illumination for 60 minutes, and the minimum luminance shall be 30 milicandelas per square meter at 10 minutes and 5 milicandelas per square meter after 90 minutes.

❖ Products utilized to meet the requirements for luminous egress path markings in high-rise buildings (see IBC Section 411.7 and Section 1025 of the code) or exit signs (see Section 1013.5) may be photoluminescent or self-luminous (see definitions in Chapter 2). An example of photoluminescent material is paint or tape that is charged by exposure to light. When the lights are turned off, the product will “glow” in the dark. Self-luminous products do not need an outside light source to charge them like photoluminescent materials do.

A variety of materials can comply with the referenced standards for egress path markings (UL 1994, and ASTM E2072) and for signs (UL 924).

ASTM E2072 allows the use of paints and coatings, which can be useful because it avoids a potential tripping hazard, especially in locations where the surface substrate may not be even. The luminescence of the selected marking system must provide an illumination of 1 footcandle (11 lux) for 60 minutes, which is consistent with the requirement in Section 1008.2 for the illumination of walking surfaces. Section 1008.3 requires the emergency lighting system to have power for 90 minutes; however, because of normal battery considerations, the IFC only requires a 60-minute duration in existing buildings.

**1025.5 Illumination.** Where *photoluminescent* exit path markings are installed, they shall be provided with not less than 1 footcandle (11 lux) of illumination for not less than 60 minutes prior to periods when the building is occupied and continuously during occupancy.

❖ Analogous to rechargeable batteries, many photoluminescent egress path markings require exposure to light to perform properly. Thus, photoluminescent egress path markings must be exposed to a minimum 1 footcandle (11 lux) of light energy at the walking surface for at least 60 minutes prior to the building being occupied. The charging rate for photoluminescent egress path markings is based on the wattage of lamps used to provide egress path illumination. Therefore it is important to verify that the specified lamps have sufficient wattage to meet the specified time period. This requirement may be a concern for buildings developed with the IECC or trying for LEED certification.

Note that this requirement does not apply to self-luminous materials since these materials operate independently of the external power source. See the definitions for “Photoluminescent” and “Self-luminous” in Chapter 2.

**SECTION 1026  
HORIZONTAL EXITS**

**1026.1 Horizontal exits.** *Horizontal exits* serving as an *exit* in a *means of egress* system shall comply with the requirements of this section. A *horizontal exit* shall not serve as the only *exit* from a portion of a building, and where two or more *exits* are required, not more than one-half of the total number of *exits* or total *exit* minimum width or required capacity shall be *horizontal exits*.

**Exceptions:**

1. *Horizontal exits* are permitted to comprise two-thirds of the required *exits* from any building or floor area for occupancies in Group I-2.
2. *Horizontal exits* are permitted to comprise 100 percent of the *exits* required for occupancies in Group I-3. Not less than 6 square feet (0.6 m<sup>2</sup>) of accessible space per occupant shall be provided on each side of the *horizontal exit* for the total number of people in adjoining compartments.

❖ Horizontal exits can provide up to 50 percent of the exits from a given area of a building. The percentage is higher for Group I-2 and I-3 occupancies where the evacuation strategy is defend in place rather than direct egress (see Commentary Figure 1026.1 for a typical horizontal exit arrangement). However, a horizontal exit cannot serve as the only exit from a single exit space. Section 1026.4 allows for some areas to have all the exits from a space to be horizontal exits under specific conditions. A horizontal exit can be designed for either one-way or two-way operation, depending on the exiting needs of each side of the wall providing the horizontal exit.

A horizontal exit may be an element of a means of egress when in compliance with the requirements of this section. The actual horizontal exit is the protected door opening in a wall, or the open-air balcony or bridge that separates two areas of a building. A horizontal exit is often used in hospitals and in prisons where it is not feasible or desirable that all occupants exit the facility (see Chapter 2 for the definition of a “Horizontal exit”).

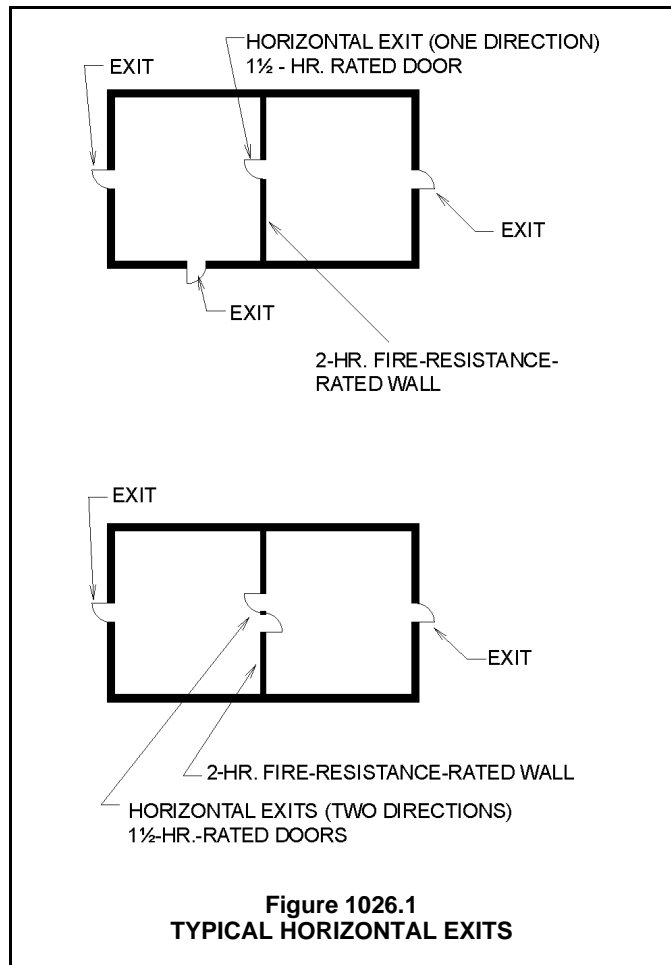
Horizontal exits and their associated “refuge areas” are considered to provide the same or higher level of protection as an “area of refuge” for people who cannot use the egress system. Sections 1009.3 and 1009.4 allow for a horizontal exit or an area of refuge as alternatives. See these sections for exceptions for buildings with sprinkler systems and/or where the path of travel has protection from the accumulation of smoke (i.e., open parking garages, open air assembly seating, smoke-protected assembly seating).

**1026.2 Separation.** The separation between buildings or refuge areas connected by a *horizontal exit* shall be provided by a *fire wall* complying with Section 706; or by a *fire barrier* complying with Section 707 or a *horizontal assembly* complying with Section 711, or both. The minimum *fire-resistance rating* of the separation shall be 2 hours. Opening protectives in *horizontal exits* shall also comply with Section 716. Duct and air transfer openings in a *fire wall* or *fire barrier* that serves as a *horizontal exit* shall also comply with Section 717. The *horizontal exit* separation shall extend vertically through all levels of the building unless floor assemblies have a *fire-resistance rating* of not less than 2 hours with no unprotected openings.

**Exception:** A *fire-resistance rating* is not required at *horizontal exits* between a building area and an above-grade *pedestrian walkway* constructed in accordance with Section 3104, provided that the distance between connected buildings is more than 20 feet (6096 mm).

*Horizontal exits* constructed as *fire barriers* shall be continuous from *exterior wall* to *exterior wall* so as to divide completely the floor served by the *horizontal exit*.

❖ The basic concept of a horizontal exit is that during a fire emergency, the occupants of a floor will transfer from one fire area to another. Separation between areas of a building can be accomplished by a fire wall



**Figure 1026.1  
TYPICAL HORIZONTAL EXITS**

(see IBC Section 706), a fire barrier (see IBC Section 707), horizontal assemblies (see IBC Section 711) or a combination thereof, with a fire-resistance rating not less than 2 hours. Any fire shutters or fire doors must have an opening protective of not less than 1½ hours (see IBC Table 716.5). Ducts and air transfer openings must comply with IBC Section 717.

In buildings of Groups I-2 and I-3, it may also be desirable (while not mandatory) for the horizontal exit to serve as a smoke barrier. In such cases, the wall containing the horizontal exit must also comply with the requirements for a smoke barrier (see IBC Section 709).

In order to decrease the amount of smoke able to migrate around the edges of a horizontal exit, the horizontal exit must extend from at least the floor to the deck above (i.e., fire barrier), as well as across the floor level from one side of the building to another. Moving up from floor to floor, there are two choices. One option is that the horizontal exit can extend vertically through all levels of the building (i.e., fire wall or fire barriers). The second option is to utilize fire barriers that are not aligned vertically (i.e., a combination of fire barriers and horizontal assemblies), but then the floor must have a 2-hour fire-resistance rating and no unprotected openings are permitted between any two refuge areas. The supporting construction would also have to be a minimum of 2 hours.

The exception is permitting a pedestrian walkway or sky bridge to act as a horizontal exit when buildings are at least 20 feet (6096 mm) apart.

**1026.3 Opening protectives.** *Fire doors in horizontal exits* shall be self-closing or automatic-closing when activated by a *smoke detector* in accordance with Section 716.5.9.3. Doors, where located in a cross-corridor condition, shall be automatic-closing by activation of a *smoke detector* installed in accordance with Section 716.5.9.3.

❖ For the safety of occupants using a horizontal exit, it is important for the doors to be fire doors that are self-closing or automatic-closing by activation of a smoke detector. Smoke detectors that initiate automatic-closing should be located at both sides of the doors (see the commentary to Section 907.3 for an additional explanation of the installation requirements). Any openings in the fire barriers or fire walls used as horizontal exits must be protected in coordination with the rating of the wall. There is a reference to IBC Section 716 for opening protectives.

**1026.4 Refuge area.** The refuge area of a *horizontal exit* shall be a space occupied by the same tenant or a public area and each such refuge area shall be adequate to accommodate the original *occupant load* of the refuge area plus the *occupant load* anticipated from the adjoining compartment. The anticipated *occupant load* from the adjoining compartment shall be based on the capacity of the *horizontal exit doors* entering the refuge area.

❖ The building area on the discharge side of a horizontal exit must serve as a refuge area for the occupants

of both sides of the floor areas connected by the horizontal exit. Therefore, adequate space must be available on each side of the wall to hold the full occupant load of that side, plus the number of occupants from the other side that may be required to use the horizontal exit. Explaining the anticipated occupant load is easiest with an example. If one side of the horizontal exit contained an assembly space with 750 occupants, three exits would be required. If one of the exits through the horizontal exit was a double door, that double exit door would have a capacity of 320 (64 inches/0.2 = 320 occupants). Therefore, the refuge area must be sized for the occupant load in the space, plus the 320 people who might come through the horizontal exit. This is a higher number than would be anticipated if the occupant load of the assembly space was divided equally between the three exits, but it is also not the entire occupant load of the assembly space.

**1026.4.1 Capacity.** The capacity of the refuge area shall be computed based on a *net floor area* allowance of 3 square feet (0.2787 m<sup>2</sup>) for each occupant to be accommodated therein.

**Exceptions:** The *net floor area* allowable per occupant shall be as follows for the indicated occupancies:

1. Six square feet (0.6 m<sup>2</sup>) per occupant for occupancies in Group I-3.
2. Fifteen square feet (1.4 m<sup>2</sup>) per occupant for ambulatory occupancies in Group I-2.
3. Thirty square feet (2.8 m<sup>2</sup>) per occupant for nonambulatory occupancies in Group I-2.

❖ These refuge areas are meant to hold the occupants temporarily in a safe place until they can evacuate the premises in an orderly manner or, in the case of hospitals and like facilities, to hold bedridden patients and other nonambulatory occupants in a protected area until the fire emergency has ended. This is commonly referred to as a defend-in-place strategy. The size of the refuge area is based on the nature of the expected occupants. In the case of Group I-3, the area will be used to hold the occupants until deliberate egress can be accomplished with staff assistance or supervision. In other cases, it is assumed that the occupants simply wait in line to egress through the required exit facilities provided on the discharge side. Although similar language is used in describing the “area of refuge” for an accessible means of egress, Section 1009.6 specifies area requirements that are insufficient for use as a “refuge area” for a horizontal exit. Care must be taken when applying both principles to the same horizontal exit.

The 3-square-foot (0.28 m<sup>2</sup>) per occupant requirement is based on the maximum permitted occupant density at which orderly movement to the exits is reasonable. The 30-square-foot (2.8 m<sup>2</sup>) per hospital or nursing home patient requirement is based on the space necessary for a bed or litter. It should be noted that 30 square feet (2.8 m<sup>2</sup>) is not based on the total

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occupant load, as would be determined in accordance with Section 1004.1, but rather on the number of nonambulatory patients. The 15-square-foot (1.4 m<sup>2</sup>) requirement for occupancies in Group I-2 facilities is based on each ambulatory patient having a staff attendant.

**1026.4.2 Number of exits.** The refuge area into which a *horizontal exit* leads shall be provided with *exits* adequate to meet the occupant requirements of this chapter, but not including the added *occupant load* imposed by persons entering the refuge area through *horizontal exits* from other areas. Not less than one refuge area exit shall lead directly to the exterior or to an *interior exit stairway* or *ramp*.

**Exception:** The adjoining compartment shall not be required to have a *stairway* or door leading directly outside, provided the refuge area into which a *horizontal exit* leads has *stairways* or doors leading directly outside and are so arranged that egress shall not require the occupants to return through the compartment from which egress originates.

❖ In a single-tenant facility, any of the spaces that are constantly available (i.e., not lockable) can be used as places of refuge. However, in spaces housing more than one tenant, public refuge areas, such as corridors or passageways, must be provided and be accessible at all times. This requirement is necessary because if a horizontal exit connected two areas occupied by different tenants, the tenants could (for privacy and security purposes) render the necessary free access through the horizontal exit ineffective. When the horizontal exit discharges into a public or common space, such as a corridor leading to an exit, each tenant can obtain the desired security.

Note that the capacity of exits (such as an exit stairway) from a refuge area into which a horizontal

exit leads is required to be sufficient for the design occupant load in the area, and does not include those who come into the space from other areas via the horizontal exit. This is because the adjacent refuge area is of sufficient safety to house occupants during a fire or until the egress system is available.

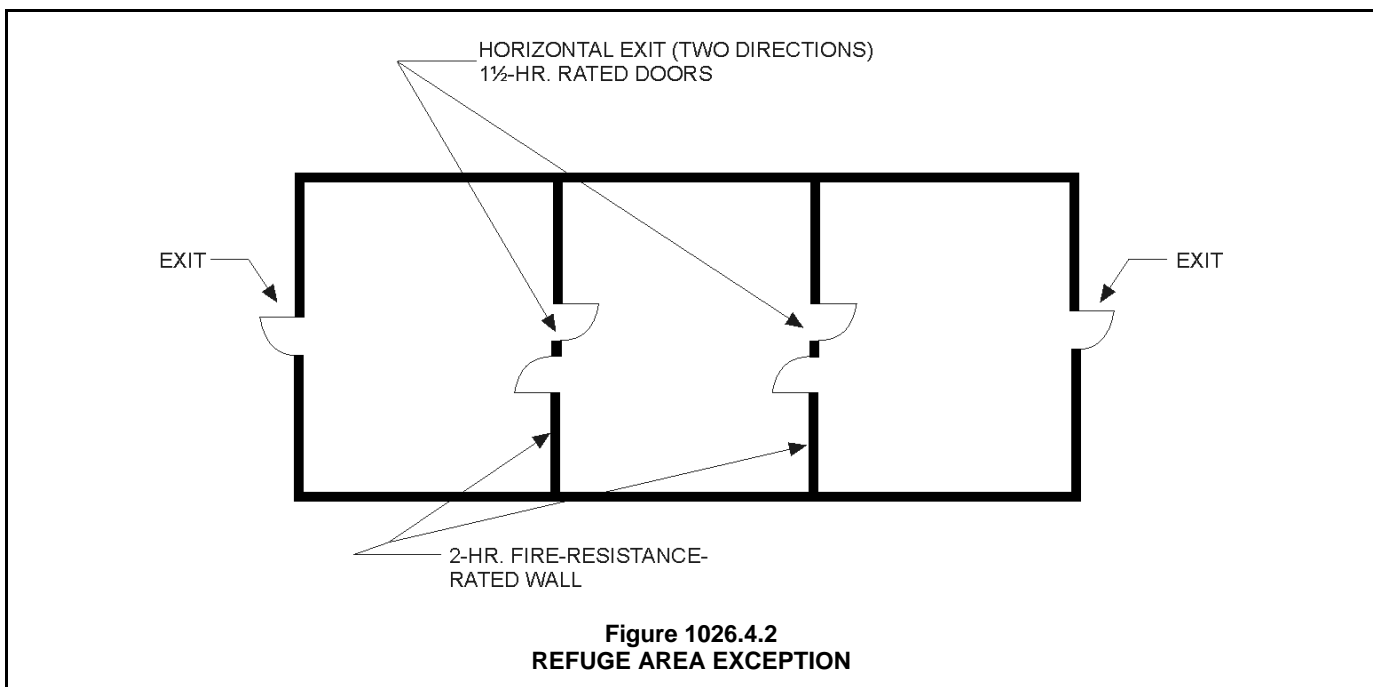
The door through the horizontal exit and the second exit must meet the separation requirements in Section 1007.1.1. Measurement of the travel distance stops at the doorway that serves as the horizontal exit. There are no requirements for travel distance from the horizontal exit to the exit (i.e., exterior exit doorway, exit stairway or exit ramp) on the other side; however, the areas on each side need to be evaluated for all means of egress requirements individually.

When there is one horizontal exit and two fire compartments, at least one exit from each side of the horizontal exit must go directly to the outside of an exit stairway or ramp enclosure (see Commentary Figure 1026.1). The exception allows for a central building/fire area with access to two horizontal exits and no direct exterior exit door or exit stairway/ramp enclosure as long as the piece on each side has access to exterior exits or exit stairways/ramps (see Commentary Figure 1026.4.2).

## SECTION 1027 EXTERIOR EXIT STAIRWAYS AND RAMPS

**1027.1 Exterior exit stairways and ramps.** *Exterior exit stairways* and *ramps* serving as an element of a required *means of egress* shall comply with this section.

❖ Stairways and ramps can be exit access, exit or exit discharge elements. Exterior exit access and exit dis-



charge stairways and ramps typically involve a change of elevation of less than a story. Exterior exit access stairways or ramps between stories must comply with Section 1019.3 and, where permitted as part of the required means of egress, are limited by Section 1006.3. Exit stairways and ramps traverse a full story or more. Interior exit stairways and ramps must be enclosed in accordance with Section 1023. This section addresses exterior stairways and ramps that function as exit elements.

Exterior exit stairways and ramps are an important element of the means of egress system and must be designed and constructed so that they will serve as a safe path of travel. The general requirements in Section 1011 also apply to exterior stairways (for ramp provisions, see Section 1012).

Outdoor stadiums and open parking garages are examples of buildings that may appear to have exterior exit stairways, but actually have open exit access stairways (Sections 1017, 1019 and 1029).

**1027.2 Use in a means of egress.** *Exterior exit stairways* shall not be used as an element of a required *means of egress* for Group I-2 occupancies. For occupancies in other than Group I-2, *exterior exit stairways* and *ramps* shall be permitted as an element of a required *means of egress* for buildings not exceeding six stories above *grade plane* or that are not *high-rise buildings*.

❖ This section specifies the conditions where exterior exit ramps or stairways can be used as required exits. Exterior exit stairways are not permitted for Group I-2 since quick evacuation of nonambulatory patients from buildings using exterior stairways is impractical. Some patients may not be capable of self-preservation and, therefore, may require assistance from staff. The period of evacuation of nonambulatory patients could become lengthy, especially in bad weather conditions.

Exterior stairways or ramps are not allowed to be required exits in buildings that exceed six stories in height because of the hazard of using such a stairway or ramp in poor weather. Some persons may not be willing to use such a stair due to vertigo. When confronted with a view from a great height, vertigo sufferers can become confused, disoriented and dizzy. They could injure themselves, become disoriented or refuse to move (freeze). In a fire situation, they could become an obstruction in the path of travel, possibly causing panic and injuries to other users of the exit.

**1027.3 Open side.** *Exterior exit stairways* and *ramps* serving as an element of a required *means of egress* shall be open on not less than one side, except for required structural columns, beams, *handrails* and *guards*. An open side shall have not less than 35 square feet (3.3 m<sup>2</sup>) of aggregate open area adjacent to each floor level and the level of each intermediate

landing. The required open area shall be located not less than 42 inches (1067 mm) above the adjacent floor or landing level.

❖ An important factor in exterior exit stairways or ramps is natural ventilation. Sufficient natural ventilation is necessary so that smoke will not be trapped above the stairway or ramp walking surfaces, thereby compromising safe egress.

The exterior exit stairway or ramp must have at least one of its sides directly facing an outer court, yard or public way. This will allow the products of combustion escaping from the interior of the building to quickly vent to the outdoor atmosphere and let the building occupants egress down the exterior exit stairway or ramp. Since exterior exit stairways or ramps are partially bounded by exterior walls, a minimum amount of exterior openness is specified by the code.

The openings on each and every floor level and landing must total 35 square feet (3.3 m<sup>2</sup>) or greater. The openings for which credit is given must occur higher than 42 inches (1067 mm) above each floor and intermediate landing level. [The bottom edge of the opening is consistent with the height requirements for guards (see Section 1015.3)]. With a standard 8-foot (2438 mm) ceiling height minus the 42-inch-high (1067 mm) guard and a typical 8-foot-wide (2438 mm) opening, the result would be 4½ feet x 8 feet = 36 square feet (3.34 m<sup>2</sup>). Openings of this height and area readily dissipate the smoke buildup from the exterior exit stairway or ramp (see Commentary Figure 1027.3).

**1027.4 Side yards.** The open areas adjoining *exterior exit stairways* or *ramps* shall be either *yards*, *courts* or *public ways*; the remaining sides are permitted to be enclosed by the *exterior walls* of the building.

❖ This section simply specifies the type of areas that the exterior opening of the exterior exit stairway or ramp is to adjoin. These open spaces will enable the smoke to dissipate from the exterior exit stairway or ramp so it will be usable as a required exit. See Section 1027.3 for a discussion of the opening requirements. See Sections 1027.4 and 1206 for the minimum sizes of yards and courts.

**1027.5 Location.** *Exterior exit stairways* and *ramps* shall have a minimum fire separation distance of 10 feet (3048 mm) measured at right angles from the exterior edge of the *stairway* or *ramps*, including landings, to:

1. Adjacent *lot lines*.
2. Other portions of the building.
3. Other buildings on the same lot unless the adjacent building *exterior walls* and openings are protected in accordance with Section 705 based on *fire separation distance*.

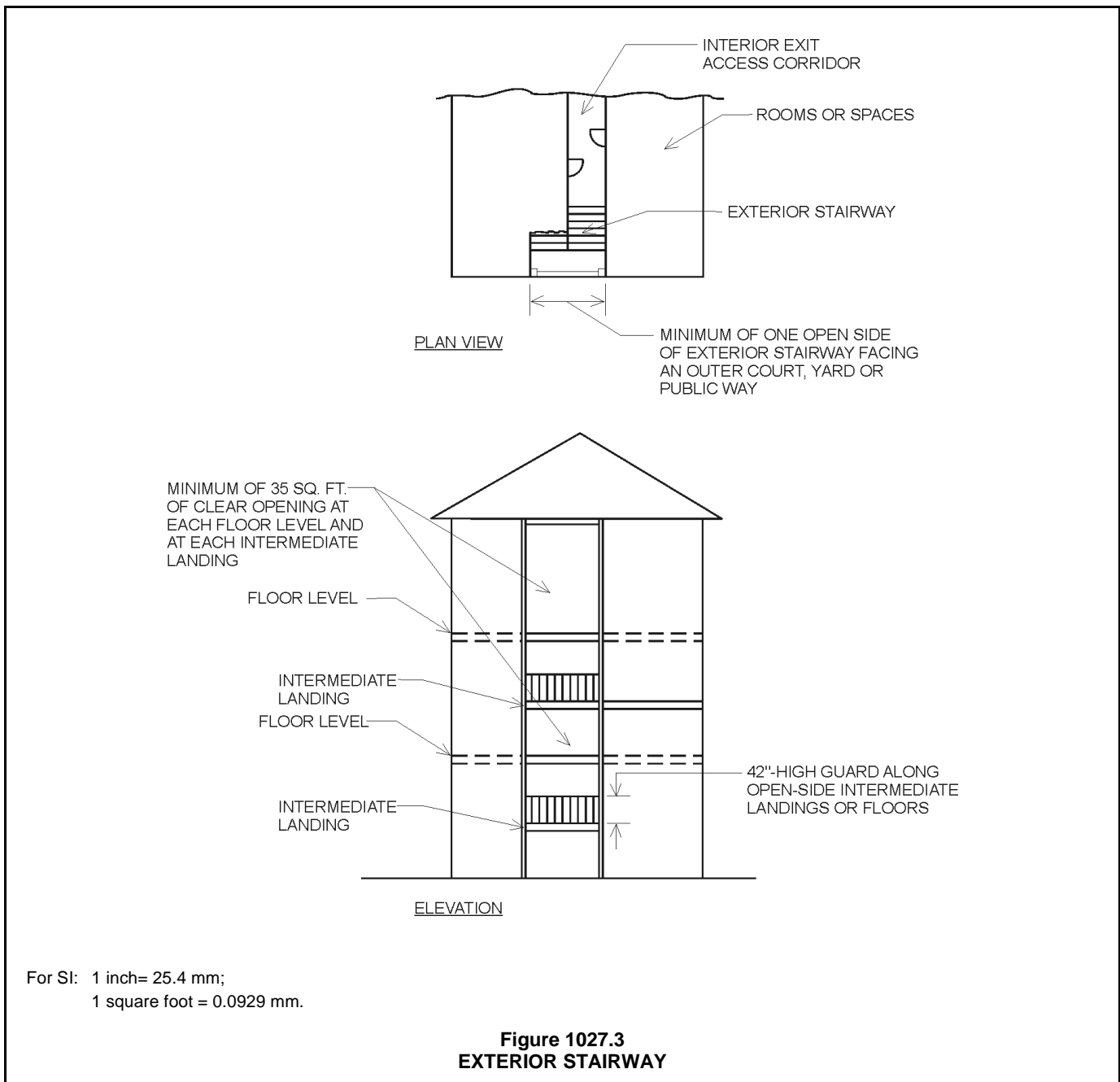
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For the purposes of this section, other portions of the building shall be treated as separate buildings.

- ❖ The location requirements of this section protect the users of the exterior exit stairway or ramp from the effects of a fire in another building on the same lot or an adjacent lot. The separation distance reduces the exposure to heat and smoke. If the exterior exit stairway or ramp is closer than specified, then adjacent buildings' exterior walls and openings are to be protected in accordance with IBC Section 705 so that the users of the exterior exit stairway or ramp are protected. The reason for a minimum required distance to a lot line is to provide for a future building that could be built on an adjacent lot. While buildings on

the same lot can be considered one building for height and area limitations (see IBC Section 503.1.2), they must be separated by a minimum of 10 feet (3048 mm) if there is a path for exit discharge between them. The purpose of the last sentence is to clarify that an exterior exit stairway or ramp needs a minimum 10-foot separation where a building wraps around on itself, such as a U-shaped building. It is not intended that the distance be measured to an imaginary lot line between buildings on the same lot.

Requirements are the same for exterior egress balconies (Section 1021.4). For an illustration of exterior egress balconies and exterior exit stairways working together, see Commentary Figure 1027.5.



**1027.6 Exterior exit stairway and ramp protection.** *Exterior exit stairways and ramps* shall be separated from the interior of the building as required in Section 1023.2. Openings shall be limited to those necessary for egress from normally occupied spaces. Where a vertical plane projecting from the edge of an *exterior exit stairway or ramp* and landings is exposed by other parts of the building at an angle of less than 180 degrees (3.14 rad), the exterior wall shall be rated in accordance with Section 1023.7.

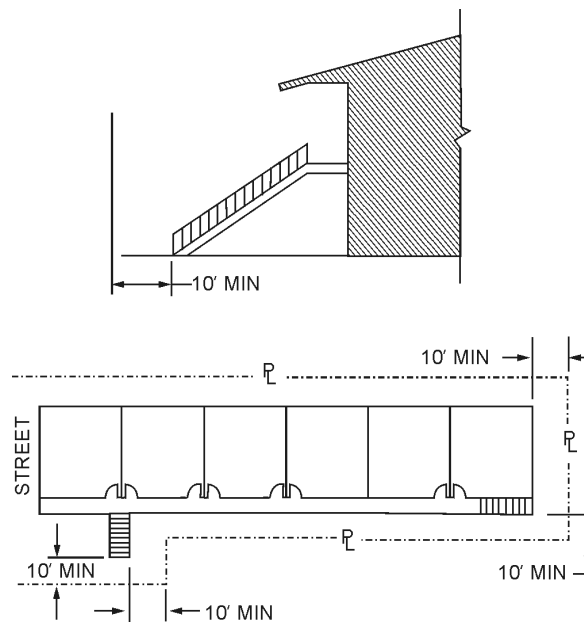
**Exceptions:**

1. Separation from the interior of the building is not required for occupancies, other than those in Group R-1 or R-2, in buildings that are not more than two stories above *grade plane* where a *level of exit discharge* serving such occupancies is the first story above *grade plane*.
2. Separation from the interior of the building is not required where the *exterior exit stairway or ramp* is served by an *exterior exit ramp* or balcony that connects two remote *exterior exit stairways* or other *approved exits* with a perimeter that is not less than 50 percent open. To be considered open, the opening shall be not less than 50 percent of the height of the enclosing wall, with the top of the openings not less than 7 feet (2134 mm) above the top of the balcony.
3. Separation from the open-ended *corridor* of the building is not required for *exterior exit stairways or ramps*, provided that Items 3.1 through 3.5 are met:
  - 3.1. The building, including open-ended *corridors*, and *stairways and ramps*, shall be equipped throughout with an *automatic*

*sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2.

- 3.2. The open-ended *corridors* comply with Section 1020.
- 3.3. The open-ended *corridors* are connected on each end to an *exterior exit stairway or ramp* complying with Section 1027.
- 3.4. The *exterior walls* and openings adjacent to the *exterior exit stairway or ramp* comply with Section 1023.7.
- 3.5. At any location in an open-ended *corridor* where a change of direction exceeding 45 degrees (0.79 rad) occurs, a clear opening of not less than 35 square feet (3.3 m<sup>2</sup>) or an *exterior stairway or ramp* shall be provided. Where clear openings are provided, they shall be located so as to minimize the accumulation of smoke or toxic gases.

- ❖ Exterior exit stairways or ramps must be protected from interior fires that may project through windows or other openings adjacent to the exit stairway or ramp, possibly endangering the occupants using this means of egress to reach grade. The protection of an exterior exit stairway or ramp is to be obtained by separating the exterior exit from the interior of the building using exterior walls having a fire-resistance rating of at least 1 hour with opening protectives. Consistent with the protection required in Sections 1023.2 and 1023.7 for interior exit stairways, the fire-resistance rating must be provided for a distance of 10 feet (3048 mm) horizontally and vertically from the ramp or stairway



For SI: 1 foot = 304.8 mm.

**Figure 1027.5**  
**EXTERIOR BALCONY AND STAIRWAY ADJACENT TO LOT LINE**

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edges, and from the ground to a level of 10 feet (3048 mm) above the highest landing.

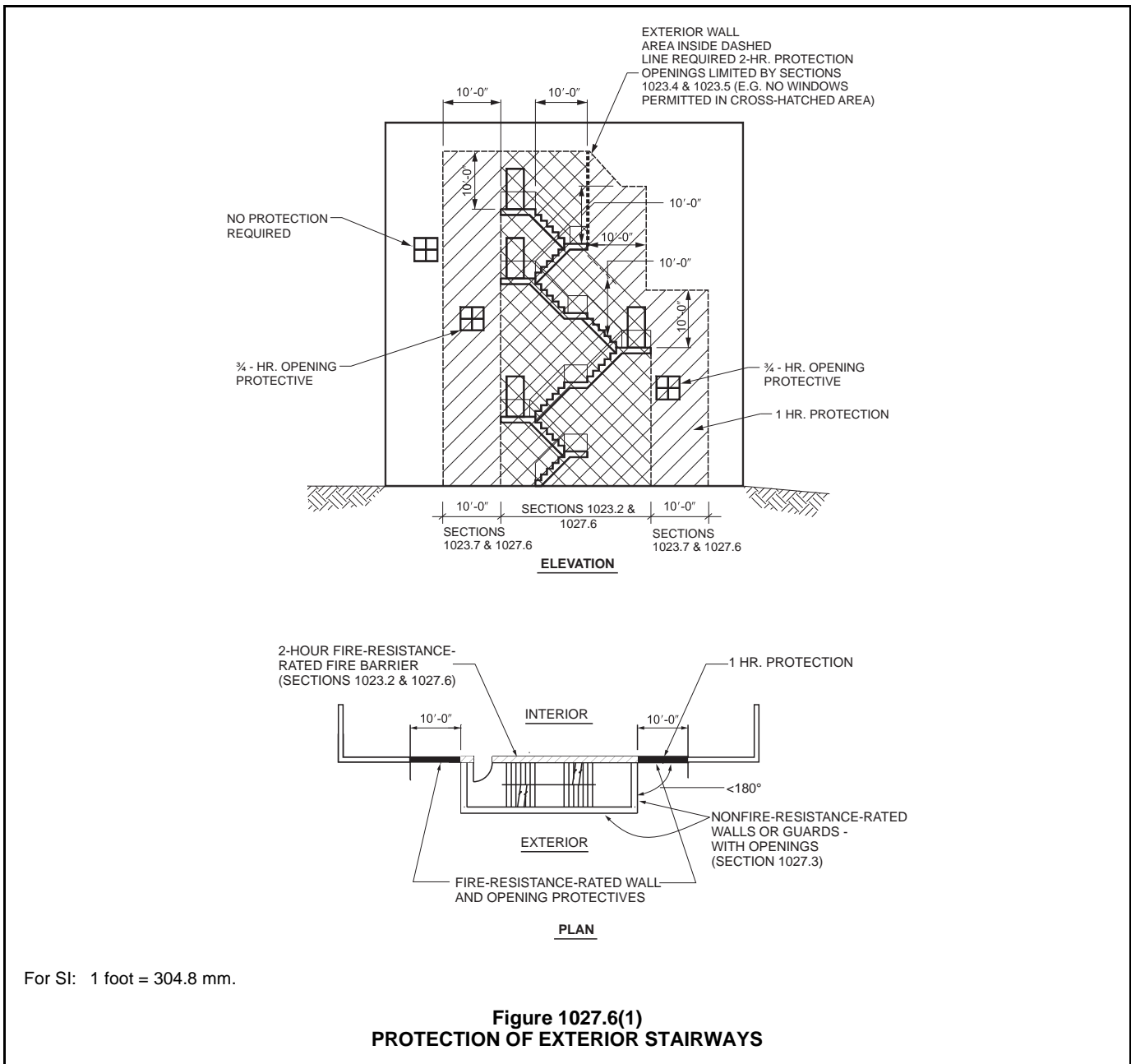
All window and door openings falling inside the 10-foot (3048 mm) horizontal separation distance as well as all window and door openings 10 feet (3048 mm) above the topmost landing and below the stairway must be protected with minimum 3/4-hour fire protection-rated opening protectives [see Commentary Figure 1027.6(1)]. The last sentence is similar to Section 1023.7 except that instead of measuring the angle between the building exterior walls and the unprotected walls at the exterior of the stairway or ramp, the measurement is between the building exterior walls and a vertical projection for the planes of the guard of the exterior stairway and ramp including landings.

Openings within the width of the stairway must only

be from normally occupied spaces. This is consistent with the requirements for vertical exit enclosures (see Sections 1023.4 and 1023.5).

Exception 1 indicates that opening protectives are not required for occupancies (other than Groups R-1 and R-2) that are two stories or less above grade when the level of exit discharge is at the lower story. The reason for this exception is that in cases of fire in low buildings, the occupants are usually able to evacuate the premises before the fire can emerge through exterior wall openings and endanger the exit ramp or stairways. In hotels and apartments, however, the occupants' response to a fire emergency could be significantly reduced because they may be either unfamiliar with the surroundings or sleeping.

Exception 2 allows the opening protectives to be



omitted when an exterior exit access balcony is served by two exits and when the exits are remote from each other. Remoteness is regulated by Section 1007. This exception is applicable to all groups. In such instances, it is unlikely that the users of the exterior stairway or ramp will become trapped by fire, since they have the option of using the balcony to gain access to either of the two available exits, and the products of combustion will be vented directly to the outside (see Section 1021.1 regarding exterior balconies). At least one-half of the total perimeter of the exterior balcony must be permanently open to the outside. The requirement for at least one-half the height of that level to be open allows for columns, solid guards and architectural or decorative elements, such as arches. With the top of the opening at least 7 feet (2134 mm) above the walking surface, products of combustion can vent and allow occupant passage below the smoke layer [see Commentary Figure 1027.6(2)].

An open-ended corridor is not defined in Chapter 2. Exception 3 deletes the requirement for a separation between the interior of the building and the exterior wall area immediately adjacent to the exit stairway where an open-ended corridor (breezeway) interfaces with an exterior stairway or ramp. In other words, a door is not required between the exterior exit stairway and the open-ended corridor. The separation is not needed because of the NFPA 13 or 13R sprinkler system is required in all areas of the building, including the open-ended corridor. The other characteristics of the open-ended corridor described in this exception are needed so that it is safe to be used in the event of a fire. The requirements for an exterior stairway or ramp at each end, and the additional openings or

exterior stairways or ramps where the open-ended corridor has a change of direction of greater than 45 degrees (0.79 rad), are for adequate ventilation of the open-ended corridor. The corridor may be required to be rated per Table 1020.1. The reference back to Section 1023.7 results in any exterior walls that form an angle less than 180 degrees (3.14 rad) from the side of the exterior exit stairway to be protected for a distance of 10 feet (3048 mm) [see Commentary Figure 1027.6(3)]. Exit access travel distance on an open-ended corridor is measured to the first riser of an exterior stair or the beginning slope of an exterior ramp.

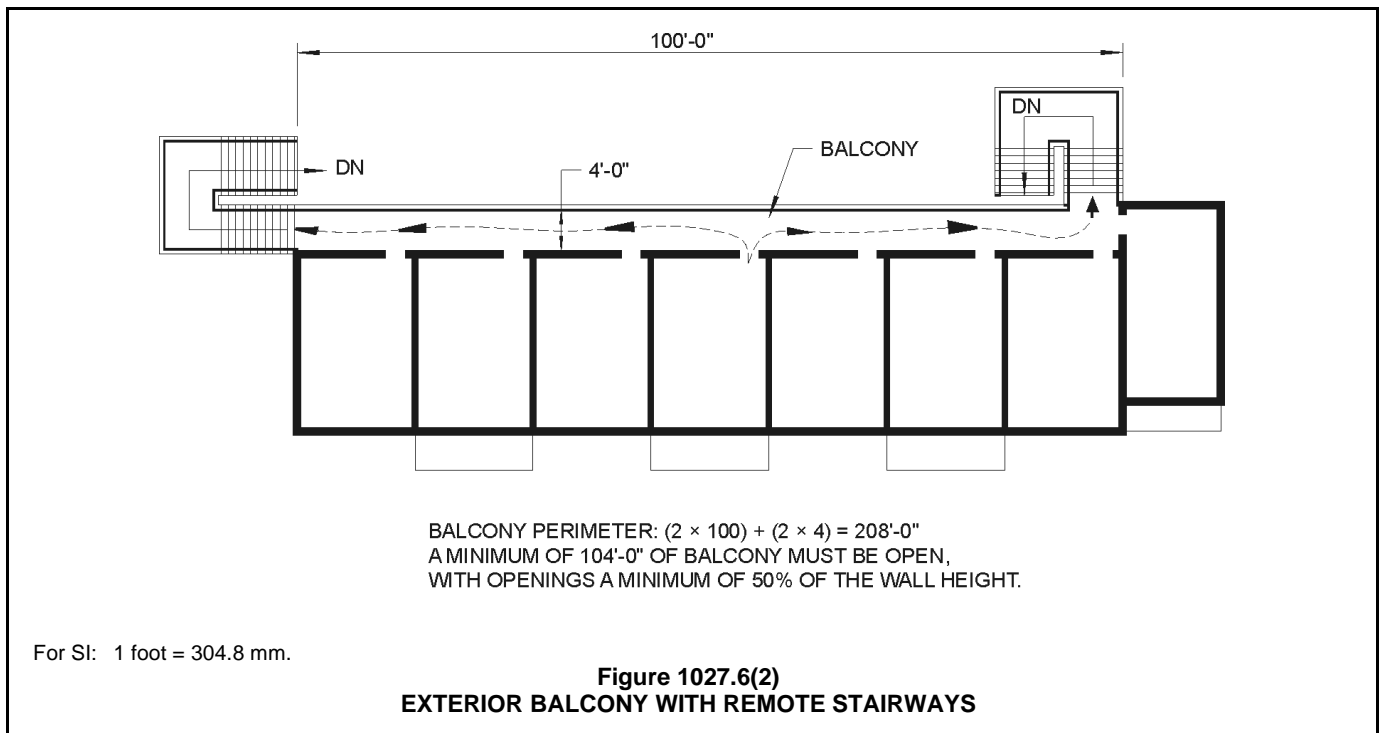
Similar separation language is used in describing the exterior wall requirements for an exterior area for assisted rescue that is provided at an exit located above grade level. Where there are steps, they are merely part of the exit discharge, not exterior exit stairways as addressed in this section.

**SECTION 1028  
EXIT DISCHARGE**

**1028.1 General.** Exits shall discharge directly to the exterior of the building. The *exit discharge* shall be at grade or shall provide a direct path of egress travel to grade. The *exit discharge* shall not reenter a building. The combined use of Exceptions 1 and 2 shall not exceed 50 percent of the number and minimum width or required capacity of the required exits.

**Exceptions:**

1. Not more than 50 percent of the number and minimum width or required capacity of *interior exit stairways and ramps* is permitted to egress through



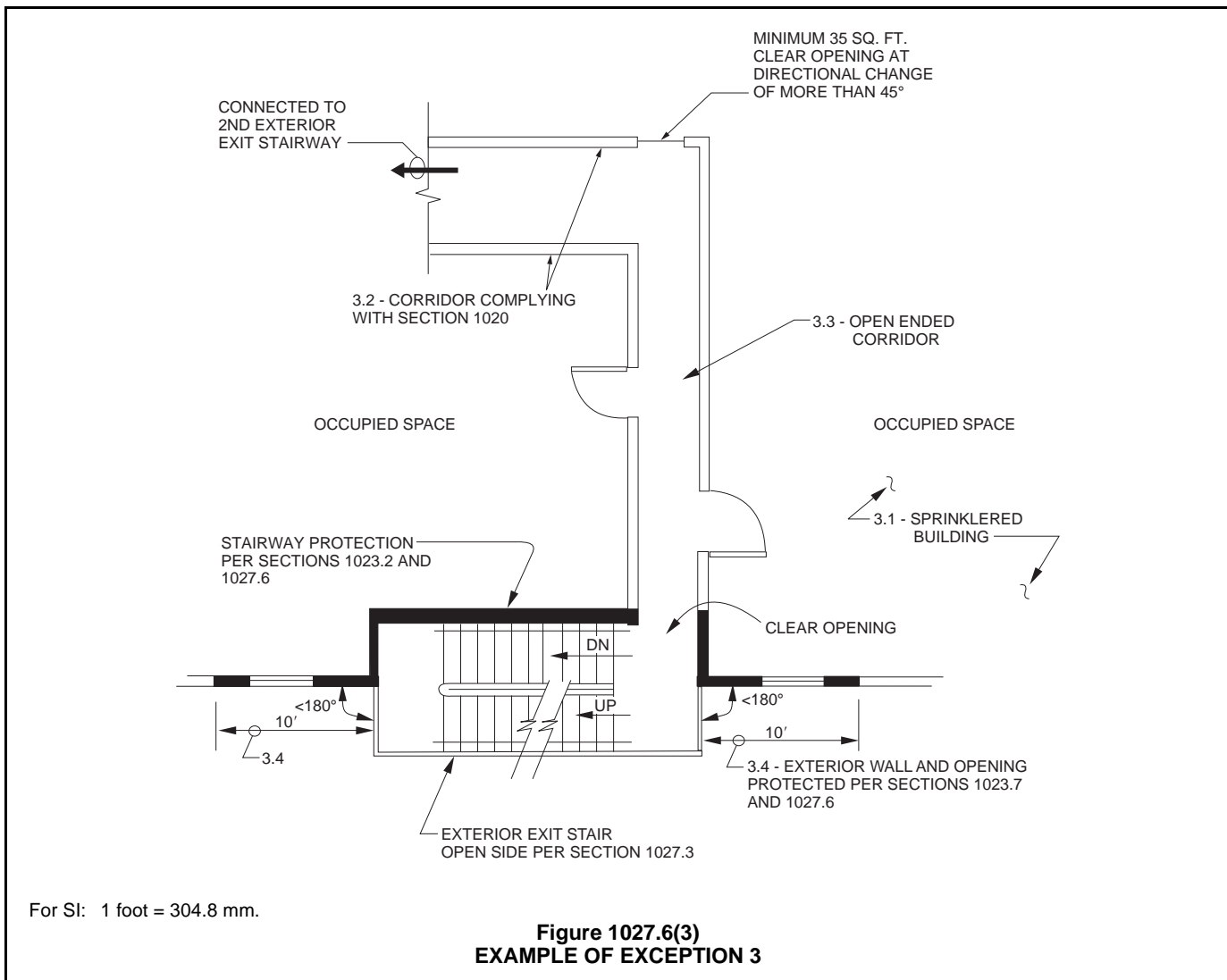
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areas on the level of discharge provided all of the following conditions are met:

- 1.1. Discharge of *interior exit stairways* and *ramps* shall be provided with a free and unobstructed path of travel to an exterior *exit* door and such *exit* is readily visible and identifiable from the point of termination of the enclosure.
- 1.2. The entire area of the *level of exit discharge* is separated from areas below by construction conforming to the *fire-resistance rating* for the enclosure.
- 1.3. The egress path from the *interior exit stairway* and *ramp* on the *level of exit discharge* is protected throughout by an *approved automatic sprinkler system*. Portions of the *level of exit discharge* with access to the egress path shall be either equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, or separated from

the egress path in accordance with the requirements for the enclosure of *interior exit stairways* or *ramps*.

- 1.4. Where a required *interior exit stairway* or *ramp* and an *exit access stairway* or *ramp* serve the same floor level and terminate at the same *level of exit discharge*, the termination of the *exit access stairway* or *ramp* and the *exit discharge* door of the *interior exit stairway* or *ramp* shall be separated by a distance of not less than 30 feet (9144 mm) or not less than one-fourth the length of the maximum overall diagonal dimension of the building, whichever is less. The distance shall be measured in a straight line between the *exit discharge* door from the *interior exit stairway* or *ramp* and the last tread of the *exit access stairway* or termination of slope of the *exit access ramp*.
2. Not more than 50 percent of the number and minimum width or required capacity of the *interior exit stairways* and *ramps* is permitted to egress through a



vestibule provided all of the following conditions are met:

- 2.1. The entire area of the vestibule is separated from areas below by construction conforming to the *fire-resistance rating* of the *interior exit stairway* or *ramp enclosure*.
- 2.2. The depth from the exterior of the building is not greater than 10 feet (3048 mm) and the length is not greater than 30 feet (9144 mm).
- 2.3. The area is separated from the remainder of the *level of exit discharge* by a *fire partition* constructed in accordance with Section 708.

**Exception:** The maximum transmitted temperature rise is not required.

- 2.4. The area is used only for *means of egress* and *exits* directly to the outside.
3. *Horizontal exits* complying with Section 1026 shall not be required to discharge directly to the exterior of the building.

❖ The exit discharge is the third piece of the means of egress system, which includes exit access, exit and exit discharge. The general provisions for means of egress in Sections 1003 through 1015 are applicable to the exit discharge. The basic provision is that exits must discharge directly to the outside of the building. The exit discharge is the path from the termination of the exit to the public way. When it is not practical to discharge directly to the outside, there are four alternatives: an exit passageway (see Section 1024), an exit discharge lobby (see Section 1028.1, Exception 1), an exit discharge vestibule (see Section 1028.1, Exception 2) or a horizontal exit (see Sections 1026 and 1028.1, Exception 3). While Exceptions 1 and 2 could be applicable for exit passageways and exit ramps, they are most often applied for exit stairways. The commentary for Section 1027 will be limited to interior exit stairways that are enclosed in accordance with Section 1023 (see Sections 1006 and 1019.3 for exit access stairway requirements). Up to 50 percent of the interior exit stairways in a building may use either Exception 1 or 2; therefore, neither exception is viable for a single-exit building. In a two- or three-exit building, either a lobby or a vestibule can be used for exit discharge for one of the exit stairways. In a four-exit building, two of the exit stairways can use either a lobby or a vestibule for exit discharge.

An interior exit discharge lobby is permitted to receive the discharge from an exit stairway in lieu of the stairway discharging directly to the exterior. A fire door must be provided at the point where the exit stairway discharges into the lobby. Without an opening protective between the stairway and a lobby, it would be possible for the stairway to be directly exposed to smoke movement from a fire in the lobby. The opening protective provides for full continuity of

the vertical component of the exit arrangement. Additionally, in buildings where stair towers must be pressurized, pressurization would not be possible without a door at the lobby level.

An exit discharge lobby is the sole location recognized in the code where an exit element can be used for purposes other than pedestrian travel for means of egress. The lobby may contain furniture or decoration and nonoccupiable spaces may open directly into the lobby. The lobby, and all other areas on the same level that are not separated from the lobby by fire barriers consistent with the rating of the stair enclosure, must be sprinklered in accordance with an NFPA 13 or NFPA 13R system [see Commentary Figure 1028.1(1)]. If the entire level is sprinklered, no separation is required. In this case, the automatic sprinkler system is anticipated to control and (perhaps) eliminate the fire threat so as not to jeopardize the path of egress of the occupants. The lobby floor and any supporting construction must be rated the same as the stairway enclosure. If the lobby is slab on grade, this requirement is not applicable. This is consistent with the fundamental concept that an exit enclosure provides the necessary level of protection from adjacent areas. A path of travel through the lobby must be continually clear and available. The exit door leading out of the building must be visible and identifiable immediately when a person leaves the exit. This does not mean the exterior exit door must be directly in front of the door at the bottom of the stairway, but the intent is that it should be within the general range of vision. A person should not have to turn completely around or go around a corner to be able to see the way out.

Item 1.4 addresses when an exit access stairway and an exit stairway both discharge into the same lobby on the ground floor. For example, many hotels have meeting rooms on the level immediately above the lobby. This heavier occupant load, or circulation considerations, may result in an exit access stairway coming down from that second level into the same lobby that is being used for discharge from the upper floors for one of the required exit stairways. This limitation for a 30-foot (9144) separation is to prevent an exit access stairway and an exit stairway from termination too close together on the level of exit discharge. The intent is that one localized fire event in the lobby will not jeopardize the use of both means of egress components. The 30-foot or  $1/4$  diagonal separation distances were based on the 30-foot or  $1/4$  diagonal that is specified for separation of interior stairways in a high-rise building (see IBC Section 403.5.1). This measurement is taken only at the bottom of the exit access stairway and the door to the exit enclosure. It is not required to be maintained the entire length of the stairway as required for two exit access stairways in Section 1007.1.3. The enclosure of the exit stairway offers sufficient separation protection. The intent of the exception is to allow for glazing that meets the smoke partition requirements.

## MEANS OF EGRESS

An exit is also allowed to discharge through a vestibule, provided it complies with the specified requirements of Exception 2. Vestibules utilizing this provision are not to be used for other purposes, such as access to closets, furniture/seating, drinking fountains, vending machines, etc. The vestibule floor and any supporting construction must be rated the same as the stairway enclosure. If the vestibule is slab on grade, this requirement is not applicable. The size of the vestibule is limited so that it cannot be used for other activities, and the travel distance from the exit stairway to the exterior exit doorway is limited [see Commentary Figures 1028.1(2) and 1028.1(3)]. The interior walls of the vestibule must be constructed as fire partitions with a fire-protection rating of at least 1 hour. IBC Section 708 does not reference a specific test standard for fire partitions. As such, fire partitions must comply with ASTM E119 or UL 263 per IBC Section 703.2 (see IBC Section 703.2 for additional commentary on the tests). ASTM E119 and UL 263 have a transmission of heat criterion for nonbearing partitions to be considered as having passed the test. The exception exempts fire partitions for the separation of a vestibule from having to comply with the transmission of heat criterion. Glass panels set in a metal frame can be used for the vestibule as long as they meet the rest of the ASTM E119 criteria.

Exception 3 acknowledges that horizontal exits offer refuge areas that will have access to an exit on

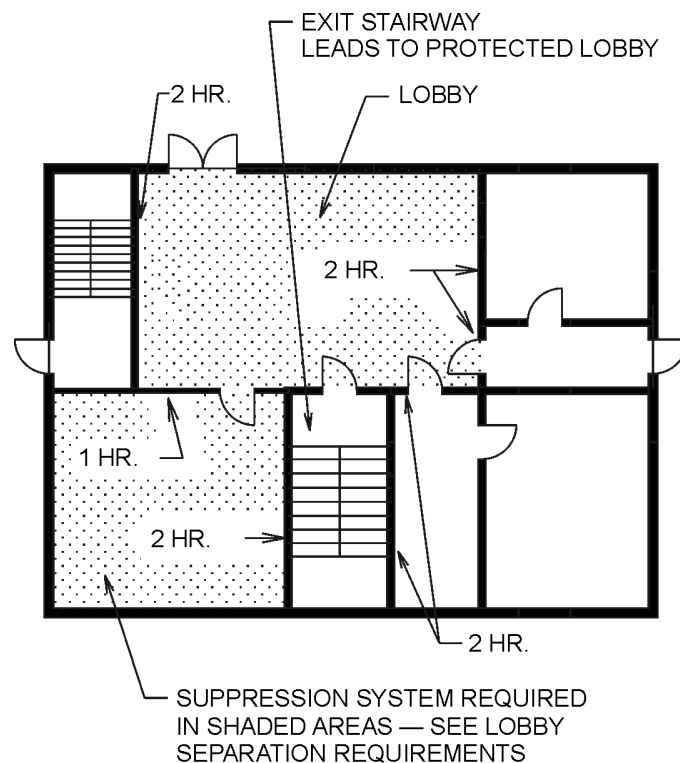
the other side; therefore, a stairway that exits through a horizontal exit is not required to exit to the exterior. Many hospitals and correctional facilities use horizontal exits to “defend in place” rather than require an immediate building evacuation. There are exit stairways or exits available from the refuge areas, so occupants can move to the outside if needed (see Section 1026 for additional information).

**1028.2 Exit discharge width or capacity.** The minimum width or required capacity of the *exit discharge* shall be not less than the minimum width or required capacity of the *exits* being served.

❖ This section specifies the exit discharge width based on minimum width and the number of occupants exiting (capacity). The exit discharge is required to be designed for the occupant from all of the exits it serves. If the exit discharge serves two exits, it is to be designed for the sum of the occupants served by both exits. Note that the capacity of the exit discharge is not required to match the total provided capacity of both exits, which is typically higher than the sum of the occupants served by both exits.

**1028.3 Exit discharge components.** *Exit discharge* components shall be sufficiently open to the exterior so as to minimize the accumulation of smoke and toxic gases.

❖ An exit discharge component could be a large open space where people could discharge in a number of

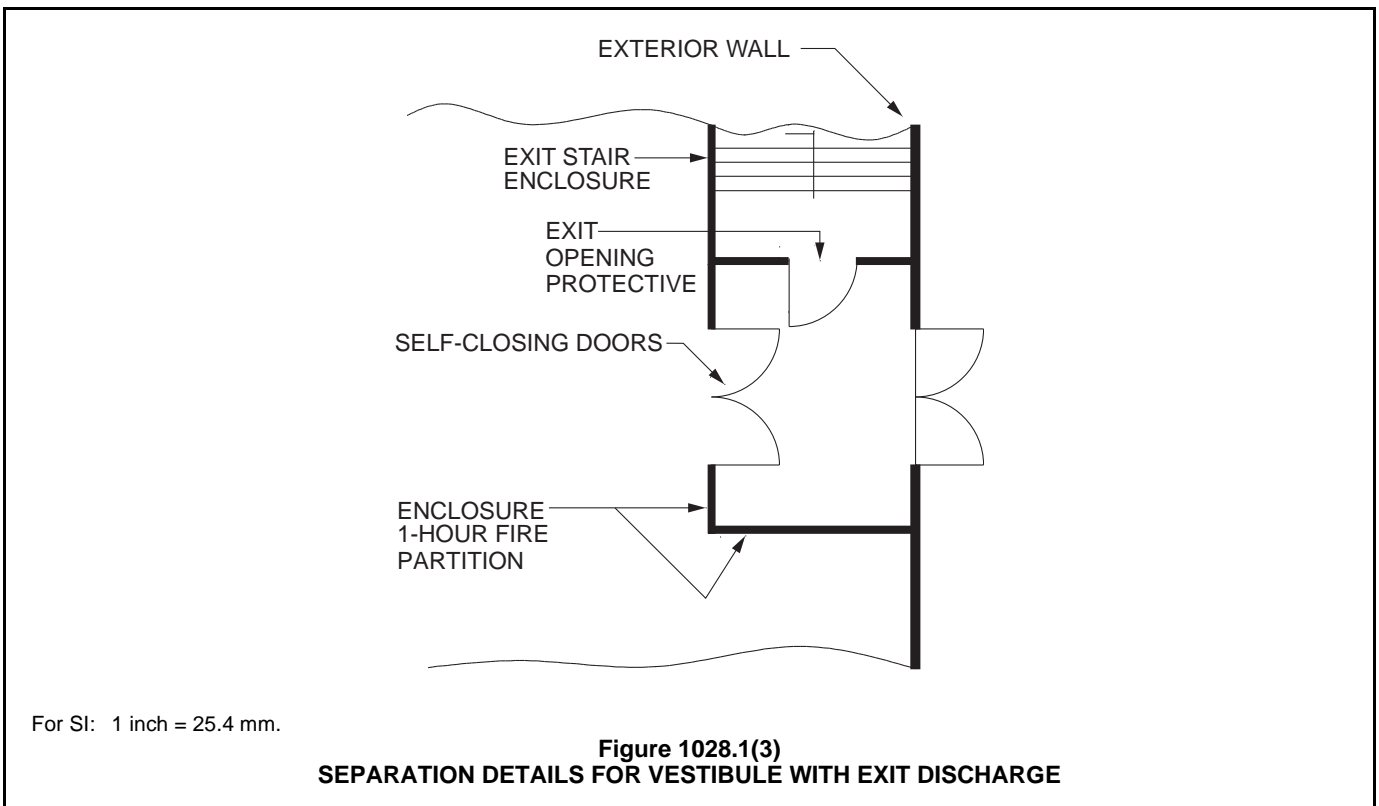
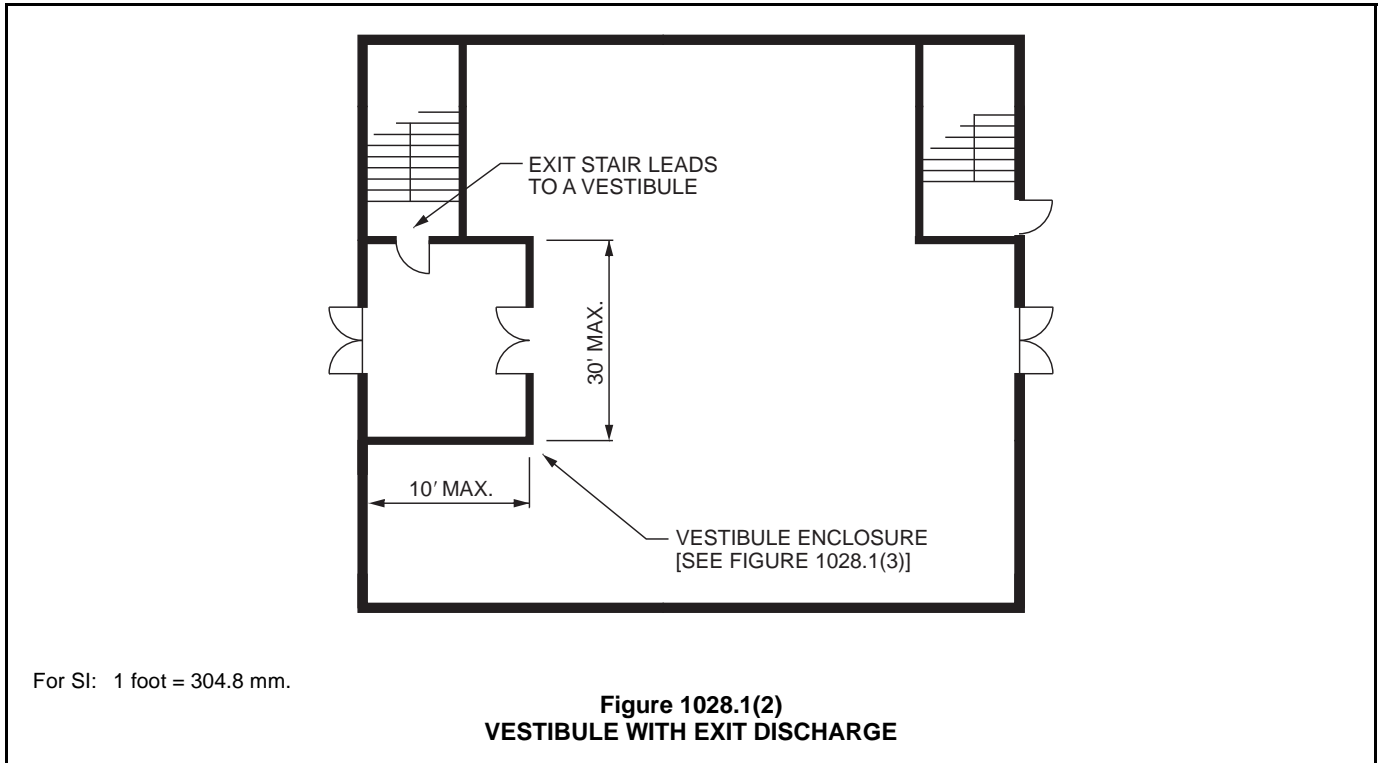


**Figure 1028.1(1)**  
**PROTECTION OF LOBBY WITH AN EXIT DISCHARGE**

different directions or it could be limited to a narrower path by landscaping or walls (i.e., egress court). In all cases, the space must be open enough to the outside that smoke and fumes will vent upward and away from people evacuating the building.

**1028.4 Egress courts.** *Egress courts* serving as a portion of the *exit discharge* in the *means of egress* system shall comply with the requirements of Sections 1028.4.1 and 1028.4.2.

❖ A portion of the exit discharge that is partially confined by exterior walls or other elements that confine



## MEANS OF EGRESS

the discharge path to a single narrow route is regulated as an egress court.

This section and the following subsections address the detailed requirements for egress courts. It is essential that exterior egress courts serving occupants from an exit to a public way be sufficiently open to prevent the accumulation of smoke and toxic gases in the event of a fire as well as wide enough to accommodate the number of occupants leaving in that direction.

See IBC Section 1206 for additional minimum width and openness requirements when yards and courts are needed for natural light or ventilation.

**1028.4.1 Width or capacity.** The required capacity of *egress courts* shall be determined as specified in Section 1005.1, but the minimum width shall be not less than 44 inches (1118 mm), except as specified herein. *Egress courts* serving Group R-3 and U occupancies shall be not less than 36 inches (914 mm) in width. The required capacity and width of *egress courts* shall be unobstructed to a height of 7 feet (2134 mm).

**Exception:** Encroachments complying with Section 1005.7.

Where an *egress court* exceeds the minimum required width and the width of such *egress court* is then reduced along the path of exit travel, the reduction in width shall be gradual. The transition in width shall be affected by a guard not less than 36 inches (914 mm) in height and shall not create an angle of more than 30 degrees (0.52 rad) with respect to the axis of the *egress court* along the path of egress travel. The width of the *egress court* shall not be less than the required capacity.

❖ The width of an exterior court is to be determined in the same fashion as for an interior corridor. The width is not to be less than required to serve the number of occupants from the exit or exits and not less than the minimum specified in this section (see also IBC Section 1206). A cross reference back to Section 1005.7 for obstructions in the width in aisles (see Section 1018.1), corridors (see Section 1020.3), exit passageways (see Section 1024.2) and exit courts (see Section 1028.4.1) reinforces the fact that the protrusion limits provision is generally applicable for these types of confined routes.

Many egress courts are significantly larger than required. Thus, the code allows such an egress court to decrease in width along the path of travel to the public way. The gradual transition requirement is so the flow of the occupants will be uniform without pockets of congestion. The transition requirements should be applied to egress courts where a reduction results in a width that is near the minimum based on the number of occupants served. It is this condition where the uniform flow of occupants is essential.

**1028.4.2 Construction and openings.** Where an *egress court* serving a building or portion thereof is less than 10 feet (3048 mm) in width, the *egress court* walls shall have not less than 1-hour *fire-resistance-rated* construction for a distance of 10

feet (3048 mm) above the floor of the *egress court*. Openings within such walls shall be protected by opening protectives having a fire protection rating of not less than  $\frac{3}{4}$  hour.

### Exceptions:

1. *Egress courts* serving an *occupant load* of less than 10.
2. *Egress courts* serving Group R-3.

❖ The purpose of this section is to protect the occupants served by the egress court from the building that they are exiting from. If occupants must walk closely by the exterior walls of the court, the walls are required to have the specified fire-resistance rating and the openings are required to be protected as specified. This requirement is only for the first 10 feet (3048 mm) above the level of the egress court since the exposure hazard from walls and openings above 10 feet (3048 mm) is reduced. The two exceptions provide for egress courts that serve a very low number of occupants and the specified residential occupancy where the protection requirement would be located.

**1028.5 Access to a public way.** The *exit discharge* shall provide a direct and unobstructed access to a *public way*.

**Exception:** Where access to a *public way* cannot be provided, a safe dispersal area shall be provided where all of the following are met:

1. The area shall be of a size to accommodate not less than 5 square feet (0.46 m<sup>2</sup>) for each person.
2. The area shall be located on the same lot not less than 50 feet (15 240 mm) away from the building requiring egress.
3. The area shall be permanently maintained and identified as a safe dispersal area.
4. The area shall be provided with a safe and unobstructed path of travel from the building.

❖ There are instances where the path of travel to the public way is not safe or not achievable because of site constraints or security concerns. The provisions in this section specify what would constitute a safe area to allow occupants of a building to assemble in an emergency. The requirement of 5 square feet (0.28 m<sup>2</sup>) would allow adequate space for standing persons as well as some space for persons in wheelchairs or on stretchers. Everyone who is expected to wait in this dispersal area for fire department assistance must be a minimum of 50 feet (15 240 mm) away from the building. This refuge must always remain open and not be used for parking, storage or temporary structures. A safe dispersal area is commonly found at schools or jails. Stadiums are more specifically addressed in Section 1010.2.1. Walls or fences may surround the building and part of the site due to other safety concerns. These walls and fences could stop occupants from reaching the public way.

## SECTION 1029 ASSEMBLY

**1029.1 General.** A room or space used for assembly purposes that contains seats, tables, displays, equipment or other material shall comply with this section.

- ❖ Any room that is used for assembly purposes, regardless of the occupancy of the rest of the building, must comply with this section. Spaces used for assembly seating may appear in buildings of other occupancy types; for example, a library in a school, or a meeting room in an office building. This includes spaces with less than 50 occupants in other occupancies. For evaluation of the occupant load and the means of egress in these spaces, these spaces are regulated based on their function, rather than their occupancy group.

Although most of the provisions in Section 1029 focus on fixed seating auditoriums or theaters, this section also addresses loose seats, tables, displays, equipment, etc. Rooms or spaces used for assembly purposes contain elements that would affect the path of travel for the means of egress. These spaces require special consideration because of the larger occupant loads and possible low lighting (e.g., night-clubs, theaters), which can possibly lead to slower fire recognition or crowd concerns.

Since this section is extensive, here is a basic breakdown:

- Sections 1029.1.1 and 1029.1.1.1 deal with bleachers and grandstands.
  - Sections 1029.3 through 1029.5 deal with number and dispersment of exits.
  - Section 1029.6 and subsections discuss aisle widths based on the required capacity.
  - Sections 1029.7 and 1029.8 are for travel distances and aisle accessways.
  - Section 1029.9 deals with where aisles are required, minimum widths, and layouts. This includes provisions for where stairways are a direct continuation of a stepped aisle (Sections 1029.9.7 through 1029.10.3).
  - Section 1029.11 discusses types of materials and walking surfaces.
  - Section 1029.12 covers the aisle accessways that lead to the main aisles as they move through tables (Section 1029.12.1) and seating in rows (Section 1029.12.2).
  - Section 1029.13 deals with slope, landings and edge protection for ramped aisles (Sections 1029.13.1 through 1029.13.1.3) and treads and risers for stepped aisles (Sections 1029.13.2 through 1029.13.2.4).
  - Section 1029.14 discusses where seating needs to be fastened to the floor in order for aisles and accessways to be maintained.
- Section 1029.15 includes handrail provisions for ramped and stepped aisles.
  - Section 1029.16 states where guards are required.

**1029.1.1 Bleachers.** *Bleachers, grandstands and folding and telescopic seating*, that are not building elements, shall comply with ICC 300.

- ❖ On February 24, 1999, the Bleacher Safety Act of 1999 was introduced in the House of Representatives. The bill, which cites the ICC and the code, authorizes the U.S. Consumer Product Safety Commission (CPSC) to issue a standard for bleacher safety. This was in response to concerns relative to accidents on bleacher-type structures. As a result, the CPSC developed and revised the *Guidelines for Retrofitting Bleachers*. The ICC Board of Directors decided that a comprehensive standard dealing with all aspects of both new and existing bleachers was warranted and authorized the formation of the ICC Consensus Committee on Bleacher Safety. The committee is composed of 12 members, including the requisite balance of general, user interest and producer interest.

ICC 300 was completed in December 2001, and submitted to ANSI on January 1, 2002. ICC 300 was reissued with some revisions in 2007 and 2012. While the term “bleachers” is generic, the standard addresses all aspects of tiered seating associated with bleachers, grandstands, and folding and telescopic seating. These types of seating are supported on dedicated structural systems, which in turn may sit on the ground or on a building floor system. Single seats or bench seats bolted down to a stepped floor are not considered a bleacher or grandstand and should comply with Section 1029. See the definitions in Chapter 2 for “Building element,” “Bleachers,” “Grandstands” and “Folding and telescopic seating.” While ICC 300 is consistent and also relies on Chapter 10 of the code for some provisions, the standard addresses items specific to these types of seating arrangements. For example, the minimum number of exits from a bleacher is addressed in ICC 300, IBC Section 404.1; however, to determine the minimum number of exits from the room the bleacher is located in, Section 1006 is applicable. The bleacher standard references IBC Chapter 11 and ICC A117.1 for accessibility requirements.

The ICC 300 has minimum requirements for new, alterations, repair, operation and maintenance of bleacher systems. A bleacher or grandstand is defined as “Tiered seating supported on a dedicated structural system and two or more rows high and is not a building element.” The intent of the terms “dedicated structural system” and “not a building element” in the definition is to recognize that bleacher systems sit on the floor or ground and have a support system separate from the building system. However, the bleacher could rely on the building system for lateral or gravity support. The intent of “two or more rows” is

so that a tiered floor system with a bench or row of seats on each tier would not be considered a bleacher.

The criteria in ICC 300 include provisions for construction; means of egress within the bleacher system; inspection and maintenance for existing bleachers; and for when seating systems are relocated.

#### 1029.1.1.1 Spaces under grandstands and bleachers.

Where spaces under *grandstands* or *bleachers* are used for purposes other than ticket booths less than 100 square feet (9.29 m<sup>2</sup>) and toilet rooms, such spaces shall be separated by *fire barriers* complying with Section 707 and *horizontal assemblies* complying with Section 711 with not less than 1-hour *fire-resistance-rated* construction.

❖ Sometimes spaces under grandstands are used for other purposes such as bathrooms, concession stands, storage, etc. If that space caught on fire, it could jeopardize the safe evacuation options for persons on the bleachers. For safety, the spaces below must be separated from the bleachers by fire-resistance-rated construction. This is typically the roof and back walls of the concession stand or storage room. If the space below is either a small ticket booth or bathrooms of any size, the potential fire load is low enough that these spaces are not required to be separated.

Note that Section 903.2.1.5 requires enclosed spaces with an area of over 1,000 square feet (93 m<sup>2</sup>) and under an outdoor bleacher system to be sprinklered.

While the path for means of egress passing under the bleachers (i.e., vomitory) is not specifically addressed in this section, when a bleacher system is outside, the capacity factors for determining minimum egress width [Table 404.5(3) of ICC 300] are based on the assumption that the egress route is essentially open to the outside and, therefore, has a limited chance for the accumulation of smoke along that route. Two of the three legacy codes specifically exempted open means of egress routes under bleachers from separation requirements.

**1029.2 Assembly main exit.** A building, room or space used for assembly purposes that has an *occupant load* of greater than 300 and is provided with a main *exit*, that main *exit* shall be of sufficient capacity to accommodate not less than one-half of the *occupant load*, but such capacity shall be not less than the total required capacity of all *means of egress* leading to the *exit*. Where the building is classified as a Group A occupancy, the main *exit* shall front on not less than one street or an unoccupied space of not less than 10 feet (3048 mm) in width that adjoins a street or *public way*. In a building, room or space used for assembly purposes where there is not a well-defined main *exit* or where multiple main *exits* are provided, *exits* shall be permitted to be distributed around the perimeter of the building provided that the total capacity of egress is not less than 100 percent of the required capacity.

❖ Assembly buildings, as well as other buildings including spaces that function as assembly spaces (e.g.,

the band classroom in a school, the training room in an office, the cafeteria in a large factory), present an unusual life safety problem that includes frequent higher occupant densities and, therefore, larger occupant loads and the opportunity for irrational mass response to a perceived emergency (i.e., panic). For this reason, the code requires a specific arrangement of the exits. Studies have indicated that in any emergency, occupants will tend to egress via the same path of travel used to enter the room and building. Therefore, a main entrance to the building or space must also be designed as the main exit to accommodate this behavior, even if the required exit capacity might be more easily accommodated elsewhere. The main entrance (and exit) must be sized to accommodate at least 50 percent of the total occupant load of the structure and must front on a large, open space, such as a street or lobby, for rapid dispersal of the occupants outside the building or space. The remaining exits must also accommodate at least 50 percent of the total occupant load from each level (see Commentary Figure 1029.2). The total occupant load includes those within the theater seating area, the foyer and any other space (e.g., ticket booth, concession stand, offices, storage and the like). When the assembly space is within a mixed use building, the intent is that the main exits from the space comply with these provisions for one-half the capacity, but not necessarily that they lead directly to the outside. Egress requirements from the building would depend on how it was anticipated for the assembly space occupants to disperse. For example, an office building may have a large training/conference room where the path of exit access travel from the room goes out a main exit from the space and then disseminates into the general floor egress system. The room exit access doors may need to meet the 50-percent criterion, but once the occupants leave the room and enter the general floor egress system, exit capacity can be dispersed.

The required width of the means of egress in places of assembly is more often determined by the occupant load than in most other occupancies. In other occupancies, the minimum required widths and the travel distances will often determine the required widths and locations of the exits.

This section only requires the main exit to accommodate 50 percent of the occupant load when there is a single main entrance. Therefore, a large stadium or civic center, in which there are numerous entrances (and exits), need not comply with the main entrance criteria.

**1029.3 Assembly other exits.** In addition to having access to a main *exit*, each level in a building used for assembly purposes having an *occupant load* greater than 300 and provided with a main *exit*, shall be provided with additional *means of egress* that shall provide an egress capacity for not less than one-half of the total *occupant load* served by that level and shall comply with Section 1007.1. In a building used for assembly purposes where there is not a well-defined main

*exit* or where multiple main *exits* are provided, *exits* for each level shall be permitted to be distributed around the perimeter of the building, provided that the total width of egress is not less than 100 percent of the required width.

❖ This section provides for the egress of one-half of the total occupant load by way of exits other than the main exit that is described in Section 1029.2. Assembly buildings, as well as other buildings including spaces that function as assembly spaces, that are provided with multiple entrances but no single main entrance do not provide a well-defined main exit; therefore, the total required exit width needs to be distributed around the perimeter of the space or building. Examples of these assemblies would be a school gymnasium or a large stadium or civic center in which there are numerous entrances (and exits).

**1029.4 Foyers and lobbies.** In Group A-1 occupancies, where persons are admitted to the building at times when seats are not available, such persons shall be allowed to wait in a lobby or similar space, provided such lobby or similar space shall not encroach upon the minimum width or required capacity of the *means of egress*. Such foyer, if not directly connected to a public street by all the main entrances or *exits*, shall have a straight and unobstructed *corridor* or path of travel to every such main entrance or *exit*.

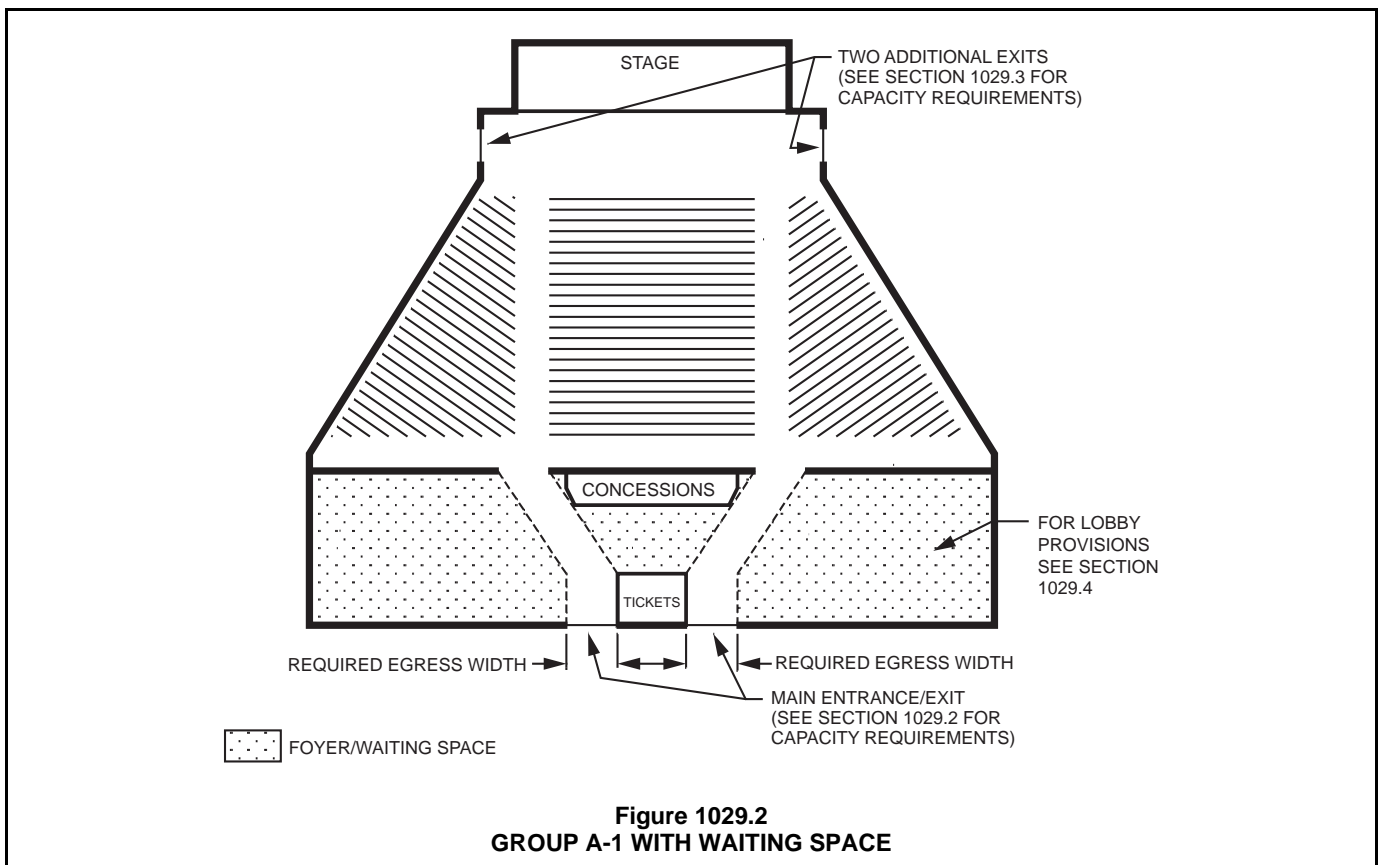
❖ In theaters, people may arrive and wait for the next show while another group has yet to exit. This is extremely common in multiplex theater complexes. In every case, the main entrance (exit) and all other

exits are to be constantly available for the entire building occupant load.

For example, because of the queuing of large crowds, particularly in theaters where a performance may be in progress and people must wait to attend the next one, standing space is often provided. For reasons of safety, such spaces cannot be located in or interfere with established paths of egress from the assembly areas. While a facility may choose to separate the route for means of egress using partitions or railings from the general lobby space to allow for easy traffic flow through the lobby to the street, it is not required to designate these areas (see Commentary Figure 1029.2).

**1029.5 Interior balcony and gallery means of egress.** For balconies, galleries or press boxes having a seating capacity of 50 or more located in a building, room or space used for assembly purposes, not less than two *means of egress* shall be provided, with one from each side of every balcony, gallery or press box.

❖ This section states the threshold where two means of egress are required based on the occupant load of the interior balcony, gallery or press box. Those two exits need to be dispersed. Section 1019.3, Exception 8, allows for both stairways to be unenclosed exit access stairways where they are effectively part of the main seating bowl. These requirements will ensure that at least one path of travel is always available and occupants face a minimum number of hazards.



**Figure 1029.2**  
**GROUP A-1 WITH WAITING SPACE**

For balconies, galleries or press boxes with 50 or fewer occupants, see Section 1029.8. When balconies, galleries or press boxes contain wheelchair spaces, the area must also meet the accessible means of egress requirements (Sections 1009.1, Exception 3, and 1029.8).

**1029.6 Capacity of aisle for assembly.** The required capacity of *aisles* shall be not less than that determined in accordance with Section 1029.6.1 where *smoke-protected assembly seating* is not provided and with Section 1029.6.2 or 1029.6.3 where *smoke-protected assembly seating* is provided.

❖ The means of egress width for spaces used for assembly is to be in accordance with this section and the referenced sections instead of the criteria specified in Section 1005 when dealing with the means of egress within the seating area. The width factors in Section 1029.6 and its subsections apply to those doorways, passageways, stepped aisles, ramped aisles and level aisles that are within the assembly seating areas.

The Board for the Coordination of Model Codes (BCMC) issued a report on means of egress dated June 10, 1985. The provisions in Section 1029 are based on this report. This report limits the application of these provisions to aisles and aisle accessways that provide exit access within the room or space with the assembly seating. This would include aisle accessways, level aisles, stepped aisles and ramped aisles. The primary concern for occupant safety would be that where the different provisions for the capacity requirements in Sections 1005 and 1029 were utilized, there would not be a bottleneck in the path of travel for means of egress. For example, a common configuration at football fields is to have the seating area raised several feet above grade. Where a step or series of steps leading to grade from a raised seating area are a continuation of the stepped aisle, the width of the stepped aisle between seats and the continuation without adjacent seats should be the same. In theaters, commonly the occupants leave the seating area for a concourse or lobby area that leads to exit stairways between floor levels. In this situation, the capacity requirement in Section 1005.3 would be applicable for the exit stairway. For the many situations between these two scenarios, the decision would be based on the configuration of the seating and exit stairways between levels.

For example, in a facility without smoke protection and an occupant load of 800, doorways would need to be calculated based on 0.20 inches (5.1 mm) per occupant (see Item 4 of Section 1029.6.1). An occupant load of 800 x 0.2 inches (4064 mm) = 160 inches (4064 mm) of egress width capacity, which translates into not less than five doors [assuming each with a minimum 32-inch (813 mm) clear opening]. This facility needs to have not less than three distinct means of egress (Section 1006.3). A main exit must accommodate not less than one-half of the occupant load (Section 1029.2). Therefore, the result would be not less

than six doors: three located at the main exit and three others distributed to at least two other locations (Section 1029.3).

Different means of egress width criteria are also specified for assembly seating where smoke protection is provided versus areas where smoke protection is not provided. The egress width for smoke-protected seating is allowed to be less than for areas where smoke protection is not provided, since the smoke level is required to be maintained at least 6 feet (1829 mm) above the floor of the means of egress, according to Section 1029.6.2.1.

**1029.6.1 Without smoke protection.** The required capacity in inches (mm) of the *aisles* for assembly seating without smoke protection shall be not less than the *occupant load* served by the egress element in accordance with all of the following, as applicable:

1. Not less than 0.3 inch (7.6 mm) of *aisle* capacity for each occupant served shall be provided on stepped *aisles* having riser heights 7 inches (178 mm) or less and tread depths 11 inches (279 mm) or greater, measured horizontally between tread *nosings*.
2. Not less than 0.005 inch (0.127 mm) of additional *aisle* capacity for each occupant shall be provided for each 0.10 inch (2.5 mm) of riser height above 7 inches (178 mm).
3. Where egress requires stepped *aisle* descent, not less than 0.075 inch (1.9 mm) of additional *aisle* capacity for each occupant shall be provided on those portions of *aisle* capacity having no *handrail* within a horizontal distance of 30 inches (762 mm).
4. Ramped *aisles*, where slopes are steeper than one unit vertical in 12 units horizontal (8-percent slope), shall have not less than 0.22 inch (5.6 mm) of clear *aisle* capacity for each occupant served. Level or ramped *aisles*, where slopes are not steeper than one unit vertical in 12 units horizontal (8-percent slope), shall have not less than 0.20 inch (5.1 mm) of clear *aisle* capacity for each occupant served.

❖ This section prescribes the criteria needed to calculate the clear widths of aisles and aisle accessways in order to provide sufficient capacity to handle the occupant loads established by the “catchment areas” described in Section 1029.9.2. Clear width is to be measured to walls, edges of seating and tread edges.

The criteria for determining the required widths are based on analytical studies and field tests that used people to model egress situations [see Commentary Figures 1029.6.1(1) and 1029.6.1(2)].

Criterion 1 addresses the method for determining the required egress width for stepped aisles. This method corresponds with the requirements of Section 1005.3.1 for egress width per occupant of stairways in an unsprinklered building.

Criterion 2 addresses the method for determining the additional stepped aisle width required where the risers along that stepped aisle are greater than 7 inches (178 mm) high.

Criterion 3 addresses the method for determining the additional stepped aisle width where a handrail is not located within 30 inches (762 mm). With a center handrail, that would be stepped aisles wider than 60 inches (1524 mm). Side aisles have handrails along the wall. If the handrail is the top of the guard, then this requirement would apply to any side aisles greater than 30 inches (762 mm) wide. Because of the increased chance of falling and not being within reach of a handrail, the capacity per occupant is increased by 25 percent for the entire stepped aisle. For example, to calculate the capacity of a 72-inch-wide (1829 mm) stepped aisle, the answer would be 72 inches/0.375 inch = 192 occupants.

Criterion 4 addresses the method for determining the required widths for level or ramped and level means of egress. Where slopes are less than 1:12 (see definition for "Ramp"), the capacity requirements are also less. Level floors are quicker to negotiate than ramped surfaces for persons with limited mobility. Ramped aisle slopes are addressed in Section 1029.13.1.

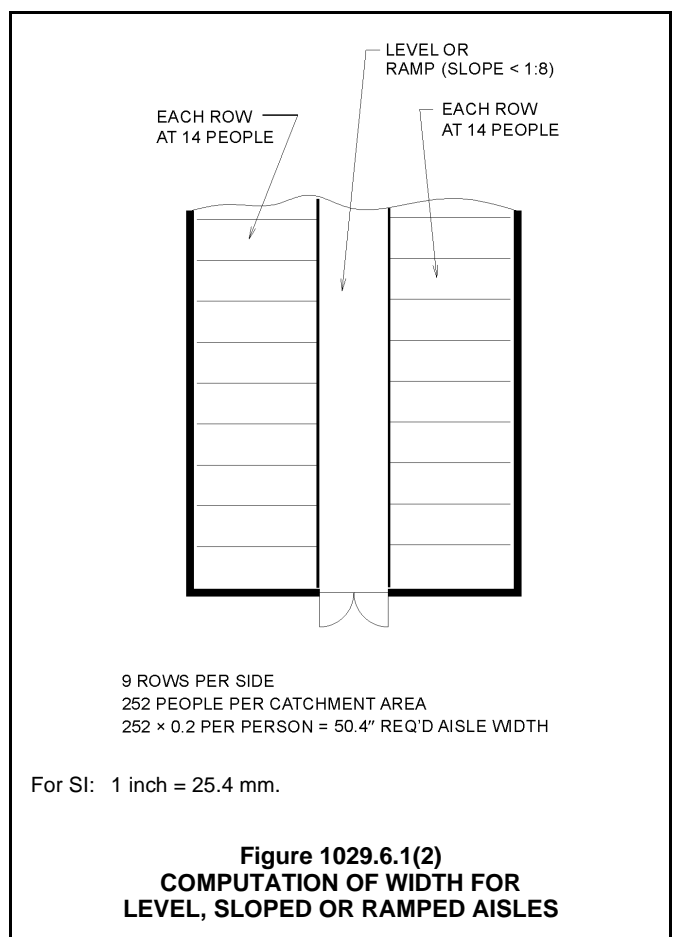
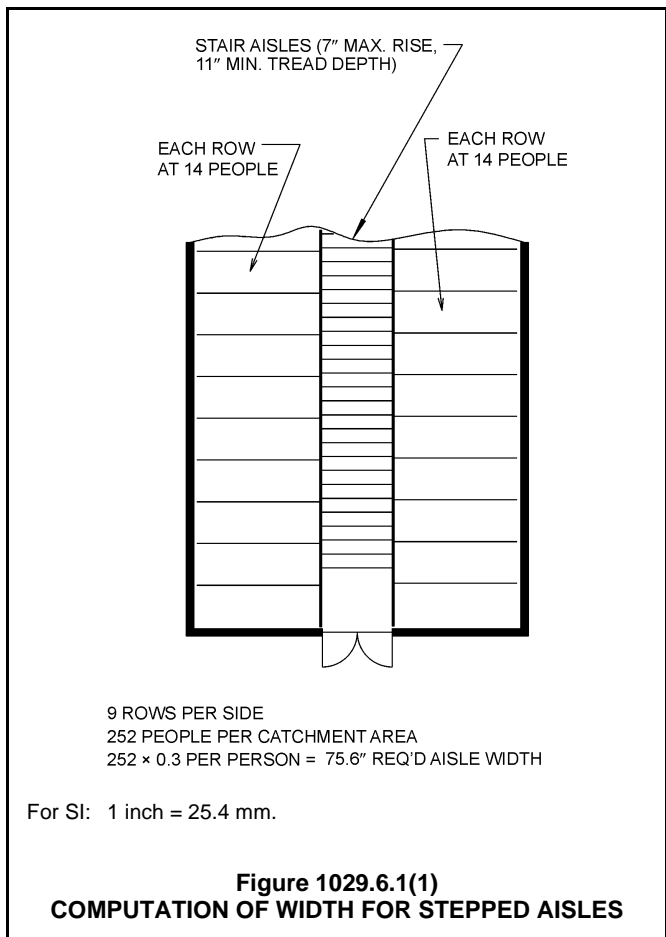
These provisions are applicable within the seating area itself. When the occupants have left the seating bowl and have moved to stairways outside of the room, or have moved to cross aisles and then stairways or ramps leaving the balcony level, Section 1005.3 would be applicable. See Sections 1029.9.6.1

through 1029.10.3 for stairways that are a direct continuation of stepped aisles.

**1029.6.2 Smoke-protected assembly seating.** The required capacity in inches (mm) of the aisle for *smoke-protected assembly seating* shall be not less than the occupant load served by the egress element multiplied by the appropriate factor in Table 1029.6.2. The total number of seats specified shall be those within the space exposed to the same smoke-protected environment. Interpolation is permitted between the specific values shown. A life safety evaluation, complying with NFPA 101, shall be done for a facility utilizing the reduced width requirements of Table 1029.6.2 for *smoke-protected assembly seating*.

**Exception:** For outdoor *smoke-protected assembly seating* with an *occupant load* not greater than 18,000, the required capacity in inches (mm) shall be determined using the factors in Section 1029.6.3.

❖ Special consideration is given to facilities with features that will prevent the means of egress from being blocked by smoke. Facilities to be considered smoke protected by Sections 1029.6.2.1 through 1029.6.2.3 are permitted increases in travel distance, egress capacity, and dead-end aisle and row lengths. Smoke control increases allowable egress time. Typically, model codes based on research by Dr. John Fruin and others recognize the need for occupants exposed to the fire environment to evacuate to a safe



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area within 90 seconds of notification and to reach the exterior or enclosed exit stairway within 5 minutes. With the increases permitted for smoke-protected facilities, these times are effectively doubled since the time available for safe egress also increases.

The exception is a pointer to the specific criteria for outdoor seating areas. For outdoor stadiums with 18,000 seats or greater, use Table 1029.6.2.

**TABLE 1029.6.2.** See page 10-187.

❖ This section requires the egress component to be of adequate size to accommodate the occupant load. For smoke-protected seating, the egress width per occupant is based on Table 1029.6.2. Typically, the larger the facility, the higher the ceiling; therefore, more space for smoke containment is associated with more time for egress. The egress width per occupant for nonsmoke-protected seating is to be based on Section 1029.6.1 and is similar to the provisions in Section 1005.3.

Where the entire means of egress is smoke protected, the concourse and any stairways and ramps can also use the same capacity numbers (see Section 1005.3.1, Exception 2, and Section 1005.3.2, Exception 2) to determine egress width. If the concourse surrounding the smoke-protected seating bowl is not also smoke protected, the requirements in Sections 1005.3.2 and 1005.3.1 would be applicable to determine widths required for capacity of the concourse, stairways and ramps providing means of egress from the seating bowl to the exterior of the building. See Sections 1029.9.6.1 through 1029.10.3 for stairways that are a direct continuation of stepped aisles.

**1029.6.2.1 Smoke control.** *Aisles and aisle accessways* serving a *smoke-protected assembly seating* area shall be provided with a smoke control system complying with Section 909 or natural ventilation designed to maintain the smoke level not less than 6 feet (1829 mm) above the floor of the *means of egress*.

❖ The means of egress (aisles and aisle accessways) within the assembly seating area are required to have some type of smoke control system that will prevent smoke buildup from encroaching on the egress path. This may be a mechanical smoke control system,

designed in accordance with Section 909, or natural ventilation as in open-air stadiums.

In either type of system, the major consideration is that a smoke-free environment be maintained at least 6 feet (1829 mm) above the floor of the means of egress for a period of at least 20 minutes.

**1029.6.2.2 Roof height.** A *smoke-protected assembly seating* area with a roof shall have the lowest portion of the roof deck not less than 15 feet (4572 mm) above the highest *aisle* or *aisle accessway*.

**Exception:** A roof canopy in an outdoor stadium shall be permitted to be less than 15 feet (4572 mm) above the highest *aisle* or *aisle accessway* provided that there are no objects less than 80 inches (2032 mm) above the highest *aisle* or *aisle accessway*.

❖ One element of a smoke-protected assembly seating facility is that the lowest portion of the roof is required to be at least 15 feet (4572 mm) above the highest *aisle* or *aisle accessway*. The objective of this provision is to have a minimum 6-foot (1829 mm) smoke-free height to accommodate safe egress through the area. The additional 9 feet (2743 mm) of height is to provide a volume of space that will act to dissipate smoke. The measurement of the height is shown in Commentary Figures 1029.6.2.2(1) and 1029.6.2.2(2).

**1029.6.2.3 Automatic sprinklers.** Enclosed areas with walls and ceilings in buildings or structures containing *smoke-protected assembly seating* shall be protected with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1.

### Exceptions:

1. The floor area used for contests, performances or entertainment provided the roof construction is more than 50 feet (15 240 mm) above the floor level and the use is restricted to low-fire-hazard uses.
2. Press boxes and storage facilities less than 1,000 square feet (93 m<sup>2</sup>) in area.
3. Outdoor seating facilities where seating and the *means of egress* in the seating area are essentially open to the outside.

❖ If there are areas in the smoke-protected assembly seating structure enclosed by walls and ceilings, the entire structure is to be provided with an automatic sprin-

**TABLE 1029.6.2**  
**WIDTH OF AISLES FOR SMOKE-PROTECTED ASSEMBLY**

TOTAL NUMBER OF SEATS IN THE SMOKEPROTECTED ASSEMBLY SEATING	INCHES OF CLEAR WIDTH PER SEAT SERVED			
	Stairs and aisle steps with handrails within 30 inches	Stairs and aisle steps without handrails within 30 inches	Passageways, doorways and ramps not steeper than 1 in 10 in slope	Ramps steeper than 1 in 10 in slope
Equal to or less than 5,000	0.200	0.250	0.150	0.165
10,000	0.130	0.163	0.100	0.110
15,000	0.096	0.120	0.070	0.077
20,000	0.076	0.095	0.056	0.062
Equal to or greater than 25,000	0.060	0.075	0.044	0.048

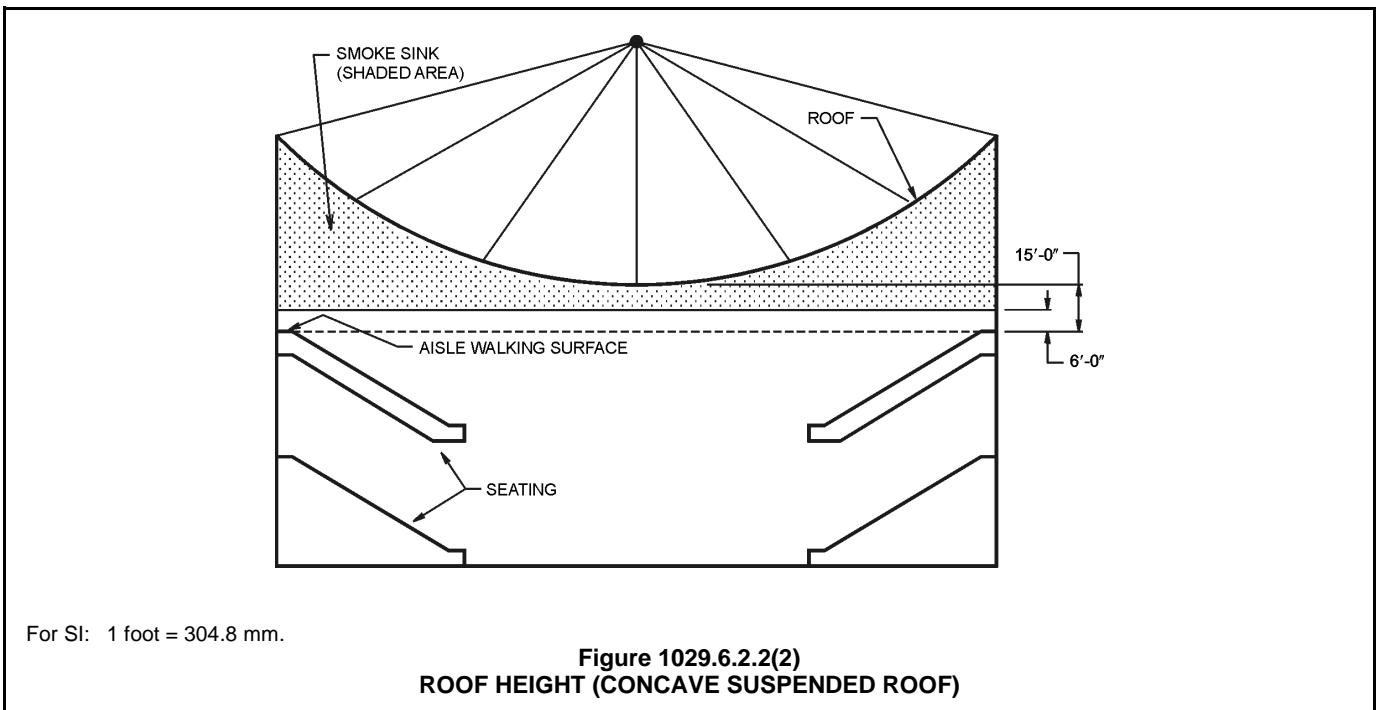
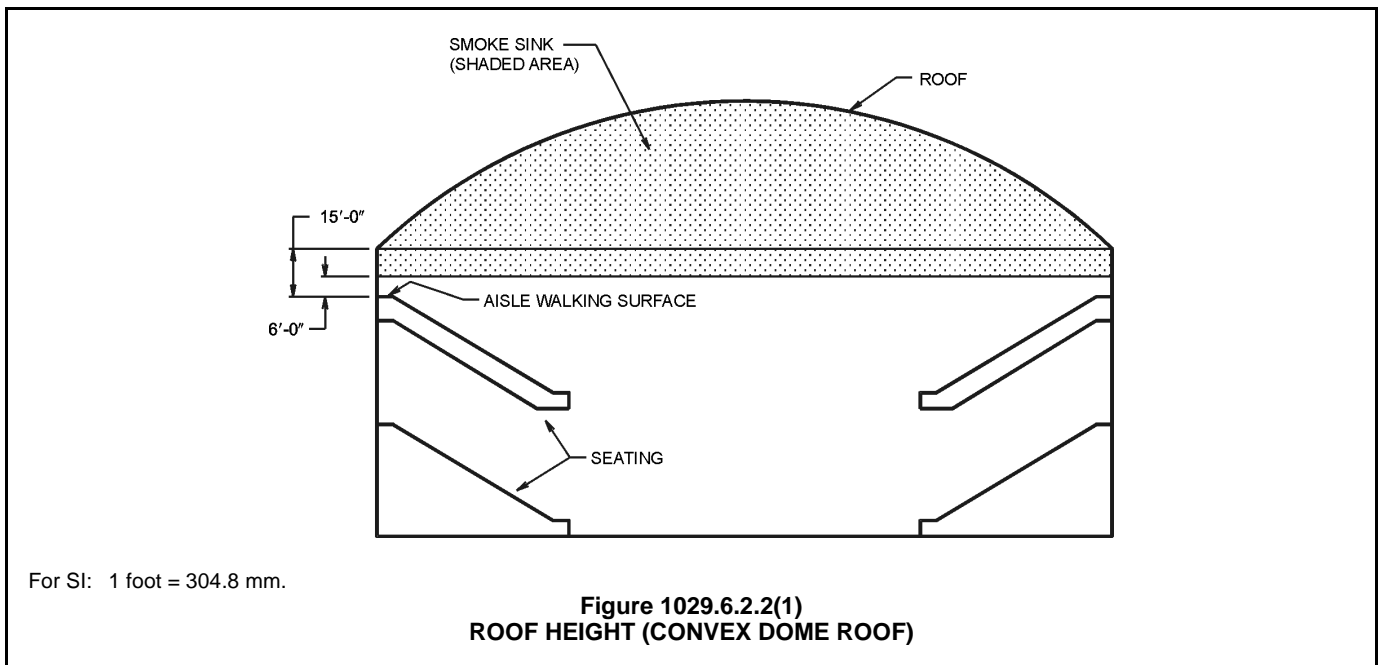
For SI: 1 inch = 25.4 mm.

kler designed to meet the requirements of NFPA 13.

Exception 1 indicates that the area over the playing field or performance area is not required to be sprinklered if the use of the floor area is restricted. If the facility is used for conventions, trade shows, displays or similar purposes, sprinklers are required throughout, since the occupancy would no longer be a low-fire-hazard use. A characteristic of a low-fire-hazard occupancy is that the fuel load caused by combustibles is approximately 2 pounds per square foot (9.8 kg/m<sup>2</sup>) or less.

In order for the contest, performance or entertain-

ment area to be nonsprinklered, the roof over that area must be at least 50 feet (15 240 mm) above the floor in addition to the floor area meeting the low fire-hazard criteria. The 50-foot (15 240 mm) criterion was selected because the response time for sprinklers at this height is extremely slow. It is estimated that the response time for standard sprinklers [50 feet (15 240 mm) above a floor with a fire having a heat release rate of 5 British thermal units (Btu) per square foot per second] exceeds 15 minutes. Therefore, it is not reasonable to install sprinklers at that height with little expectation of timely activation [see Commen-



tary Figure 1029.6.2.3(1)]. Note that if this exception is utilized, the tradeoffs for a fully sprinklered building, such as increased height and area limitations or decreased corridor ratings, are no longer permitted.

Exception 2 indicates that automatic sprinklers are not required in small spaces in buildings. Sprinklers are required in press box and storage areas of outdoor facilities when the area exceeds 1,000 square feet (93 m<sup>2</sup>). The primary reason for sprinklers in these areas is that both are anticipated to have a relatively large combustible load when compared to the main seating and participant areas. Additionally, in the case of storage areas, there is an increased potential for an undetected fire condition to occur [see Commentary Figure 1029.6.2.3(2)].

Exception 3 provides for outdoor seating facilities where smoke entrapment is not a safety concern.

**1029.6.3 Outdoor smoke-protected assembly seating.** The required capacity in inches (mm) of aisles shall be not less than the total *occupant load* served by the egress element multiplied by 0.08 (2.0 mm) where egress is by stepped *aisle* and multiplied by 0.06 (1.52 mm) where egress is by level *aisles* and ramped *aisles*.

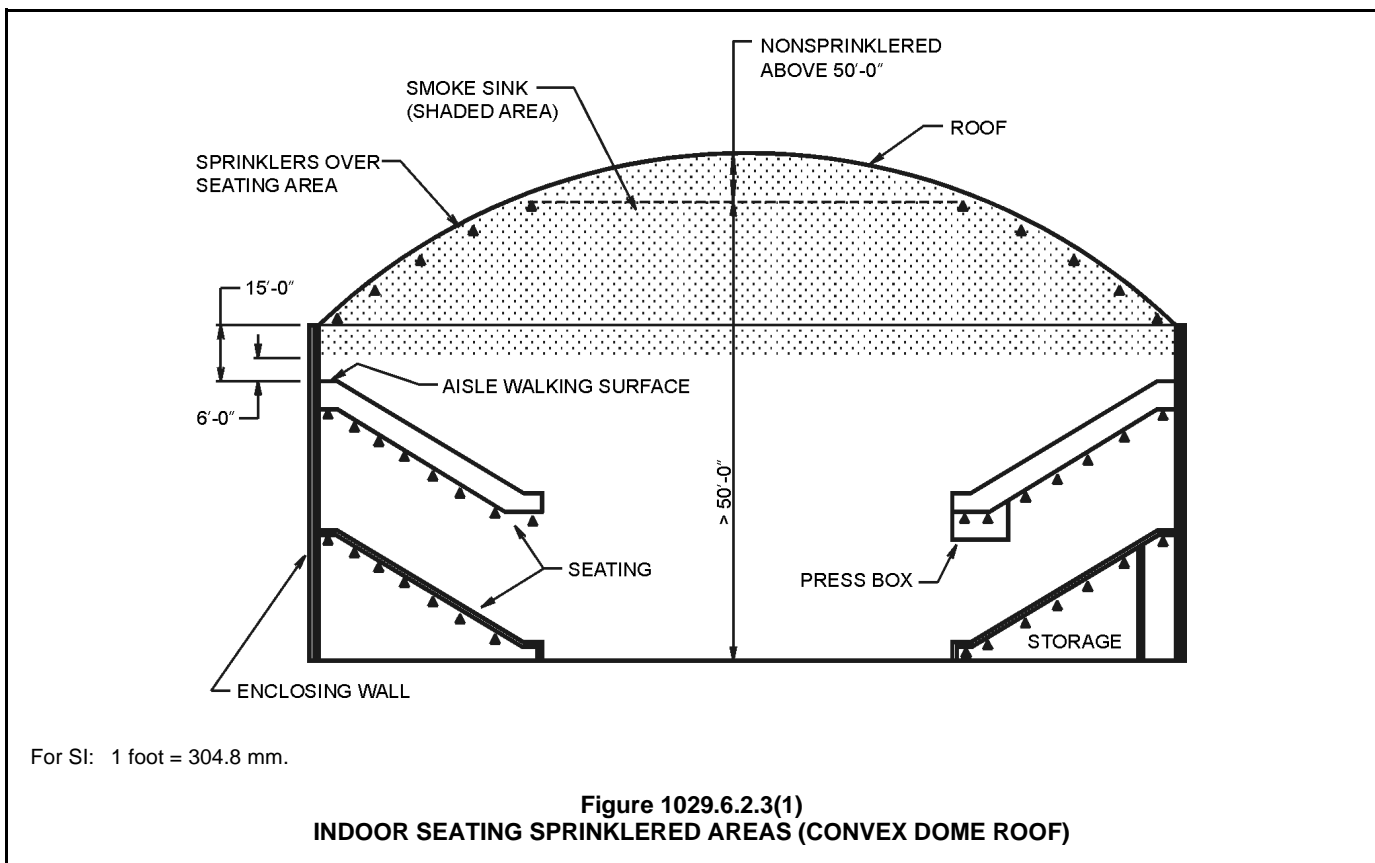
**Exception:** The required capacity in inches (mm) of *aisles* shall be permitted to comply with Section 1029.6.2 for the number of seats in the outdoor *smoke-protected assembly seating* where Section 1029.6.2 permits less capacity.

❖ This section lists the coefficients determining the width of aisles required for outdoor smoke-protected

assembly seating areas. Note that the coefficients are significantly less when compared to the values in Section 1029.6.1 for assembly areas without smoke protection. The coefficients are also less than those for smoke-protected assembly seating in Table 1029.6.2 except for very large assembly areas. The exception in this section would apply where the coefficients in Table 1029.6.2 are less than those in this section.

Low coefficients are a result of the very low hazards for outdoor smoke-protected assembly areas and increased egress time. Where the entire means of egress is essentially open to the exterior, the concourse and any stairways and ramps can also use the same capacity numbers (see Section 1005.3.1, Exception 2, and Section 1005.3.2, Exception 2) to determine egress width. If the concourse surrounding the outdoor seating bowl is enclosed, the requirements in Sections 1005.3.2 and 1005.3.1 would be applicable to determine widths required for capacity of the concourse, stairways and ramps providing means of egress from the seating bowl to the exterior of the building. See Sections 1029.9.6.1 through 1029.10.3 for stairways that are a direct continuation of stepped aisles.

Generally, an outdoor assembly area meets the smoke control requirements of Section 1029.6.2 by natural ventilation and does not require an automatic sprinkler system according to Section 1029.6.2.3, Exception 3.



**1029.7 Travel distance.** *Exits* and *aisles* shall be so located that the travel distance to an *exit* door shall be not greater than 200 feet (60 960 mm) measured along the line of travel in nonsprinklered buildings. Travel distance shall be not more than 250 feet (76 200 mm) in sprinklered buildings. Where *aisles* are provided for seating, the distance shall be measured along the *aisles* and *aisle accessways* without travel over or on the seats.

**Exceptions:**

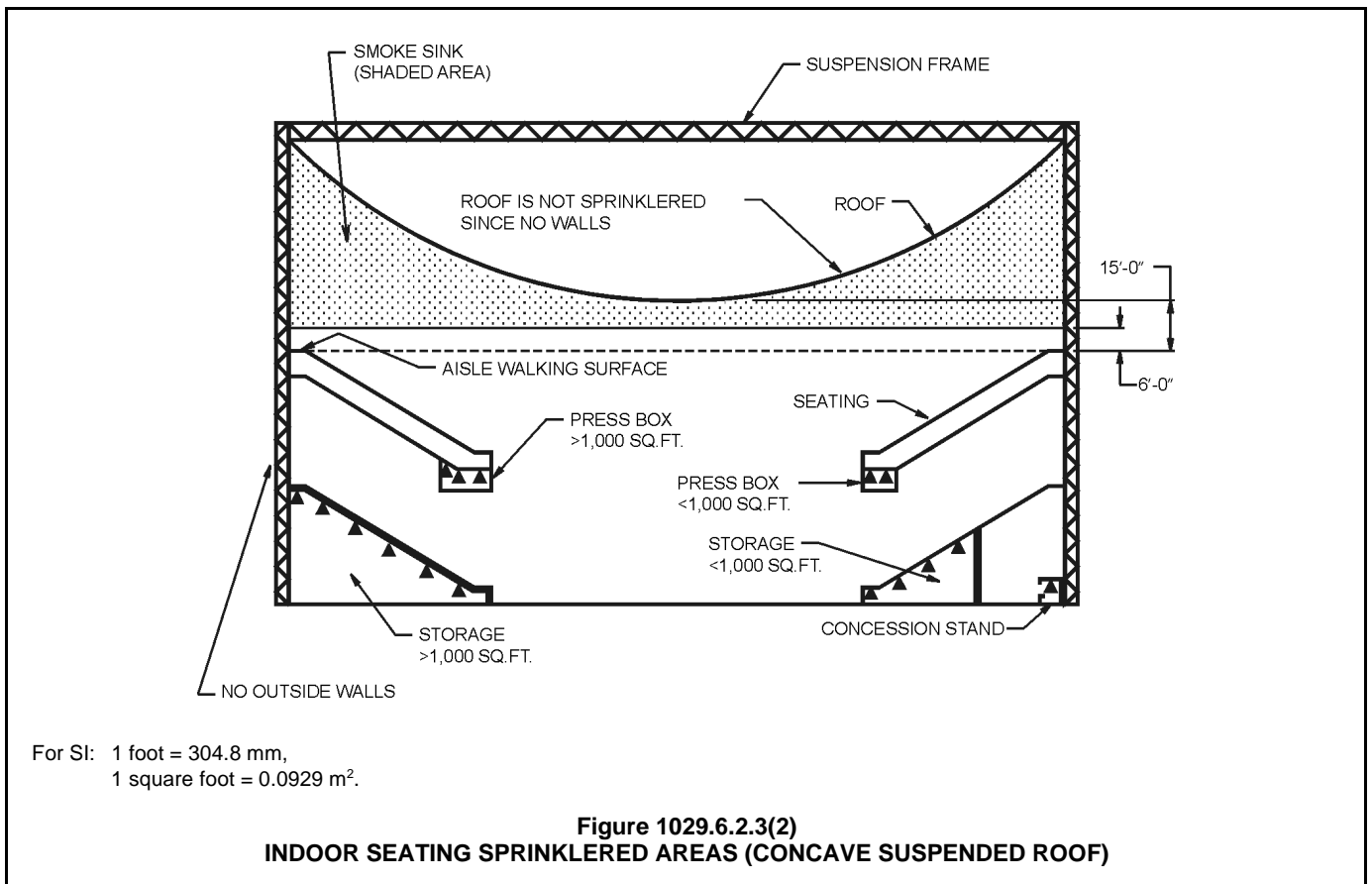
1. *Smoke-protected assembly seating:* The travel distance from each seat to the nearest entrance to a vomitory or concourse shall not exceed 200 feet (60 960 mm). The travel distance from the entrance to the vomitory or concourse to a *stairway*, *ramp* or walk on the exterior of the building shall not exceed 200 feet (60 960 mm).
  2. *Open-air seating:* The travel distance from each seat to the building exterior shall not exceed 400 feet (122 m). The travel distance shall not be limited in facilities of Type I or II construction.
- ❖ This section includes the travel distance limits for an assembly occupancy, which are the same as those in Table 1017.2 for Group A. The travel distance is to be measured along the same path the occupants would normally take to exit the facility.
- Exception 1 provides an extended travel distance for smoke-protected assembly seating that meets the requirements of Sections 1029.6.2 through 1029.6.2.3.

Exception 2 applies to open-air seating areas where the smoke and fire hazard is very low. The Type I and II construction referred to in this exception is described in IBC Section 602.

**1029.8 Common path of egress travel.** The *common path of egress travel* shall not exceed 30 feet (9144 mm) from any seat to a point where an occupant has a choice of two paths of egress travel to two *exits*.

**Exceptions:**

1. For areas serving less than 50 occupants, the *common path of egress travel* shall not exceed 75 feet (22 860 mm).
  2. For *smoke-protected assembly seating*, the *common path of egress travel* shall not exceed 50 feet (15 240 mm).
- ❖ The maximum travel distance down a single aisle accessway between rows of seating to a location where a patron would have two choices for a way out of the space is 30 feet (9144 mm). In smoke-protected seating, the common path of travel can be up to 50 feet (15 240 mm).
- If the room or space (e.g., box, gallery or balcony) has 50 or fewer occupants, the travel distance can be increased to 75 feet (22 860 mm). For example, this allows for a path of travel from a box seat, out of the box and to a main aisle or even a corridor located outside the assembly room itself.



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When this section is referenced for accessible means of egress (see Section 1009.1, Exception 3), the utilization of Exception 1 would include the entire occupant load of the seating area, box, gallery or balcony, not just the number of wheelchair spaces and/or companion seats. Wheelchair spaces that are integrated into the general seating would have the same common path of travel distance of 30 feet (9144 mm) before the person needing the accessible route could choose two different paths for accessible means of egress. This provides the same level of protection for the persons in the accessible seating as provided for others within the space.

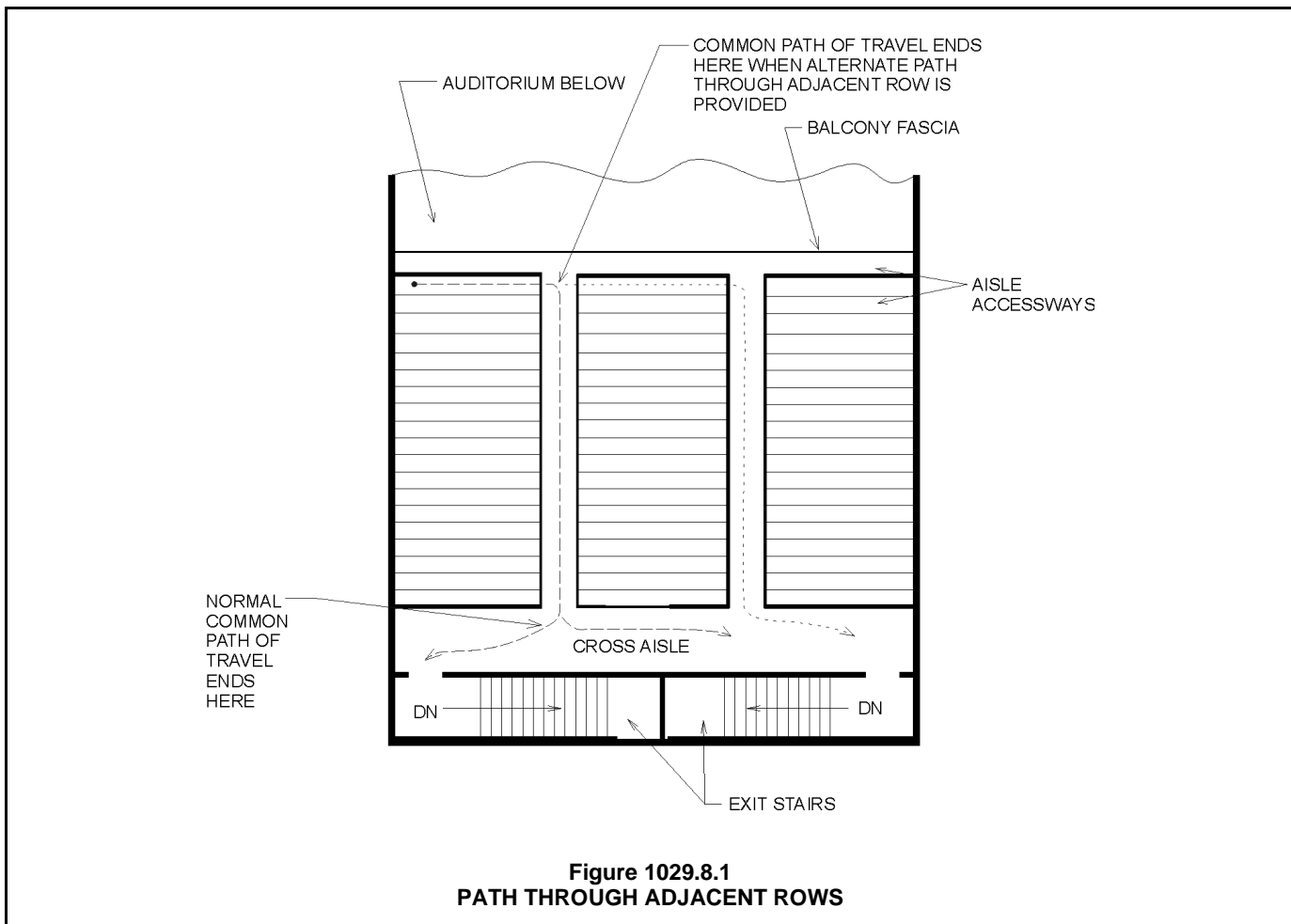
Sections 1006.2.1, 1006.3.2 and 1029.8 must be considered when determining the common path of travel requirements for a building. Section 1006.2.1 regulates the means of egress from a room or space. Section 1029.8, however, regulates the distance to a decision point within a room or space used for assembly seating where a single access row of seating is provided to a location where a patron would have two choices for a way out of the space.

**1029.8.1 Path through adjacent row.** Where one of the two paths of travel is across the *aisle* through a row of seats to another *aisle*, there shall be not more than 24 seats between the two *aisles*, and the minimum clear width between rows

for the row between the two *aisles* shall be 12 inches (305 mm) plus 0.6 inch (15.2 mm) for each additional seat above seven in the row between *aisles*.

**Exception:** For *smoke-protected assembly seating* there shall be not more than 40 seats between the two *aisles* and the minimum clear width shall be 12 inches (305 mm) plus 0.3 inch (7.6 mm) for each additional seat.

❖ In establishing the point where the occupants of a row served by a single access aisle have two distinct paths of travel, the code allows one of those paths to be through the rows of an adjacent seating area or section. This requirement increases the row widths for the single-access seating section and the adjacent dual-access seating section. This allows the occupants to either travel down the single access aisle or readily traverse the oversized row widths to gain access to a second means of egress (see Commentary Figure 1029.8.1). This exception allows a greater number of seats spaced with a minimum clearance of 12 inches (305 mm) for smoke-protected assembly seating that complies with Sections 1029.6.2 through 1029.6.2.3 or Section 1029.6.3. For the base width requirements for single- and dual-access rows, see the commentary to Sections 1029.12.2 through 1029.12.2.2.



**1029.9 Assembly aisles are required.** Every occupied portion of any building, room or space used for assembly purposes that contains seats, tables, displays, similar fixtures or equipment shall be provided with *aisles* leading to *exits* or *exit access doorways* in accordance with this section.

❖ This section requires that each assembly space have designated aisles. For aisle accessway requirements, see Section 1029.10. For aisles in other occupancies, see Section 1018.

**1029.9.1 Minimum aisle width.** The minimum clear width for *aisles* shall comply with one of the following:

1. Forty-eight inches (1219 mm) for stepped *aisles* having seating on each side.

**Exception:** Thirty-six inches (914 mm) where the stepped *aisles* serve less than 50 seats.

2. Thirty-six inches (914 mm) for stepped *aisles* having seating on only one side.

**Exception:** Twenty-three inches (584 mm) between a stepped *aisle handrail* and seating where a stepped *aisle* does not serve more than five rows on one side.

3. Twenty-three inches (584 mm) between a stepped *aisle handrail* or *guard* and seating where the stepped *aisle* is subdivided by a mid-*aisle handrail*.

4. Forty-two inches (1067 mm) for level or ramped *aisles* having seating on both sides.

**Exceptions:**

1. Thirty-six inches (914 mm) where the *aisle* serves less than 50 seats.
2. Thirty inches (762 mm) where the *aisle* does not serve more than 14 seats.
5. Thirty-six inches (914 mm) for level or ramped *aisles* having seating on only one side.

**Exception:** For other than ramped *aisles* that serve as part of an *accessible route*, 30 inches (762 mm) where the ramped *aisle* does not serve more than 14 seats.

❖ The clear widths of aisles established by the formulas given in Section 1029.6 must not be less than the minimum width requirements of this section. The development of minimum width requirements is based on the association of aisle capacity with the path of exit travel as influenced by the different features of aisle construction. The purpose is to create an aisle system that would provide an even flow of occupant egress. The minimum width of the aisles is also based on an anticipated movement of people in two directions.

Items 1, 2 and 3 deal with stepped aisles. Items 4 and 5 deal with ramped and level aisles. Items 1, 3 and 4 deal with aisles with seating on both sides. Items 2 and 5 deal with aisles with seating on one side. Note that each exception is only applicable to the item directly above. For example, per Item 4, where there is seating on both sides, the minimum ramped or level aisle width is 42 inches (1219 mm),

except where that aisle serves less than 50 seats it can be 36 inches (914 mm) wide (Exception 1) and where that aisle serves less than 15 seats it can be 30 inches (762 mm) wide (Exception 2).

**1029.9.2 Aisle catchment area.** The *aisle* shall provide sufficient capacity for the number of persons accommodated by the catchment area served by the *aisle*. The catchment area served by an *aisle* is that portion of the total space served by that section of the *aisle*. In establishing catchment areas, the assumption shall be made that there is a balanced use of all *means of egress*, with the number of persons in proportion to egress capacity.

❖ The determination of required aisle and aisle accessway width is a function of the occupant load. In calculating the required widths, the assumption is that in a system or network of aisles and aisle accessways serving an occupied area, people will normally exit the area in a way that will distribute the occupant load throughout the system in proportion to the egress capacity of the aisles and aisle accessways. Each aisle and aisle accessway would take its tributary share (catchment area) of the total occupant load (see Commentary Figure 1029.9.2).

In addition to the provisions in this section, the requirement for the capacity of the main exit and other exits must also be considered (see Sections 1029.2 and 1029.3). While this section assumes an equal distribution, Section 1029.2 requires that where the facility has a main exit, the main exit and the access thereto must be capable of handling 50 percent of the occupant load.

**1029.9.3 Converging aisles.** Where *aisles* converge to form a single path of egress travel, the required capacity of that path shall be not less than the combined required capacity of the converging aisles.

❖ Where one or more aisles or aisle accessways meet to form a single path of egress travel, that path must be sized to handle the combined occupant capacity of the converging aisles and aisle accessways (see Commentary Figure 1029.9.3). The reason for this requirement is to maintain the natural pace of travel all the way through the aisle accessways or aisles to the exits and to minimize the queuing of occupants.

This section requires combining the required occupant capacity of converging aisles and aisle accessways, but not necessarily the required widths. For example, if two 48-inch (1219 mm) aisles converge, the result need not be a 96-inch (2438 mm) aisle unless the 48-inch (1219 mm) width of the aisles is required based on the requirements of Section 1029.6 for the actual occupant load served. However, if the 48-inch (1219 mm) width is not based on the occupant load but is required to comply with the minimum aisle width requirements of Section 1029.9.1, the resulting aisle width must be sized for the total occupant load served by the converging aisles, as determined by Section 1029.6, but not less than the minimum widths of Section 1029.9.1.

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**1029.9.4 Uniform width and capacity.** Those portions of *aisles*, where egress is possible in either of two directions, shall be uniform in minimum width or required capacity.

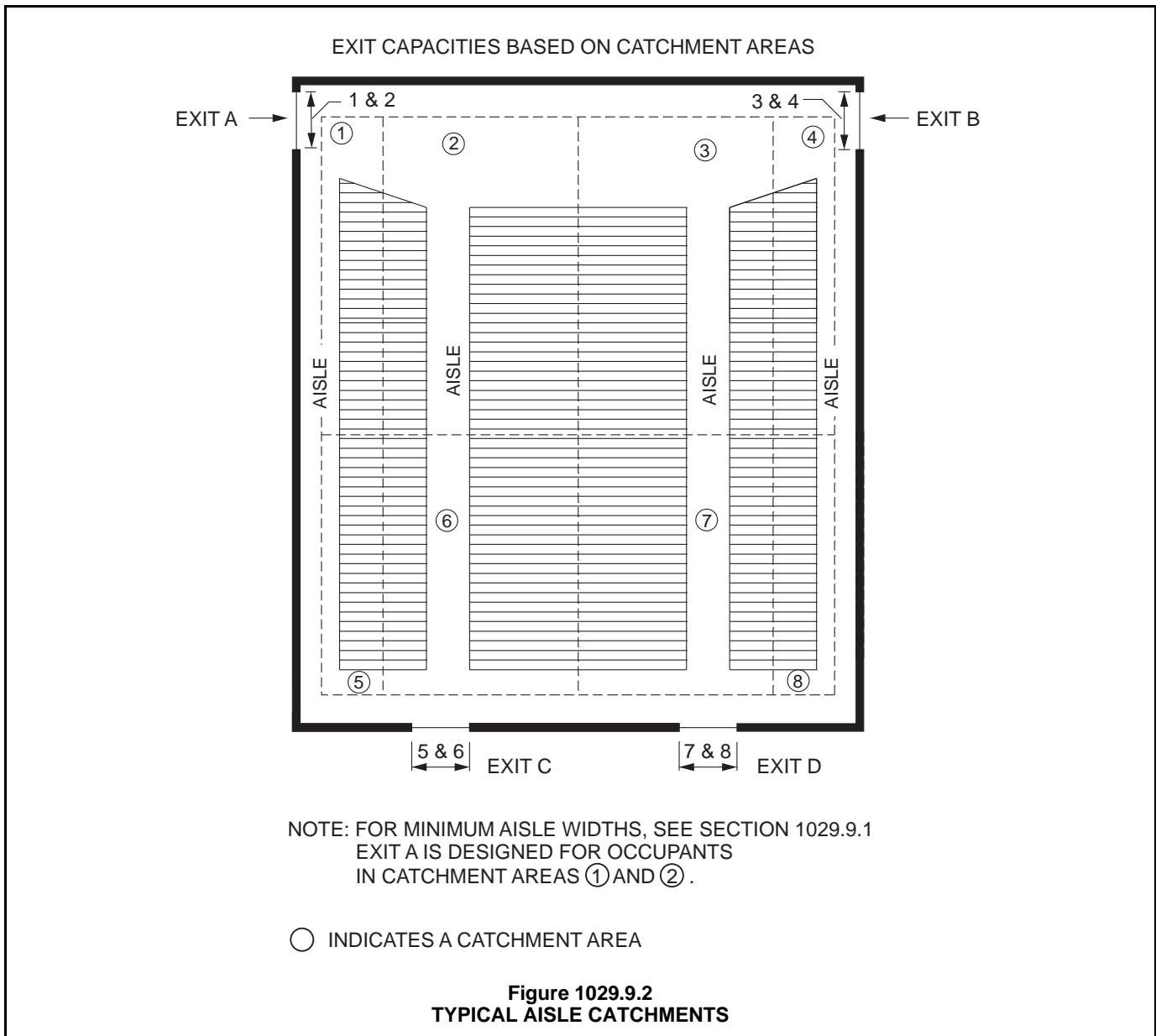
❖ Aisles that connect or lead to opposite exits must, at a minimum, be of uniform width throughout their entire lengths to allow for exit travel in two directions without creating a traffic bottleneck (see Commentary Figure 1029.9.4). They may need to be wider based on Section 1029.9.2 or 1029.9.3.

**1029.9.5 Dead end aisles.** Each end of an *aisle* shall be continuous to a cross *aisle*, foyer, doorway, vomitory, concourse or *stairway* in accordance with Section 1029.9.7 having access to an *exit*.

**Exceptions:**

1. Dead-end *aisles* shall be not greater than 20 feet (6096 mm) in length.

2. Dead-end *aisles* longer than 16 rows are permitted where seats beyond the 16th row dead-end *aisle* are not more than 24 seats from another *aisle*, measured along a row of seats having a minimum clear width of 12 inches (305 mm) plus 0.6 inch (15.2 mm) for each additional seat above seven in the row where seats have backrests or beyond 10 where seats are without backrests in the row.
3. For *smoke-protected assembly seating*, the dead end *aisle* length of vertical *aisles* shall not exceed a distance of 21 rows.
4. For *smoke-protected assembly seating*, a longer dead-end *aisle* is permitted where seats beyond the 21-row dead-end *aisle* are not more than 40 seats from another *aisle*, measured along a row of seats having an *aisle* accessway with a minimum clear width of 12 inches (305 mm) plus 0.3 inch (7.6 mm)



for each additional seat above seven in the row where seats have backrests or beyond 10 where seats are without backrests in the row.

- ❖ Both ends of a cross aisle must terminate at either an intersecting aisle, a foyer, a doorway or a vomitory (lane) that gives access to an exit(s). Each exception allows an aisle to have a dead end of limited length. Exceptions 1 and 2 address dead-end aisles in assembly spaces with or without smoke protection. Exceptions 3 and 4 address dead-end aisles only in smoke-protected assembly seating. In accordance with Exception 1, dead-end aisles (similar to corridors and passageways) that terminate at one end of a cross aisle or at a foyer, doorway or vomitory must not be more than 20 feet (6096 mm) in length. The intent of the row width requirements in the exceptions is to provide sufficient clear width between rows of seating to allow the occupants in times of emergency to pass quickly from a dead-end aisle to the aisle at the opposite end.

In Exception 2, the 0.6-inch (15 mm) increase beyond seven seats with backrests is consistent with the minimum width determined in accordance with Section 1029.12.2 for single access rows. The code recognizes that one dead-end aisle may not be usable, thus creating a single access row condition. There is a greater allowance for seating that looks similar to bleacher style seating. This is consistent with ICC 300 (see Section 1029.1.1).

Exceptions 3 and 4 allow longer dead-end aisles for smoke-protected assembly seating that complies with Sections 1029.6.2 through 1029.6.2.3 or Section

1029.6.3 (see Commentary Figure 1026.9.5). In Exception 4, there is a greater allowance for seating that looks similar to bleacher style seating. This is consistent with ICC 300 (see Section 1029.1.1).

The overall purpose of this section is to provide aisle/seating arrangements that would allow the occupants to seek safe and rapid passage to exits in case of fire or other emergency.

**1029.9.6 Aisle measurement.** The clear width for *aisles* shall be measured to walls, edges of seating and tread edges except for permitted projections.

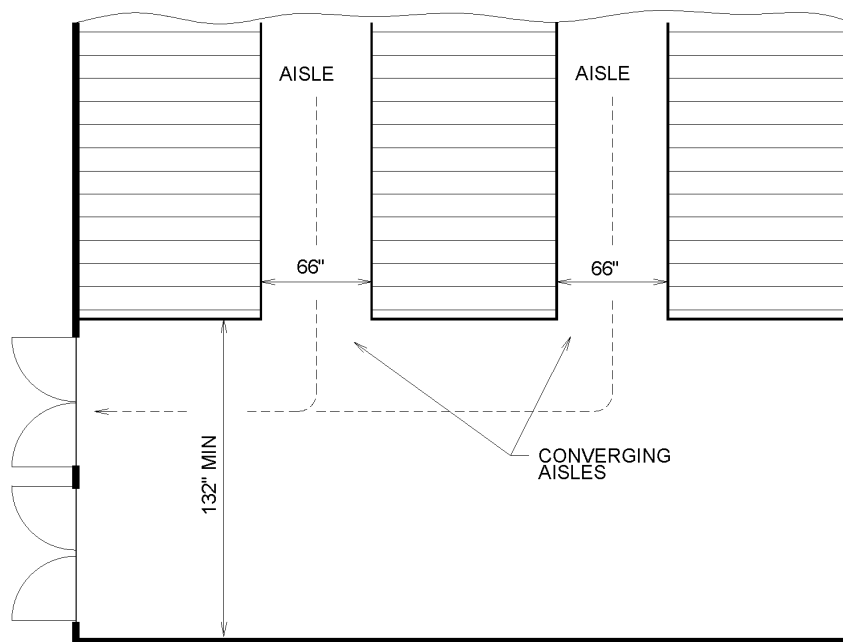
**Exception:** The clear width of *aisles* adjacent to seating at tables shall be permitted to be measured in accordance with Section 1029.12.1.

- ❖ The clear width for stepped, ramped and level aisles is measured consistently with stairways and ramps to ensure a clear width for egress. The exception is dealing with aisles in dining areas and how to measure with loose tables and chairs.

**1029.9.6.1 Assembly aisle obstructions.** There shall not be obstructions in the minimum width or required capacity of *aisles*.

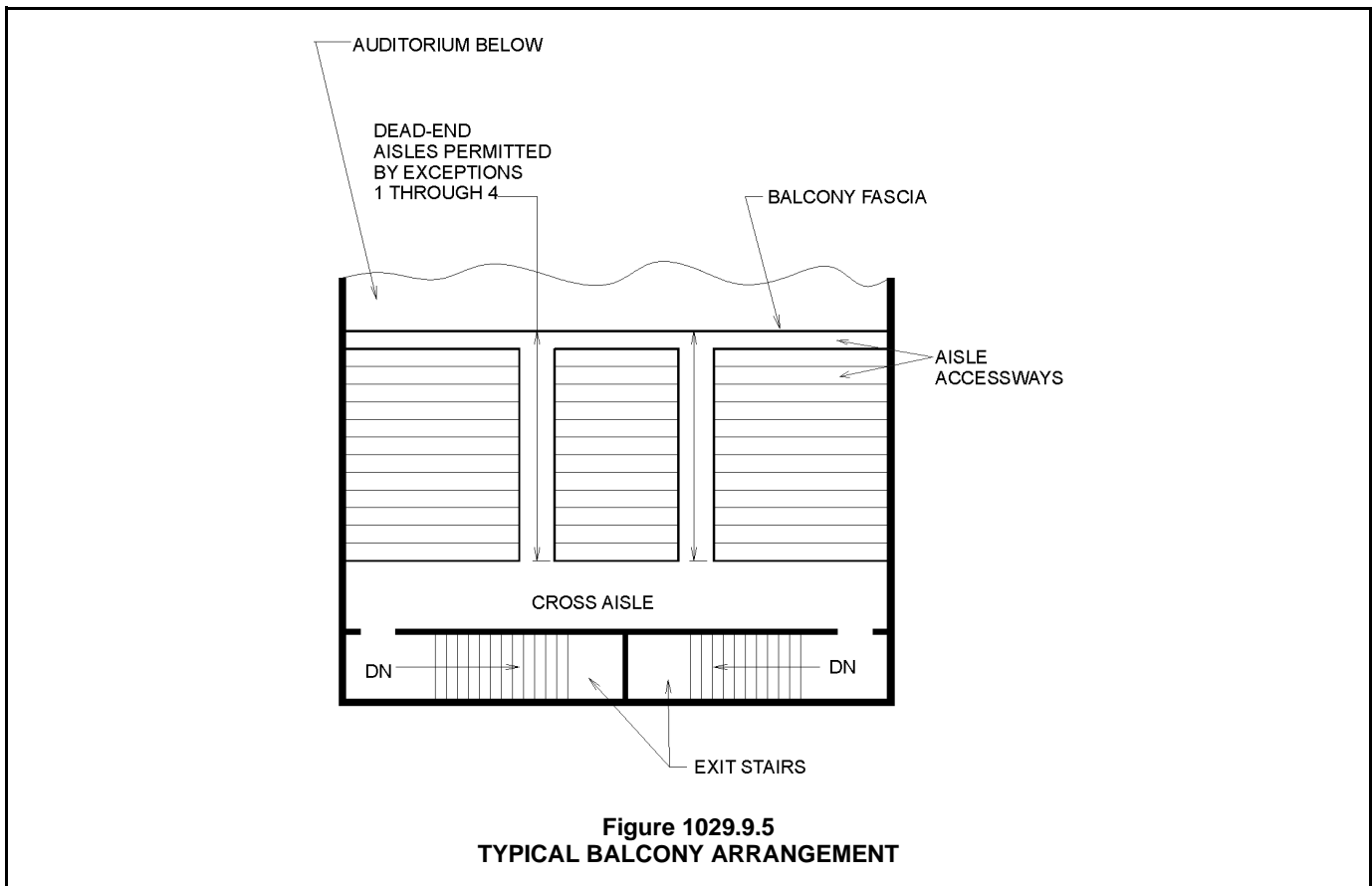
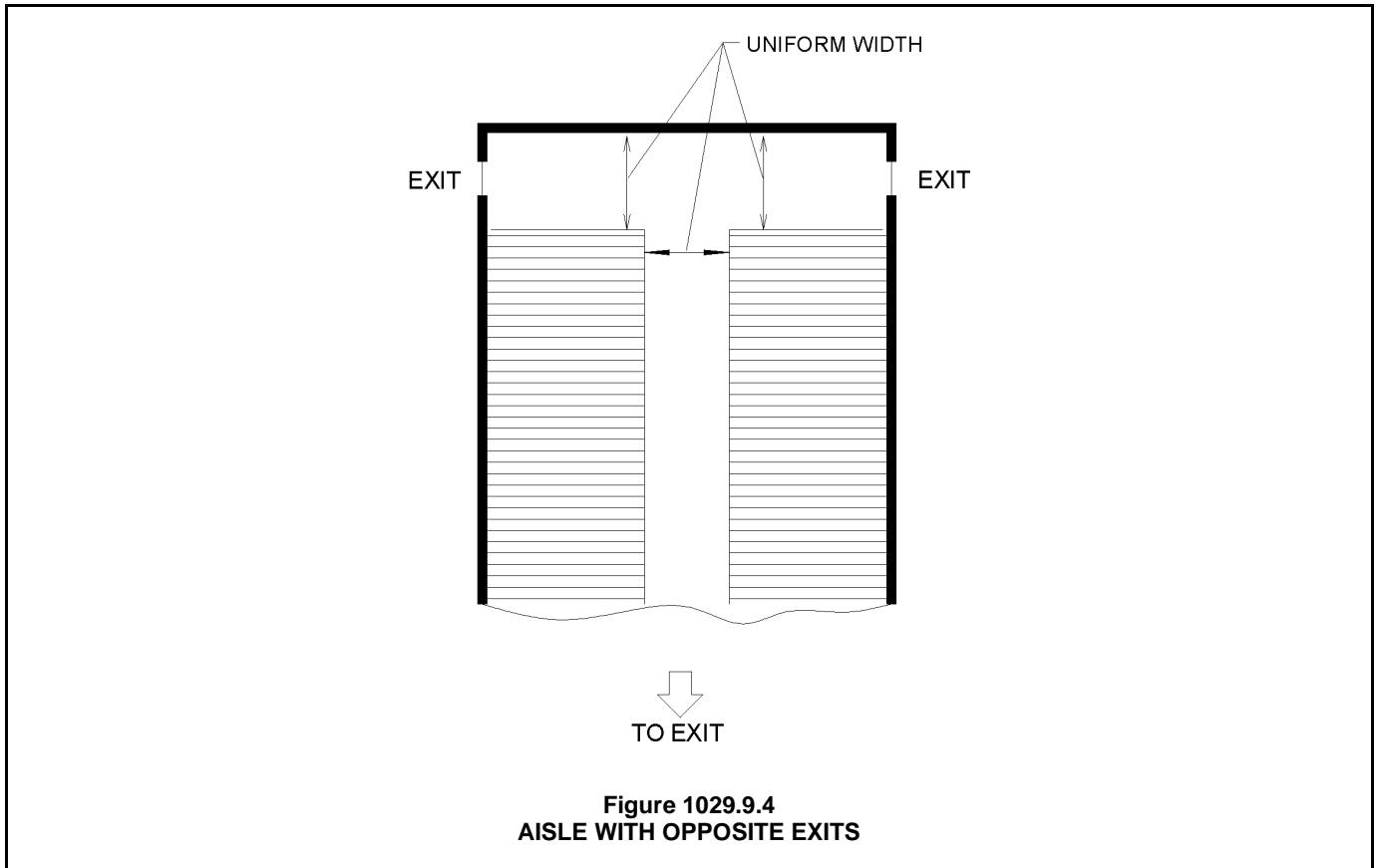
**Exception:** *Handrails* are permitted to project into the required width of stepped *aisles* and ramped *aisles* in accordance with Section 1014.8.

- ❖ Except for handrails, aisles are required to be clear of any obstructions so that the full width is available for egress purposes. Handrails are allowed to project into the required aisle width in the same manner as handrail projections in stairways.



For SI: 1 inch = 25.4 mm.

**Figure 1029.9.3**  
**COMPUTATION OF EXIT PASSAGE FOR CONVERGING AISLES**



**1029.9.7 Stairways connecting to stepped aisles.** A *stairway* that connects a stepped *aisle* to a cross *aisle* or concourse shall be permitted to comply with the assembly *aisle* walking surface requirements of Section 1029.13. Transitions between *stairways* and stepped *aisles* shall comply with Section 1029.10.

- ❖ Stairways that are a direct continuation of a stepped aisle, either at the top or bottom of the stepped aisle, and provide access to a cross aisle, shall be handled the same way as a stepped aisle for treads and risers (see Section 1029.13). For the transitions between the stepped aisle and the stairway, see Section 1029.10. For examples, see Figures 1029.9.7(1) and 1029.9.7(2).

**1029.9.8 Stairways connecting to vomitories.** A *stairway* that connects a vomitory to a cross aisle or concourse shall be permitted to comply with the assembly *aisle* walking surface requirements of Section 1029.13. Transitions between *stairways* and stepped *aisles* shall comply with Section 1029.10.

- ❖ A vomitory is an entrance that pierces the back of a seating bowl of a theater or stadium that allows for entrance into the seating area. Stairways that provide a direct connection between that vomitory and an aisle or concourse shall be handled the same way as a stepped aisle for treads and risers (see Section 1029.13). For the transitions between the stepped aisle and the stairway, see Section 1029.10.

**1029.10 Transitions.** Transitions between *stairways* and stepped *aisles* shall comply with either Section 1029.10.1 or 1029.10.2.

- ❖ Line of sight in assembly seating is an important issue that needs to be balanced with safe egress for people seated in the assembly spaces. In order to maintain line of site, sometime it is necessary to have a transition between stairways and stepped aisles that does not meet the standard tread, riser and land-

ing provisions for stairway. This section replaces the standard landing requirements for stairways with a transition tread/landing.

**1029.10.1 Transitions and stairways that maintain stepped aisle riser and tread dimensions.** Stepped *aisles*, transitions and *stairways* that maintain riser and tread dimensions shall comply with Section 1029.13 as one *exit access* component.

- ❖ Where the treads and risers on the stairway and the treads and risers on the stepped aisle are the same, the whole run can be considered as one long stepped aisle.

**1029.10.2 Transitions to stairways that do not maintain stepped aisle riser and tread dimensions.** Transitions to *stairways* from stepped *aisles* with riser and tread dimensions that differ from the *stairways* shall comply with Sections 1029.10.2.1 through 1029.10.3.

- ❖ Where the stepped aisle and directly connected stairways do not have the same tread and riser dimensions, there are options for the transition between the two sections. This transition is the tread(s) between the stepped aisle and the stairway.

**1029.10.2.1 Stairways and stepped aisles in a straight run.** Transitions where the *stairway* is a straight run from the stepped *aisle* shall have a minimum depth of 22 inches (559 mm) where the treads on the descending side of the transition have greater depth and 30 inches (762 mm) where the treads on the descending side of the transition have lesser depth.

- ❖ Typically, the treads on the stairway will have a smaller depth than the treads at the seating. Assuming that is the case, where the stairway is at the high end of the stepped aisle, a transition tread 22 inches (559 mm) in depth shall be provided between the stairway and the stepped aisle [see Commentary Figure 1029.10.2.1(1)]. Where the stairway is at the low



**Figure 1029.9.7(1)**  
EXAMPLE OF A CONTINUATION OF  
A STEPPED AISLE UP TO A CROSS AISLE



**Figure 1029.9.7(2)**  
EXAMPLE OF A CONTINUATION OF  
A STEPPED AISLE DOWN TO A FLOOR

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end of the stepped aisle, a transition tread a minimum of 30 inches (762 mm) in depth shall be provided between the stepped aisle and the stairway [see Commentary Figure 1029.10.2.1(2)].

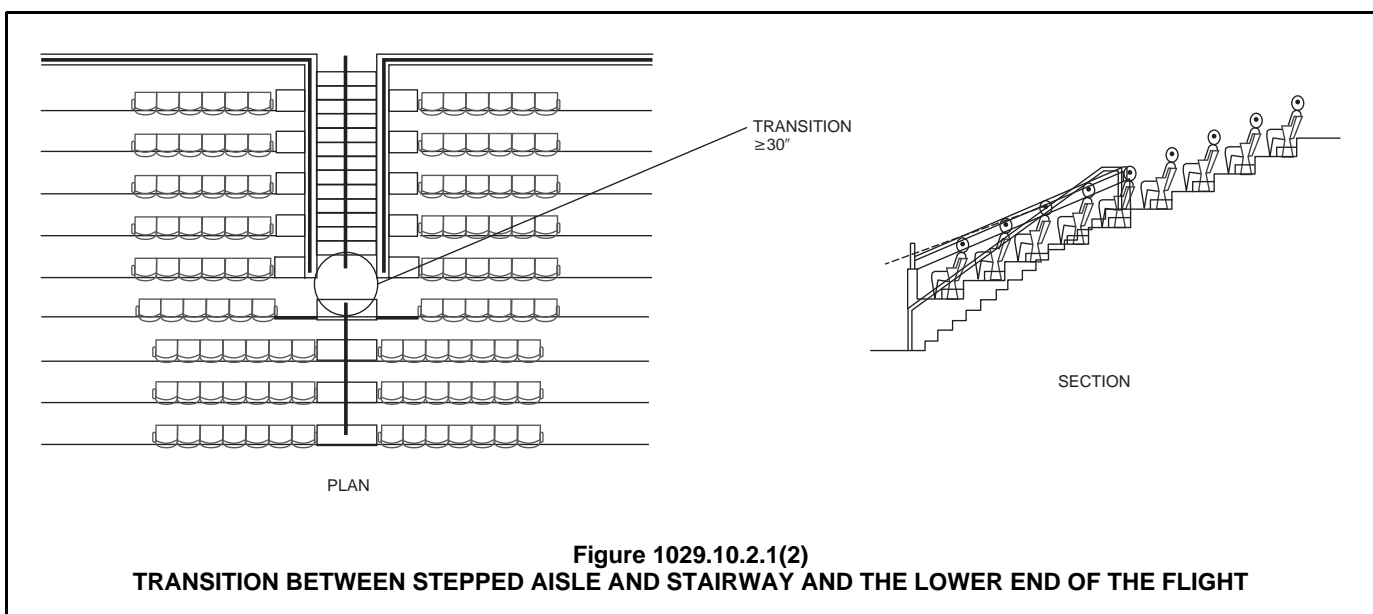
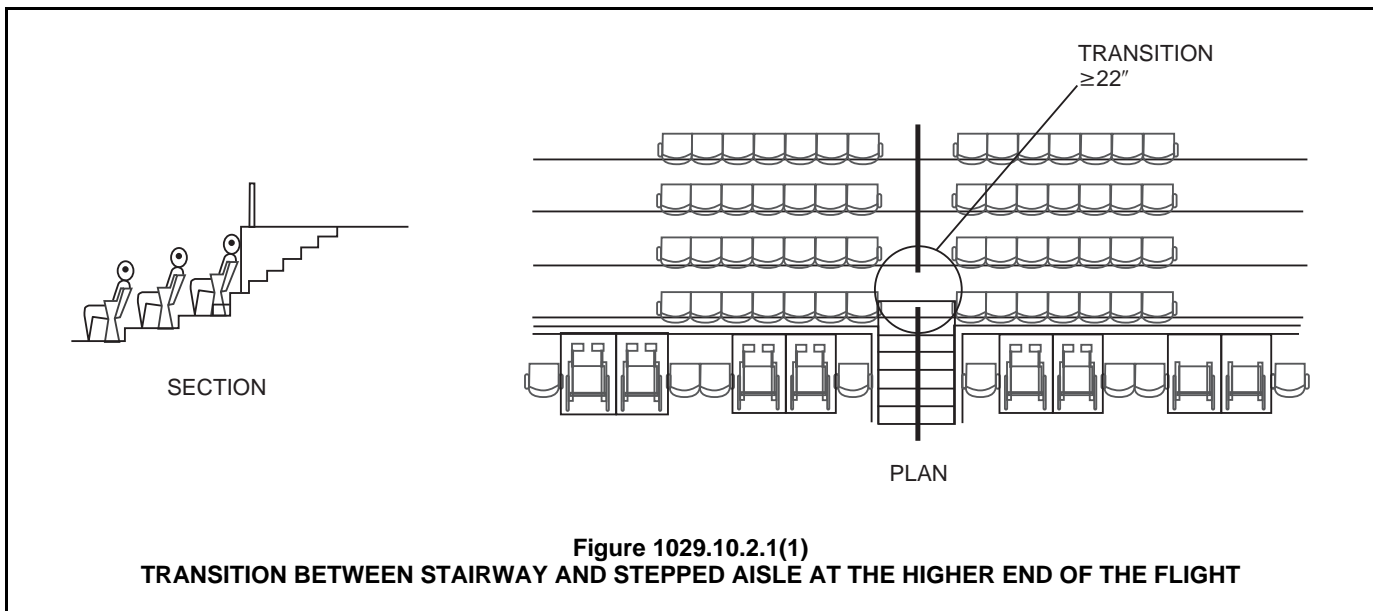
**1029.10.2.2 Stairways and stepped aisles that change direction.** Transitions where the *stairway* changes direction from the stepped *aisle* shall have a minimum depth of 11 inches (280 mm) or the stepped *aisle* tread depth, whichever is greater, between the stepped *aisle* and *stairway*.

❖ Where the stepped aisle takes a turn or takes a turn and becomes a stairway, the aisle width must be maintained (see Sections 1029.6 and 1029.9.1). The transition between the stepped aisle and the turn must continue the tread depth of the stepped aisle, or have a minimum depth of 11 inches (280 mm) to match the stairway treads, whichever is greater.

There may be more than one transition between the stepped aisle and the turn [see Commentary Figures 1029.10.2.2(1) and 1029.10.2.2(2)].

**1029.10.3 Transition marking.** A distinctive marking stripe shall be provided at each *nosing* or leading edge adjacent to the transition. Such stripe shall be not less than 1 inch (25 mm), and not more than 2 inches (51 mm), wide. The edge marking stripe shall be distinctively different from the stepped *aisle* contrasting marking stripe.

❖ At these transitions there may be a change in riser height, even if the tread depth stayed the same. The stripe is to draw attention to the transition to reduce the chance of a trip and fall. This is different from the stripes required for the stepped aisles in Sections 1029.13.2.2.1 and 1029.13.2.3.



**1029.11 Construction.** *Aisles*, stepped *aisles* and ramped *aisles* shall be built of materials consistent with the types permitted for the type of construction of the building.

**Exception:** Wood *handrails* shall be permitted for all types of construction.

❖ The construction materials permitted for stepped, ramped and level aisles are consistent with stairways and ramps.

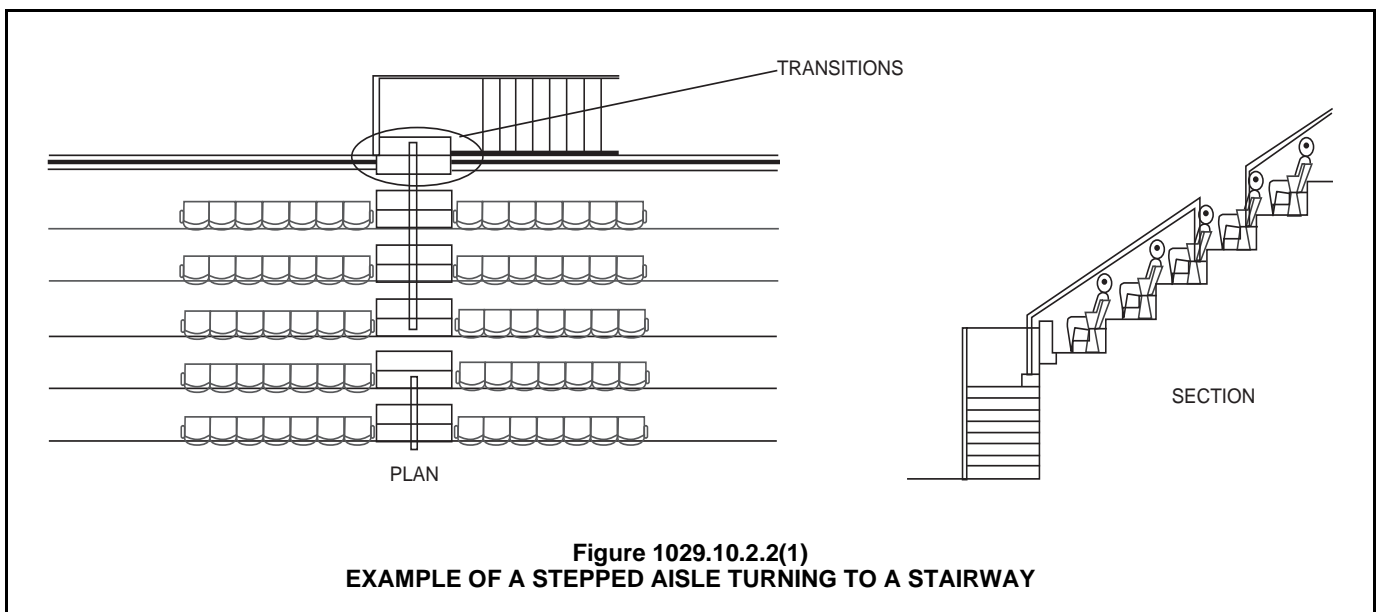
**1029.11.1 Walking surface.** The surface of *aisles*, stepped *aisles* and ramped *aisles* shall be of slip-resistant materials that are securely attached. The surface for stepped *aisles* shall comply with Section 1011.7.1.

❖ It is the intent of this section that for walking surfaces, stepped aisles will be addressed similar to stairways

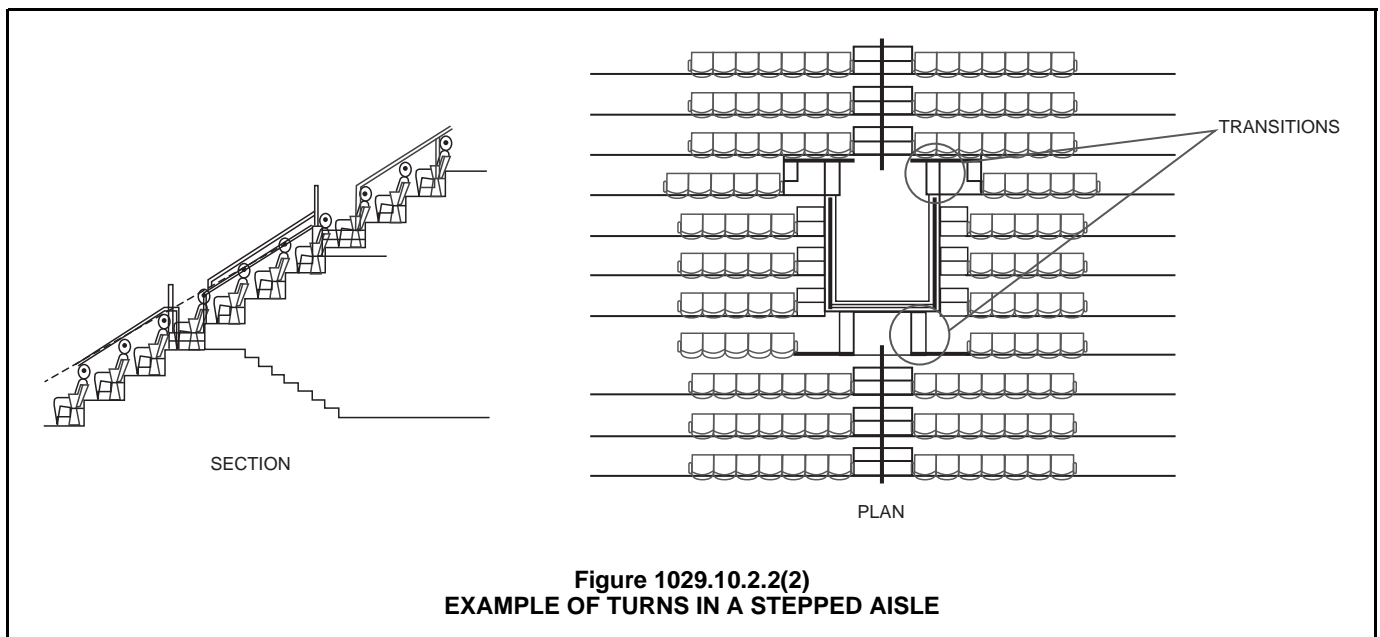
(Section 1011.7.1), level aisles the same as floors (Section 1003.4) and ramped aisles the same as ramps (Section 1012.7.1). See the commentary for these sections.

**1029.11.2 Outdoor conditions.** Outdoor *aisles*, stepped *aisles* and ramped *aisles* shall be designed so that water will not accumulate on the walking surface.

❖ Where stepped, ramped and level aisles are located in an outdoor situation, there is the same concern for the accumulation of ice and snow as there would be for exterior stairways or ramps. See Sections 1011.7.2 and 1012.7.2 regarding maximum slope to allow for drainage and when grated walking surfaces are permitted.



**Figure 1029.10.2.2(1)**  
**EXAMPLE OF A STEPPED AISLE TURNING TO A STAIRWAY**



**Figure 1029.10.2.2(2)**  
**EXAMPLE OF TURNS IN A STEPPED AISLE**

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**1029.12 Aisle accessways.** *Aisle accessways* for seating at tables shall comply with Section 1029.12.1. *Aisle accessways* for seating in rows shall comply with Section 1029.12.2.

❖ Aisle accessways are paths for means of egress between rows of seats or between tables. The aisle accessway leads to aisles, which in turn lead toward exits from the space. This is the same idea as moving through a room full of furniture to a corridor to reach an exit. In both situations, the path for means of egress is confined. For aisle accessway requirements in other occupancies, see Section 1018.

**1029.12.1 Seating at tables.** Where seating is located at a table or counter and is adjacent to an *aisle* or *aisle accessway*, the measurement of required clear width of the *aisle* or *aisle accessway* shall be made to a line 19 inches (483 mm) away from and parallel to the edge of the table or counter. The 19-inch (483 mm) distance shall be measured perpendicular to the side of the table or counter. In the case of other side boundaries for *aisles* or *aisle accessways*, the clear width shall be measured to walls, edges of seating and tread edges.

**Exception:** Where tables or counters are served by *fixed seats*, the width of the *aisle* or *aisle accessway* shall be measured from the back of the seat.

❖ Most seating at tables should be adjacent to aisles or aisle accessways. In measuring the width of an aisle or aisle accessway for movable seating, the measurement is taken at a distance of 19 inches (483 mm) perpendicular to the side of the table or counter. This 19-inch (483 mm) space from the edge of the table or counter to the line where the aisle or aisle accessway measurement begins is intended to represent the space occupied by a typical seated occupant. This dimension is also considered to be adequate to accommodate seats with armrests that are too high to fit under the table where fixed seats are used. The aisle width is permitted to be measured

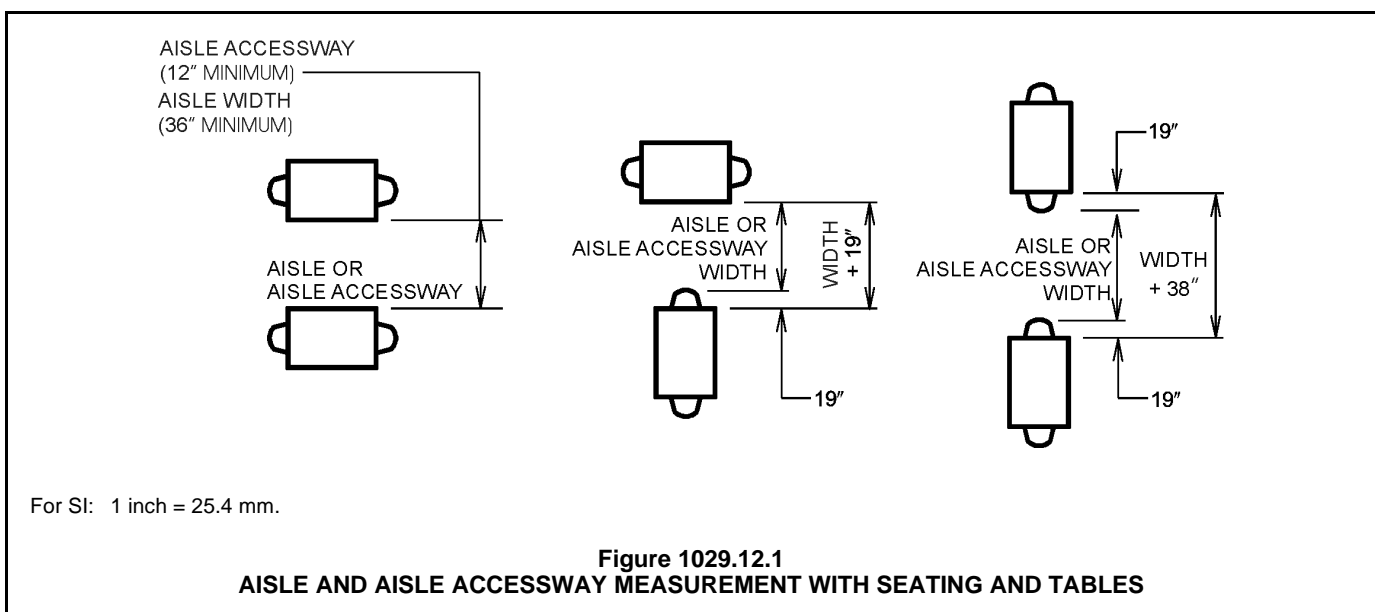
from the back of the seat based on the exception. As indicated in Commentary Figure 1029.12.1, where seating abuts an aisle or aisle accessway, 19 inches (483 mm) must be added to the required aisle or aisle accessway width for seating on only one side and 38 inches (965 mm) for seating on both sides. When seating will not be adjacent to the aisles or aisle passageways, as is the case when tables are at an angle to the aisle or aisle accessway, the measurement may be taken to the edge of the seating, table, counter or tread. Sections 1029.12.1.1 and 1029.12.1.2 address width and travel along aisle accessways. For aisles between tables, see the general requirements for aisles in assembly spaces.

**1029.12.1.1 Aisle accessway capacity and width for seating at tables.** *Aisle accessways* serving arrangements of seating at tables or counters shall comply with the capacity requirements of Section 1005.1 but shall not have less than 12 inches (305 mm) of width plus  $\frac{1}{2}$  inch (12.7 mm) of width for each additional 1 foot (305 mm), or fraction thereof, beyond 12 feet (3658 mm) of *aisle accessway* length measured from the center of the seat farthest from an *aisle*.

**Exception:** Portions of an *aisle accessway* having a length not exceeding 6 feet (1829 mm) and used by a total of not more than four persons.

❖ This section specifies two criteria for the determination of the required width of aisle accessways at tables: the requirements of Section 1005.1 for capacity based on the number of occupants and the option described in this section. The aisle accessway width is to be the wider of the two requirements. The aisle accessway width between tables is determined similarly to the aisle accessway between rows of seats that view an event.

The relationship of tables and seating sometimes results in a situation in which it is difficult to determine which chairs are served by which aisle accessway; therefore, the width of the aisle accessway is a func-



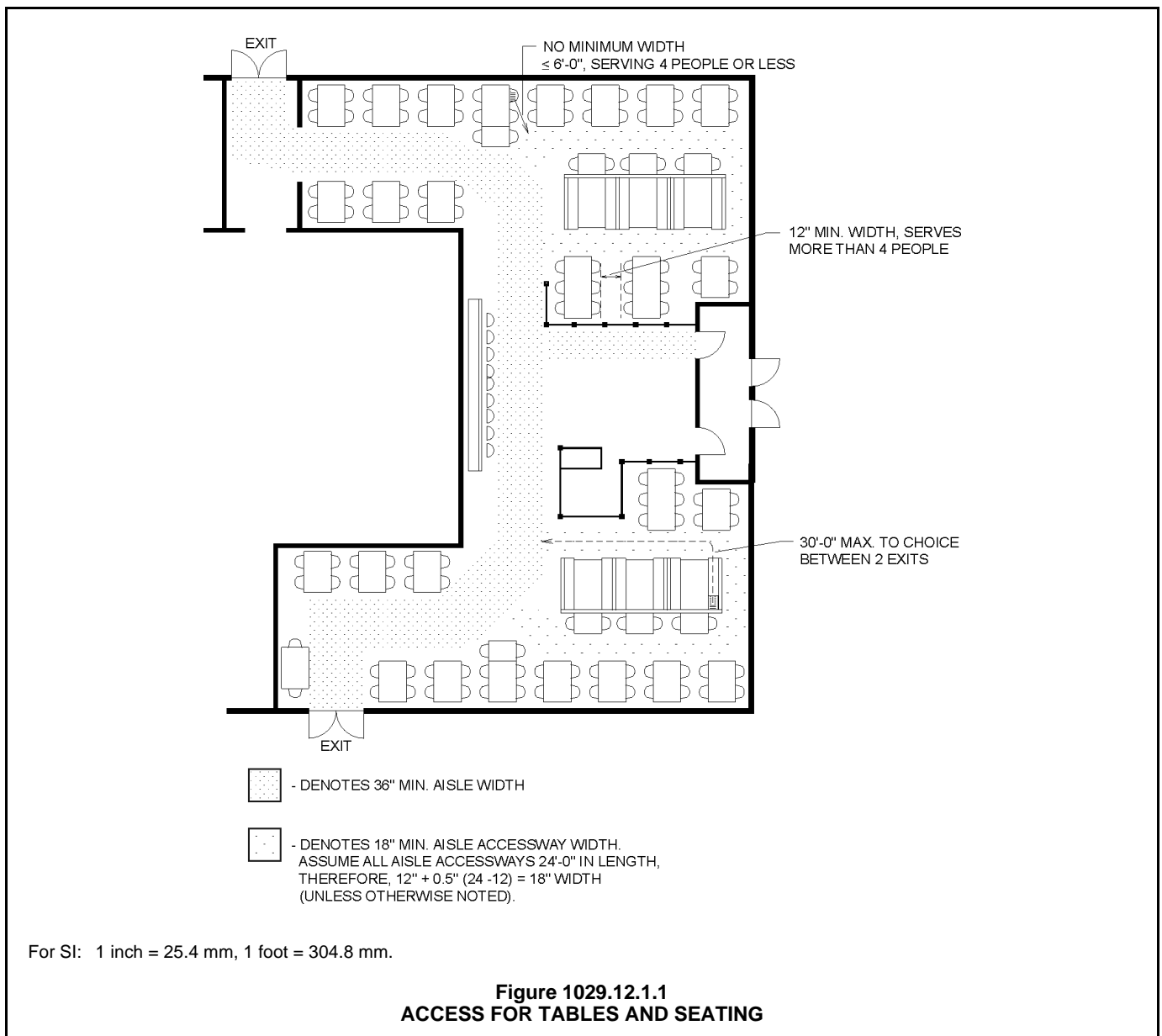
tion of the distance from the aisle. The same minimum 12 inches (305 mm) is used and is increased 1/2 inch (12.7 mm) for each additional foot of travel beyond 12 feet (3658 mm).

Recognizing that the normal use of table and chair seating will require some clearance for access and service, the exception eliminates the minimum width criteria if the distance to the aisle [or an aisle accessway of at least 12 inches (305 mm)] is less than 6 feet (1829 mm) and the number of people served is not more than four. Therefore, the first 6 feet (1829 mm) are not required to meet any minimum width criteria. After the first 6 feet (1829 mm), the requirements for an aisle accessway will apply. The length of the aisle accessway is then restricted by Section 1029.12.1.2. When the maximum length of the aisle accessway is reached, an aisle, corridor or exit access door must be provided (see Commentary Figure 1029.12.1.1).

**1029.12.1.2 Seating at table aisle accessway length.** The length of travel along the *aisle accessway* shall not exceed 30 feet (9144 mm) from any seat to the point where a person has a choice of two or more paths of egress travel to separate exits.

❖ At some point in the exit access travel, it is necessary to reach an aisle complying with the minimum widths of Section 1029.9.1. Aisle accessway travel distance for seating at tables is not to exceed 30 feet (9144 mm), which may represent a dead-end condition (see Commentary Figure 1029.12.1.1).

More and more sports facilities are starting to add venues that include dining while watching the sporting event. At this time, the code does not include provisions for dining that occurs in smoke-protected areas.



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**1029.12.2 Clear width of aisle accessways serving seating in rows.** Where seating rows have 14 or fewer seats, the minimum clear *aisle accessway* width shall be not less than 12 inches (305 mm) measured as the clear horizontal distance from the back of the row ahead and the nearest projection of the row behind. Where chairs have automatic or self-rising seats, the measurement shall be made with seats in the raised position. Where any chair in the row does not have an automatic or self-rising seat, the measurements shall be made with the seat in the down position. For seats with folding tablet arms, row spacing shall be determined with the tablet arm in the used position.

**Exception:** For seats with folding tablet arms, row spacing is permitted to be determined with the tablet arm in the stored position where the tablet arm when raised manually to vertical position in one motion automatically returns to the stored position by force of gravity.

❖ The requirements of this section are applicable to theater-type seating arrangements. This includes both “continental” and “traditional” seating arrangements. Theater-type seating is characterized by a number of seats arranged side by side and in rows. In this type of seating arrangement, the potential exists for a large number of occupants to be present in a confined environment where the ability of the occupants to move quickly is limited. In order to egress, people are required to move single file within a narrow row (i.e., aisle accessway) before reaching an aisle; both the aisle or aisle accessway limit movement toward an exit. To provide adequate passage between rows of seats, this section requires that the clear width between the back of a row to the nearest projection of the seating immediately behind must be at least 12 inches (305 mm) [see Commentary Figure 1029.12.2(1)]. Where chairs are manufactured with automatic or self-lifting seats, the minimum width requirement may be measured with the seats in a raised position. Commonly used in college lecture halls, seats with built-in tablet arms are provided so that students can take notes. For an example of a type of tablet arm that complies with the exception,

see Commentary Figure 1029.12.2(2).

When tablet chairs are used, the required width is to be determined with the tablet arm in its usable position. The exception allows for folding tablet arms that fall back into the stored position when a person rises out of the seat. With seats occupied and tablets raised, students egressing en masse down the row would at most encounter one tablet to move out of the way. With these types of arms, the aisle accessway can be measured for the seat or arm as indicated in Commentary Figure 1029.12.2(1).

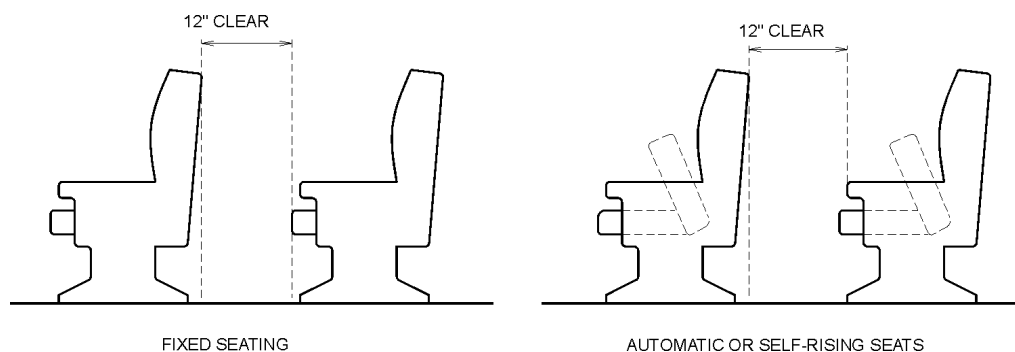
With respect to self-rising seats, ASTM F851 provides one method of determining acceptability.

**1029.12.2.1 Dual access.** For rows of seating served by *aisles* or doorways at both ends, there shall be not more than 100 seats per row. The minimum clear width of 12 inches (305 mm) between rows shall be increased by 0.3 inch (7.6 mm) for every additional seat beyond 14 seats where seats have backrests or beyond 21 where seats are without backrests.



For SI: 1 inch = 25.4 mm.

**Figure 1029.12.2(2)**  
**EXAMPLE OF FOLDING TABLET ARMS**



For SI: 1 inch = 25.4 mm.

**Figure 1029.12.2(1)**  
**MINIMUM REQUIRED ROW WIDTH CLEARANCE FOR AISLE ACCESSWAYS**

The minimum clear width is not required to exceed 22 inches (559 mm).

**Exception:** For *smoke-protected assembly seating*, the row length limits for a 12-inch-wide (305 mm) *aisle accessway*, beyond which the *aisle accessway* minimum clear width shall be increased, are in Table 1029.12.2.1.

- ❖ Where rows of seating are served by aisles or doorways located at both ends of the path of row travel, the number of seats that may be used in a row may be up to, but not more than, 100 (continental seating) and the minimum required clear width aisle accessway of 12 inches (305 mm) between rows of seats must be increased by 0.3 inch (8 mm) for every additional seat with backrests beyond 14, but not more than a total of 22 inches (559 mm) (see Commentary Figure 1029.12.2.1). The increase for seating without backrests is to allow for bench seating similar to bleacher requirements in ICC 300 (see Section 1029.1.1). For example, in a row of 24 seats, the minimum clear width would compute to 15 inches (381 mm) [12 + (0.3 x 10)]. For a row of 34 seats, a clear width of 18 inches (457 mm) would be required. Increases in the clear width between rows of seats would occur up to a row of 46 seats. From 47 to 100 seats, a maximum clear width between rows of 22 inches (559 mm) would apply.

Since the row is to provide access to an aisle in both directions, the minimum width applies to the entire length of the row aisle accessway.

The exception allows more seats in a row with the minimum 12-inch (305 mm) seat spacing since safe egress time is extended for this condition.

When a second means of egress for occupants of a single access row is possible through an adjacent dual access row, see Section 1029.8.1.

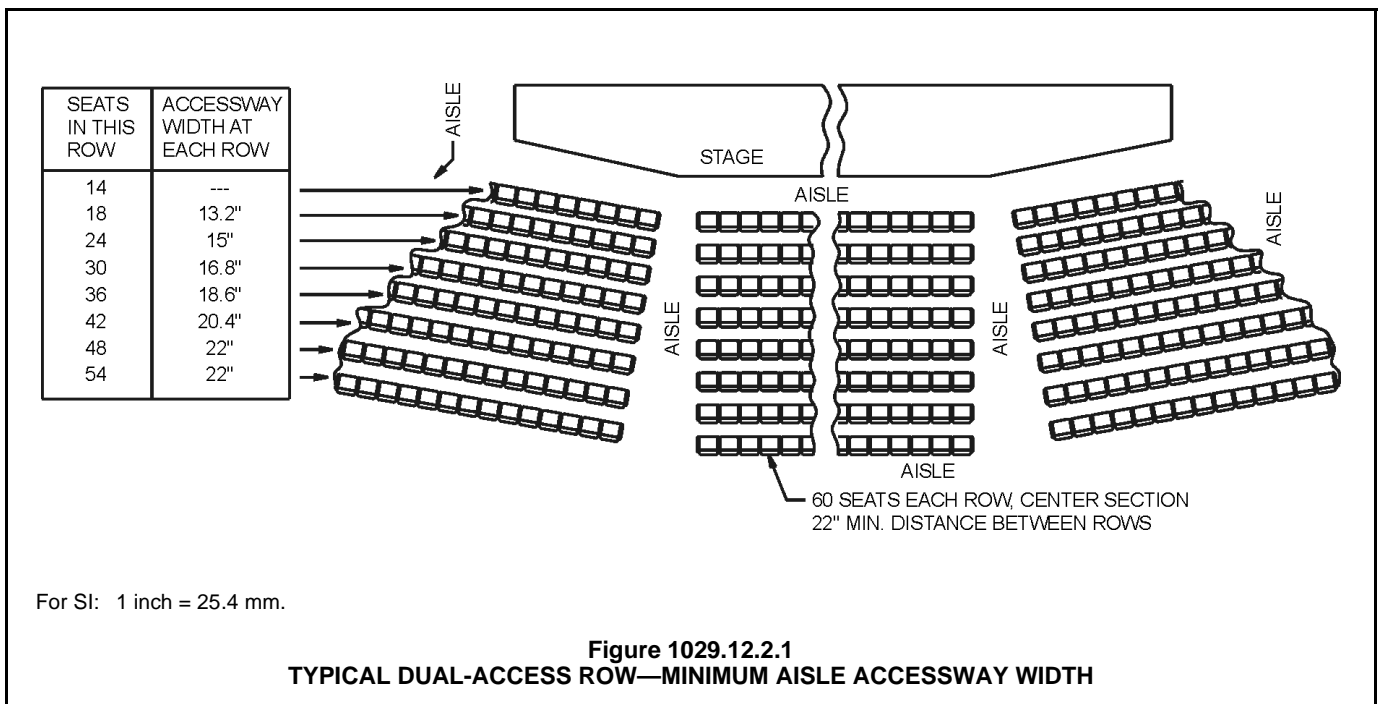
**TABLE 1029.12.2.1.** See page 10-202.

- ❖ Table 1029.10.1 recognizes the increased egress time available in smoke-protected assembly seating areas. Therefore, the table permits greater lengths of rows that have the minimum 12 inches (305 mm) of clear width. When a row exceeds the lengths identified in the table, the row width is to be increased in accordance with Section 1029.12.2.1 [0.3 inch (8 mm) per additional seat] for dual-access rows and Section 1029.12.2.2 [0.6 inch (15 mm) per additional seat] for single-access rows. Column one in this table is based on the total number of seats contained within the assembly space, not the seats per level. The increase for seating without backrests is to allow for bench seating similar to bleacher requirements in ICC 300 (see Section 1029.1.1).

**1029.12.2.2 Single access.** For rows of seating served by an *aisle* or doorway at only one end of the row, the minimum clear width of 12 inches (305 mm) between rows shall be increased by 0.6 inch (15.2 mm) for every additional seat beyond seven seats where seats have backrests or beyond 10 where seats are without backrests. The minimum clear width is not required to exceed 22 inches (559 mm).

**Exception:** For *smoke-protected assembly seating*, the row length limits for a 12-inch-wide (305 mm) *aisle accessway*, beyond which the *aisle accessway* minimum clear width shall be increased, are in Table 1029.12.2.1.

- ❖ Where rows of seating are served by an aisle or doorway at only one end of a row, the minimum clear width of 12 inches (305 mm) between rows of seats must be increased by 0.6 inch (15 mm) for every additional seat beyond seven for seats with backrests, but not more than a total of 22 inches (559 mm) (see Commentary Figure 1029.12.2.2). The increase



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for seating without backrests is to allow for bench seating similar to bleacher requirements in ICC 300 (see Section 1029.1.1). While this section does not specify the maximum number of seats permitted in a row, the 30-foot (9144 mm) common path of travel limitation (see Section 1029.8) essentially restricts the single-access row to approximately 20 seats, based on an 18-inch (457 mm) width per seat. A row of 12 seats with backrests would compute to a required minimum width of 15 inches [12 + (0.5 x 5)]. Similarly, a row of 17 seats with backrests would require a clear width of 18 inches (457 mm) and so on. Since dual access is not provided, incremental increases would be permitted in the aisle accessway width as shown in Commentary Figure 1029.12.2.2. Incremental increases in the required width would occur up to the maximum number of seats, which is determined by the 30-foot (9144 mm) dead-end limitation.

The reason for increasing the row accessway widths incrementally with increases in the number of seats per row is to provide more efficient passage for the occupants who are using the aisle accessway. As

a practical matter, where dual-access (see Section 1029.12.2.1) and single-access seating arrangements are used together, the largest computed clear width dimension would normally be applied by the designer to both arrangements so that the rows of seats will be in alignment. When a second means of egress for occupants of a single-access row is possible through an adjacent dual access row, see Section 1029.8.1.

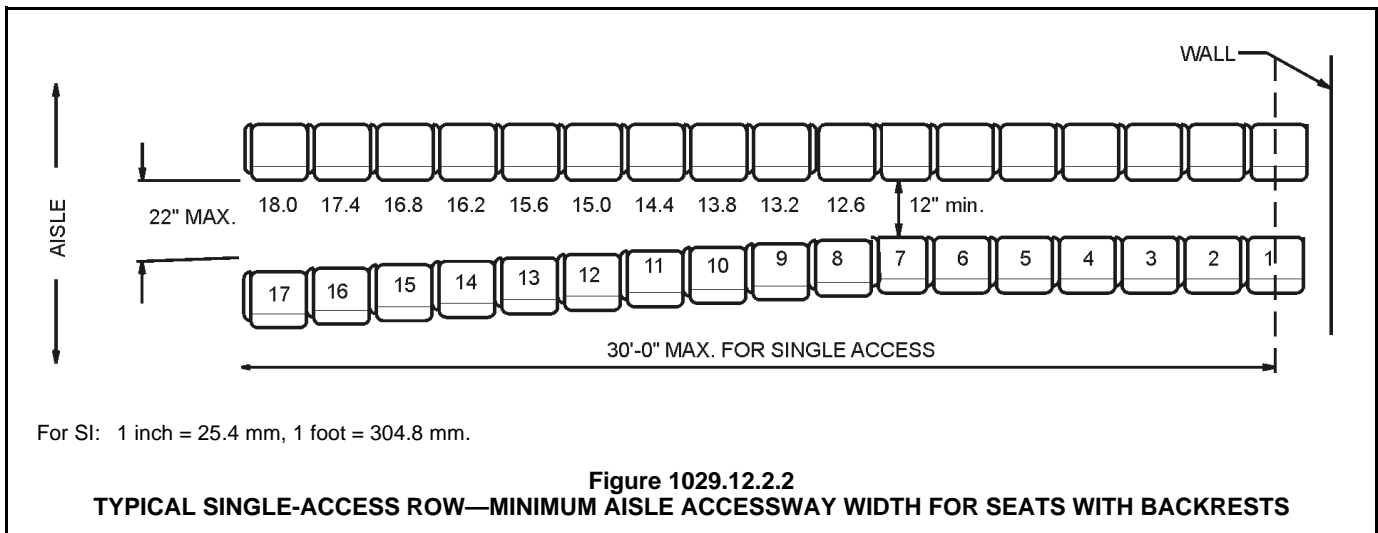
**1029.13 Assembly aisle walking surfaces.** Ramped *aisles* shall comply with Sections 1029.13.1 through 1029.13.1.3. Stepped *aisles* shall comply with Sections 1029.13.2 through 1029.13.2.4.

❖ Assembly facilities such as theaters and auditoriums often require sloping or stepped floors to provide seated occupants with preferred sightlines for viewing presentations (for sightlines for wheelchair spaces, see IBC Section 1108.2). Aisles must, therefore, be designed to accommodate the changing elevations of the floor in such a manner that the path of travel will allow occupants to leave the area at a rapid pace with minimal possibilities for stumbling or falling during times of emergency.

**[BE] TABLE 1029.12.2.1  
SMOKE-PROTECTED ASSEMBLY AISLE ACCESSWAYS**

TOTAL NUMBER OF SEATS IN THE SMOKE-PROTECTED ASSEMBLY SEATING	MAXIMUM NUMBER OF SEATS PER ROW PERMITTED TO HAVE A MINIMUM 12-INCH CLEAR WIDTH AISLE ACCESSWAY			
	Aisle or doorway at both ends of row		Aisle or doorway at one end of row only	
	Seats with backrests	Seats without backrests	Seats with backrests	Seats without backrests
Less than 4,000	14	21	7	10
4,000	15	22	7	10
7,000	16	23	8	11
10,000	17	24	8	11
13,000	18	25	9	12
16,000	19	26	9	12
19,000	20	27	10	13
22,000 and greater	21	28	11	14

For SI: 1 inch = 25.4 mm.



**1029.13.1 Ramped aisles.** *Aisles* that are sloped more than one unit vertical in 20 units horizontal (5-percent slope) shall be considered a ramped *aisle*. Ramped *aisles* that serve as part of an *accessible route* in accordance with Sections 1009 and 1108.2 shall have a maximum slope of one unit vertical in 12 units horizontal (8-percent slope). The slope of other ramped *aisles* shall not exceed one unit vertical in 8 units horizontal (12.5-percent slope).

❖ Similar to the definition for ramp in Chapter 2, aisles that slope 1:20 or less are considered sloped aisles, but are not ramps. Note that ramps that serve as part of an accessible route to and from accessible wheelchair spaces (Section 1009 and IBC Section 1108.2) must comply with the more restrictive requirements for ramps in Section 1012. This section requires that aisles with a gradient from 1:20 to 1:8 (12.5 percent slope) must meet the ramped aisle provisions in this section. Aisles with a gradient exceeding one unit vertical and eight units horizontal (12.5-percent slope) must consist of a series of treads and risers that comply with the requirements of stepped aisles in Section 1029.13.2.

**1029.13.1.1 Cross slope.** The slope measured perpendicular to the direction of travel of a ramped *aisle* shall not be steeper than one unit vertical in 48 units horizontal (2-percent slope).

❖ The limitation of one unit vertical in 48 units horizontal on the slope across the direction of travel is to prevent a severe cross slope that would pitch a user to one side (see Commentary Figure 1012.2).

**1029.13.1.2 Landings.** Ramped *aisles* shall have landings in accordance with Sections 1012.6 through 1012.6.5. Landings for ramped *aisles* shall be permitted to overlap required *aisles* or cross *aisles*.

❖ The reference for ramp landings to Sections 1012.6 through 1012.6.5 picks up the requirements for ramps to have a landing at the top and bottom of each run and when ramps change direction. This also includes requirements for landing slope, width and length. This does not pick up the requirement for ramps to have a landing at every 30 inches (762 mm) in rise as indicated in Section 1012.4. This is in consideration of the line of sight requirements for the different venues and the ability to provide a safe and smooth transition between the ramped aisles and the adjacent aisle accessways as patrons move into and out of their rows. A cross aisle or aisle can also serve as the ramp landing as long as it meets the 1:48 maximum slope provisions for landings.

**1029.13.1.3 Edge protection.** Ramped *aisles* shall have edge protection in accordance with Sections 1012.10 and 1012.10.1.

**Exception:** In assembly spaces with *fixed seating*, edge protection is not required on the sides of ramped *aisles* where the ramped *aisles* provide access to the adjacent seating and *aisle accessways*.

❖ Where an aisle has a dropoff on either side, it needs edge protection. In a seating venue, this would typi-

cally be the ramped aisle at the perimeter of the seating. This edge protection can be a wall, a horizontal rail that prevents the passage of a 4-inch (102 mm) sphere between the ramp surface and the rail, or a minimum 4-inch-high (102 mm) curb (see Commentary Figure 1012.10.1). Edge protection is not required between the ramped aisle and adjacent seating, including wheelchair seating spaces, as this could be a tripping hazard for people coming in and out of the rows.

**1029.13.2 Stepped aisles.** *Aisles* with a slope exceeding one unit vertical in eight units horizontal (12.5-percent slope) shall consist of a series of risers and treads that extends across the full width of *aisles* and complies with Sections 1029.13.2.1 through 1029.13.2.4.

❖ What must be recognized here is that stepped aisles are part of the floor construction and are intended to provide horizontal egress. Tread and riser construction for this purpose should not be directly compared to the requirements for treads and risers in conventional stairways that serve as means of vertical egress. Sometimes, because of design considerations, the gradient of an aisle is required to change from a level floor to a ramp and then to steps. In cases where there is no uniformity in the path of travel, occupants tend to be considerably more cautious, particularly in the use of stepped aisles, than they would normally be in the use of conventional stairways.

This section requires aisles with a slope of greater than 1:8 to use steps. Aisles with slopes of greater than 1:20 to 1:8 must comply with provisions for ramped aisles in Section 1029.13.1.

**1029.13.2.1 Treads.** Tread depths shall be not less than 11 inches (279 mm) and shall have dimensional uniformity.

**Exception:** The tolerance between adjacent treads shall not exceed  $\frac{3}{16}$  inch (4.8 mm).

❖ Depths of treads are not to be less than 11 inches (279 mm) and uniform throughout each flight, except that a variance of not more than  $\frac{3}{16}$  inch (4.8 mm) is permitted between adjacent treads to accommodate variations in construction. While the minimum tread depth provision is the same as the limiting dimension for treads in interior stairways (see Section 1011.5.2), it rarely applies in the construction of stepped aisles. A more common form of stepped aisle construction is to provide a tread depth equal to the back-to-back distance between rows of seats. This way the treads can be extended across the full length of the row and serve as a supporting platform for the seats. Other arrangements might require two treads between rows of seats, each tread equaling one-half of the depth of the seat row.

In theaters, for example, the back-to-back distance between rows of fixed seats usually ranges somewhere between 3 and 4 feet (914 and 1219 mm), depending on seat style and seat dimensions as well as the ease of passage between the rows (see Com-

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mentary Figure 1029.13.2.1). The selection of single-tread or two-tread construction between rows of seats depends on the gradient and suitable riser height (see Section 1029.13.2.2), as needed for sightlines.

In comparing this section to Section 1029.13.2.2, it is significant to note the emphasis placed on the tread dimension. While not desirable, the code permits riser heights to deviate; however, tread dimensions must not vary beyond the  $\frac{3}{16}$ -inch (4.8 mm) tolerance.

**1029.13.2.2 Risers.** Where the gradient of stepped *aisles* is to be the same as the gradient of adjoining seating areas, the riser height shall be not less than 4 inches (102 mm) nor more than 8 inches (203 mm) and shall be uniform within each *flight*.

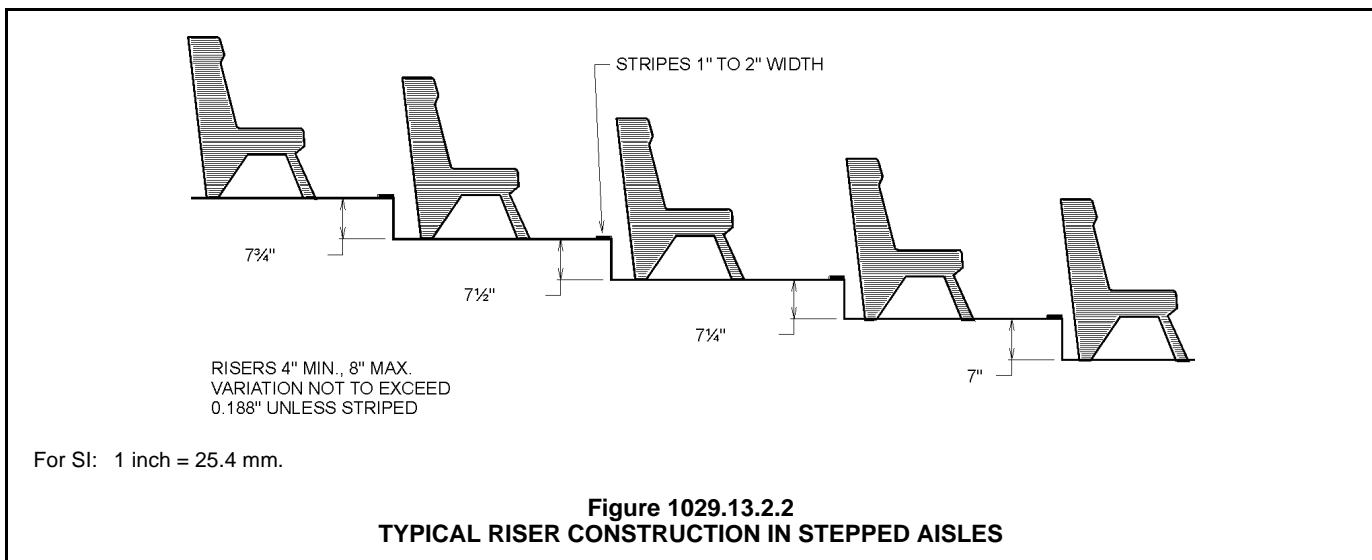
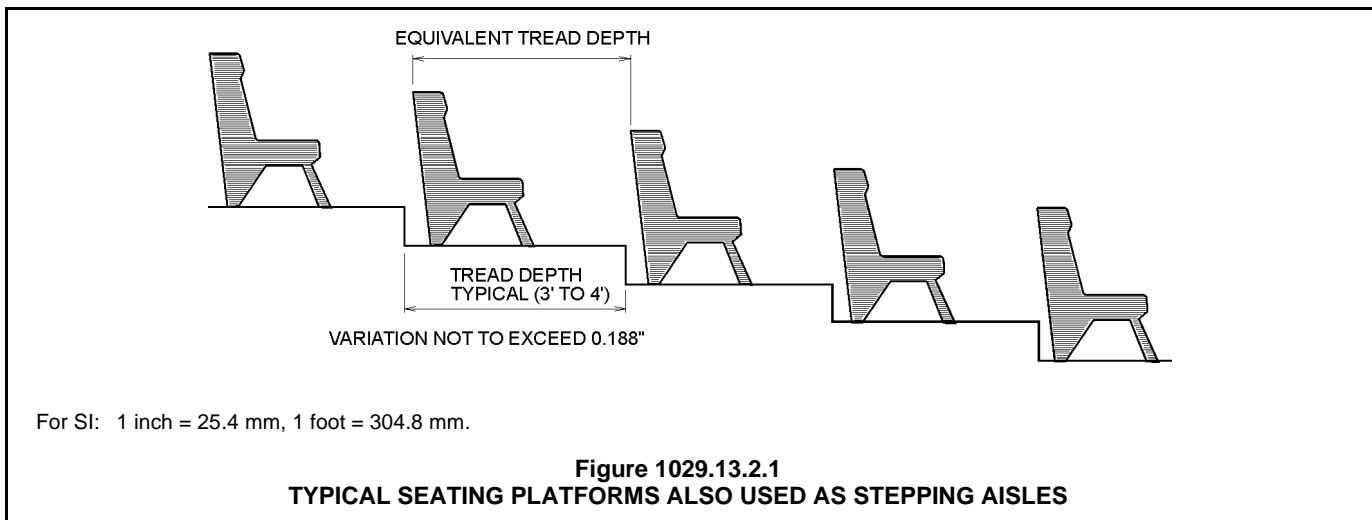
### Exceptions:

1. Riser height nonuniformity shall be limited to the extent necessitated by changes in the gradient of the adjoining seating area to maintain adequate sightlines. Where nonuniformities exceed  $\frac{3}{16}$  inch (4.8

mm) between adjacent risers, the exact location of such nonuniformities shall be indicated with a distinctive marking stripe on each tread at the *nosing* or leading edge adjacent to the nonuniform risers. Such stripe shall be not less than 1 inch (25 mm), and not more than 2 inches (51 mm), wide. The edge marking stripe shall be distinctively different from the contrasting marking stripe.

2. Riser heights not exceeding 9 inches (229 mm) shall be permitted where they are necessitated by the slope of the adjacent seating areas to maintain sightlines.

- ❖ In stepped aisles where the gradient of the aisle is the same as the gradient of the adjoining seating area, riser heights are not to be less than 4 inches (102 mm) nor more than 8 inches (203 mm) (see Commentary Figure 1029.13.2.2). For the safety of the occupants, risers should have uniform heights, where possible, throughout each flight. However, nonuniformity of riser heights is permitted in cases where changes to the gradient in the adjoining seating area



are required because of sightlines and other seating layout considerations.

Where variations in height exceed  $\frac{3}{16}$  inch (4.8 mm) between adjacent risers, a distinctive marking stripe between 1 inch (25 mm) and 2 inches (51 mm) wide is to be located on the nosings of each tread as a visual warning to the occupants to be cautious. Frequently, this is done with “runway” lights. Note that this stripe must be different from the tread contrast marking stripes required for transitions in Section 1029.10.3 and the tread stripes in Section 1029.13.2.2.1. All of these stripes must be visible in lighted conditions; therefore, they are not required to comply with the provisions for luminous tread markings in Section 1025.

While the riser height may vary to adjust to sight lines of the associated seating, there is a maximum change for adjacent treads so that there is consistency in the flight (see Section 1029.13.2.2.1).

In comparing this section with Section 1029.13.2.1, it is significant to note the emphasis placed on the tread dimension. While not desirable, the code permits riser heights to deviate; however, Section 1029.13.2.1 does not permit tread dimensions to vary beyond the  $\frac{3}{16}$ -inch (4.8 mm) tolerance.

**1029.13.2.2.1 Construction tolerances.** The tolerance between adjacent risers on a stepped *aisle* that were designed to be equal height shall not exceed  $\frac{3}{16}$  inch (4.8 mm). Where the stepped *aisle* is designed in accordance with Exception 1 of Section 1029.13.2.2, the stepped *aisle* shall be constructed so that each riser of unequal height, determined in the direction of descent, is not more than  $\frac{3}{8}$  inch (9.5 mm) in height different from adjacent risers where stepped *aisle* treads are less than 22 inches (560 mm) in depth and  $\frac{3}{4}$  inch (19.1 mm) in height different from adjacent risers where stepped *aisle* treads are 22 inches (560 mm) or greater in depth.

❖ Where risers in a stepped aisle are consistent, the construction tolerance between adjacent treads allows for a maximum difference of  $\frac{3}{16}$  inch (4.8 mm). Stairways allow for  $\frac{3}{8}$  inch (9.5 mm), but this is for the flight of stairs (see Section 1011.5.4). Where the seating arrangement allows for unequal heights, the difference between adjacent risers is greater for situations with deeper treads. With a tread of 22 inches (560 mm) or greater, most people will be taking more than one step on each tread.

**1029.13.2.3 Tread contrasting marking stripe.** A contrasting marking stripe shall be provided on each tread at the *nos-ing* or leading edge such that the location of each tread is readily apparent when viewed in descent. Such stripe shall be not less than 1 inch (25 mm), and not more than 2 inches (51 mm), wide.

**Exception:** The contrasting marking stripe is permitted to be omitted where tread surfaces are such that the location of each tread is readily apparent when viewed in descent.

❖ The exception provides for the omission of the contrasting marking stripe where the tread is readily

apparent, such as when aisle stair treads are provided with a roughened metal nosing strip or where lighted nosings occur. In this situation, the user is aware of the treads without the marking stripe. This stripe must be different from the marking stripe required for nonuniform risers in Section 1029.13.2.2.1 and the tread contrast marking stripes required for transitions in Section 1029.10.3

These stripes must be visible in lighted conditions; therefore, these stripes are not required to comply with the provisions for luminous tread markings in Section 1025.

**1029.13.2.4 Nosing and profile.** *Nosing* and riser profile shall comply with Sections 1011.5.5 through 1011.5.5.3.

❖ The profiles of treads and risers contribute to stepped aisle safety. The radius or bevel of the nosing eases the otherwise square edge of the tread and prevents irregular chipping and wear that can become a maintenance issue and seriously affect the safe use of the stepped aisles. Since safety considerations for stepped aisles and stairways are the same for nosing and riser profiles, the provisions in stairways are referenced for this requirement.

**1029.14 Seat stability.** In a building, room or space used for assembly purposes, the seats shall be securely fastened to the floor.

**Exceptions:**

1. In a building, room or space used for assembly purposes or portions thereof without ramped or tiered floors for seating and with 200 or fewer seats, the seats shall not be required to be fastened to the floor.
2. In a building, room or space used for assembly purposes or portions thereof without ramped or tiered floors for seating, the seats shall not be required to be fastened to the floor.
3. In a building, room or space used for assembly purposes or portions thereof without seating at tables and without ramped or tiered floors for seating and with greater than 200 seats, the seats shall be fastened together in groups of not less than three or the seats shall be securely fastened to the floor.
4. In a building, room or space used for assembly purposes where flexibility of the seating arrangement is an integral part of the design and function of the space and seating is on tiered levels, not more than 200 seats shall not be required to be fastened to the floor. Plans showing seating, tiers and *aisles* shall be submitted for approval.
5. Groups of seats within a building, room or space used for assembly purposes separated from other seating by railings, *guards*, partial height walls or similar barriers with level floors and having not more than 14 seats per group shall not be required to be fastened to the floor.
6. Seats intended for musicians or other performers and separated by railings, *guards*, partial height

## MEANS OF EGRESS

walls or similar barriers shall not be required to be fastened to the floor.

- ❖ The purpose of this section is to require that assembly seating be fastened to the floor where it would be a significant hazard if loose and subject to tipping over. The exceptions allow loose assembly seating for situations where the hazard is lower, such as floors where ramped or tiered seating is not used, where not more than 200 seats are used and for box seating arrangements and where a limited number of seats are within railings, guards or partial height walls.

**1029.15 Handrails.** Ramped *aisles* having a slope exceeding one unit vertical in 15 units horizontal (6.7-percent slope) and stepped *aisles* shall be provided with *handrails* in compliance with Section 1014 located either at one or both sides of the *aisle* or within the *aisle* width.

### Exceptions:

1. *Handrails* are not required for ramped *aisles* with seating on both sides.
  2. *Handrails* are not required where, at the side of the *aisle*, there is a *guard* with a top surface that complies with the graspability requirements of *handrails* in accordance with Section 1014.3.
  3. *Handrail* extensions are not required at the top and bottom of stepped *aisles* and ramped *aisles* to permit crossovers within the *aisles*.
- ❖ For the safety of occupants, handrails must be provided in aisles where ramps exceed a gradient of one unit vertical in 15 units horizontal (6.67-percent slope) (see Commentary Figure 1029.15). All stepped aisles are required to have handrails. Handrails can be on one side, both sides or in the center of the aisle. Typically, handrails are in the center of the aisle when there is seating on both sides or on one side when the aisle is adjacent to the side walls of the room or a guard. While Sections 1011.11 and 1012.8 specify that handrails are required on both sides of stairways or ramps, the exceptions in Sections 1011.1 and

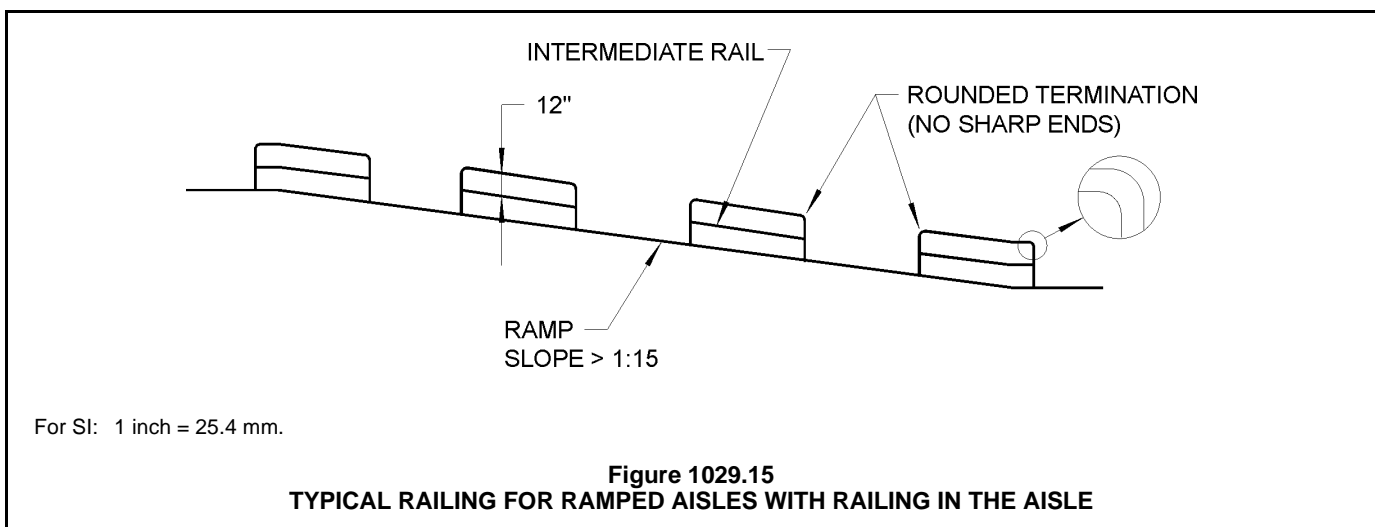
1012.1 and throughout Section 1014 allow for Section 1029.13 to be utilized for handrail location when dealing with stepped aisles, transitions and ramped aisles within assembly seating areas. This would include requiring handrails being within 30 inches (762 mm) (Section 1014.2) of the required stairway width. Safety for aisles with center handrails wider than 60 inches (1524 mm) and side aisles wider than 30 inches (762 mm) is specifically addressed with the capacity increases in Sections 1029.6.1 and 1029.6.2. What the reference to Section 1014 will require are the provisions for handrail height, graspability and fittings. Continuity, extensions, clearance and projections are more specifically addressed in Section 1029.9.1, this section and subsequent subsections.

Exception 1 omits the handrail requirements where ramped aisles are steeper, but the seats on both sides of the aisle effectively reduce the fall hazard.

Exception 2 allows handrails to be omitted where there is a guard at the side of the ramped or stepped aisle with a top rail that complies with the requirements for handrail graspability (see Section 1014.3). Note that the guard must meet the height and opening requirements specified in Section 1015 or 1029.16, as applicable.

While Section 1029.15.1 allows for discontinuous handrails, and Exception 3 (as well as Section 1014.6, Exception 2) exempts handrail extensions where they could block access to the seating, the handrail must extend the full run of the aisle stair. Stopping the handrail short of the bottom riser flight (except where permitted for mid-aisle handrails by Section 1029.15.3) would be considered a code violation. Handrails along the wall adjacent to stepped aisles or ramps should include the handrail extensions where feasible.

**1029.15.1 Discontinuous handrails.** Where there is seating on both sides of the *aisle*, the mid-aisle *handrails* shall be discontinuous with gaps or breaks at intervals not exceeding five rows to facilitate access to seating and to permit crossing



from one side of the *aisle* to the other. These gaps or breaks shall have a clear width of not less than 22 inches (559 mm) and not greater than 36 inches (914 mm), measured horizontally, and the mid-aisle *handrail* shall have rounded terminations or bends.

- ❖ Where aisles have seating on both sides, handrails may be located at the sides of the aisles, but are typically located in the center of the aisle. (Handrails on both sides of a stepped aisle will typically either block access to the aisle accessways or not be able to meet the gap requirements. Transitions per Section 1029.10 can have handrails on both sides or mid-width.) The width of each section of the subdivided aisle between the handrail and the edge of seating is to be not less than 23 inches (584 mm) measured to the handrail centerline (see Section 1029.9.1, Item 3).

For reasons of life safety in fire situations and also as a practical matter in the efficient use of the facility, a handrail down the middle of an aisle should not be continuous along its entire length. Crossovers must be provided by means of gaps or breaks in the handrail installation. Such openings must not be less than 22 inches (559 mm) or more than 36 inches (914 mm) wide, and must be provided at intervals not exceeding the distance of five rows of seats (see Commentary Figure 1029.15.1). All handrail terminations should be designed to have rounded ends or bends to avoid possible injury to the occupants (see Commentary Figure 1029.15).

**1029.15.2 Handrail termination.** *Handrails* located on the side of stepped *aisles* shall return to a wall, *guard* or the walking surface or shall be continuous to the *handrail* of an adjacent stepped *aisle flight*.

- ❖ The purpose of return requirements at handrail ends is to prevent a person from catching an article of clothing or satchel straps or from being injured by falling on the extended end of a handrail. When a handrail is on a wall adjacent to a stepped aisle, it can return the same as a handrail on a stairway.

**1029.15.3 Mid-aisle termination.** Mid-aisle *handrails* shall not extend beyond the lowest riser and shall terminate within 18 inches (381 mm), measured horizontally, from the lowest riser. *Handrail* extensions are not required.

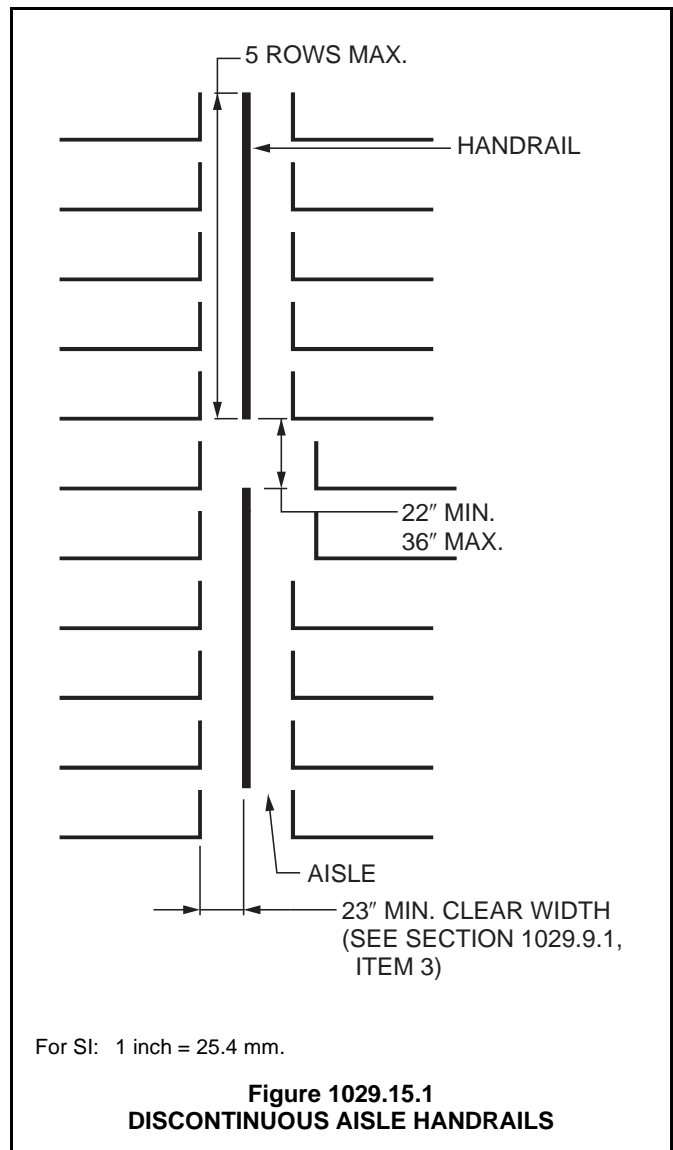
**Exception:** Mid-aisle *handrails* shall be permitted to extend beyond the lowest riser where the *handrail* extensions do not obstruct the width of the cross *aisle*.

- ❖ The intent is to clarify how far a mid-aisle handrail can stop from the bottom of a stepped aisle and still allow for a person to get past the front of the rail to enter the first row of seating. Since the purpose of a handrail is to arrest a fall or provide stability for someone moving up or down the stepped aisle, the handrails should also not start so far back that someone could not reach the handrail from the cross aisle, or have to let go too soon before they get to the cross aisle. The intent of the exception is to allow for a mid-aisle handrail to have a bottom extension if it will not block the

cross aisle. However, if a designer wants to not have a handrail extension in order to provide access to the front row of raised seats, the handrail must extend to at least 18 inches (381 mm) from the nosing of the bottom riser.

**1029.15.4 Rails.** Where mid-aisle *handrails* are provided in stepped *aisles*, there shall be an additional rail located approximately 12 inches (305 mm) below the *handrail*. The rail shall be adequate in strength and attachment in accordance with Section 1607.8.1.2.

- ❖ Handrail installations down the middle of an aisle must be constructed with intermediate rails located 12 inches (305 mm) below and parallel to main handrails. The rail below the handrail is to stop people from going under the handrail or swinging on the handrail (see Commentary Figure 1029.15). The lower rail is not intended to meet all handrail provisions for graspability; however, it does have to meet the same strength criteria as a handrail.



**1029.16 Assembly guards.** *Guards* adjacent to seating in a building, room or space used for assembly purposes shall be provided where required by Section 1015 and shall be constructed in accordance with Section 1015 except where provided in accordance with Sections 1029.16.1 through 1029.16.4. At *bleachers, grandstands* and *folding and telescopic seating*, *guards* must be provided where required by ICC 300 and Section 1029.16.1.

❖ This section establishes the scope of the guard provisions within assembly seating. Depending on the event, the sightline constraints can be for a wide viewing angle. For example, to see the entire football field, a person may have to look right and left. Good design will establish a balance between safety and sight issues that will need to be evaluated on a case-by-case basis.

Some situations unique to assembly make it necessary to strike a balance between safety requirements and line of sight issues. Section 1029.16.1 addresses the guards around the outside edge of a seating area, such as a bleacher or tiered seating arrangement that is on each side of a high-school football field, or along the first- and third-base lines at a baseball field. The perimeter guards are required for assembly seating addressed in Section 1029 and seating covered by ICC 300. The purpose of Section 1029.16.2 is to provide for occupant safety with guards along elevated cross aisles, typically in aisles that occupants use to move side to side across the seating bowl. If there is only an aisle accessway between the seats and the guard, typically found at the front of a balcony or raised section, then Section 1029.16.3 is applicable. If the aisle is moving down through the seating toward a dropoff, then Section 1029.16.4 is applicable.

**1029.16.1 Perimeter guards.** Perimeter *guards* shall be provided where the footboards or walking surface of seating facilities are more than 30 inches (762 mm) above the floor or grade below. Where the seatboards are adjacent to the perimeter, *guard* height shall be 42 inches (1067 mm) high minimum, measured from the seatboard. Where the seats are self-rising, *guard* height shall be 42 inches (1067 mm) high minimum, measured from the floor surface. Where there is an *aisle* between the seating and the perimeter, the *guard* height shall be measured in accordance with Section 1015.2.

**Exceptions:**

1. *Guards* that impact sightlines shall be permitted to comply with Section 1029.16.3.
  2. *Bleachers, grandstands* and *folding and telescopic seating* shall not be required to have perimeter *guards* where the seating is located adjacent to a wall and the space between the wall and the seating is less than 4 inches (102 mm).
- ❖ The intent of perimeter guards is to address the risk of falling from the side and back of a seating area. This question is applicable for bleacher, grandstands and folding and telescopic seating addressed in ICC 300 and other assembly seating arrangements.

ICC 300 requires guards with 4-inch openings where the floor surface has an adjacent 30-inch dropoff (ICC 300, Section 408). The dropoff is measured from the floor rather than the seatboard because the ICC 300 committee did not believe it was appropriate to require guards in a two- or three-row bleacher system. For fixed seats and benches, the height for perimeter guards is measured from the seatboard, to address when people stand on the seats. Where seats are self-rising, the guard height would be measured from the floor. Self-rising seats have backs and are very difficult to stand on.

Exception 1 is to allow for the limited situation where guards at the sides of the seating may affect the line of sight in wide venues.

Exception 2 will permit bleacher systems constructed inside the building to use the building walls as perimeter guards if the opening between the bleacher and the wall is less than the opening permitted for guards.

**1029.16.2 Cross aisles.** Cross *aisles* located more than 30 inches (762 mm) above the floor or grade below shall have *guards* in accordance with Section 1015.

Where an elevation change of 30 inches (762 mm) or less occurs between a cross *aisle* and the adjacent floor or grade below, *guards* not less than 26 inches (660 mm) above the *aisle* floor shall be provided.

**Exception:** Where the backs of seats on the front of the cross *aisle* project 24 inches (610 mm) or more above the adjacent floor of the *aisle*, a *guard* need not be provided.

❖ The purpose of this section is to provide for occupant safety with guards along elevated cross aisles. The minimum height of the guard is a function of the cross-aisle elevation above the adjacent floor or grade below [i.e., 42 inches (1067 mm) high with more than a 30-inch (762 mm) dropoff and 26 inches (660 mm) high with a 30-inch (762 mm) or less dropoff]. When the seatbacks adjacent to cross aisles are a minimum of 24 inches (610 mm) above the floor level of the cross aisle, they will serve as the guard (see Commentary Figure 1029.16.3 for an illustration of the requirements in this section).

**1029.16.3 Sightline-constrained guard heights.** Unless subject to the requirements of Section 1029.16.4, a fascia or railing system in accordance with the *guard* requirements of Section 1015 and having a minimum height of 26 inches (660 mm) shall be provided where the floor or footboard elevation is more than 30 inches (762 mm) above the floor or grade below and the fascia or railing would otherwise interfere with the sightlines of immediately adjacent seating.

❖ The purpose of this section is to provide for occupant safety with guards along elevated seating for areas other than cross aisles, such as the front of a raised area or balcony level. The seats would only have an access aisle between the seat and the dropoff.

This section specifies a height of 26 inches (660 mm) for guards along fascias. The guard height and the dropoff are measured from the floor or footboard.

This is to provide a reasonable degree of safety while improving sightlines for persons seated immediately behind a fascia or balcony edge. The guard opening configuration must comply with Section 1015.3 (see Commentary Figure 1029.16.3 for an illustration of the requirements in this section).

**1029.16.4 Guards at the end of aisles.** A fascia or railing system complying with the *guard* requirements of Section 1015 shall be provided for the full width of the *aisle* where the foot of the *aisle* is more than 30 inches (762 mm) above the floor or grade below. The fascia or railing shall be a minimum of 36 inches (914 mm) high and shall provide a minimum 42 inches (1067 mm) measured diagonally between the top of the rail and the *nosing* of the nearest tread.

❖ This section applies only where the foot end of aisles (the lower end) is greater than 30 inches (762 mm) above the adjacent floor or grade below. This typically occurs where aisles move down through rows of seating to the front edge of a balcony or raised seating area. The guard must satisfy both of the specified height requirements to provide safety for persons at the end of the aisle in case someone trips moving down the stepped or ramped aisle. The 36-inch (914 mm) minimum height is measured from the floor vertically to the top of the guard. The minimum 42-inch (1067 mm) diagonal dimension from the nosing of the nearest stair tread to the top of the fascia or guard provides sufficient height to arrest a fall from the nearest aisle riser (see Commentary Figure

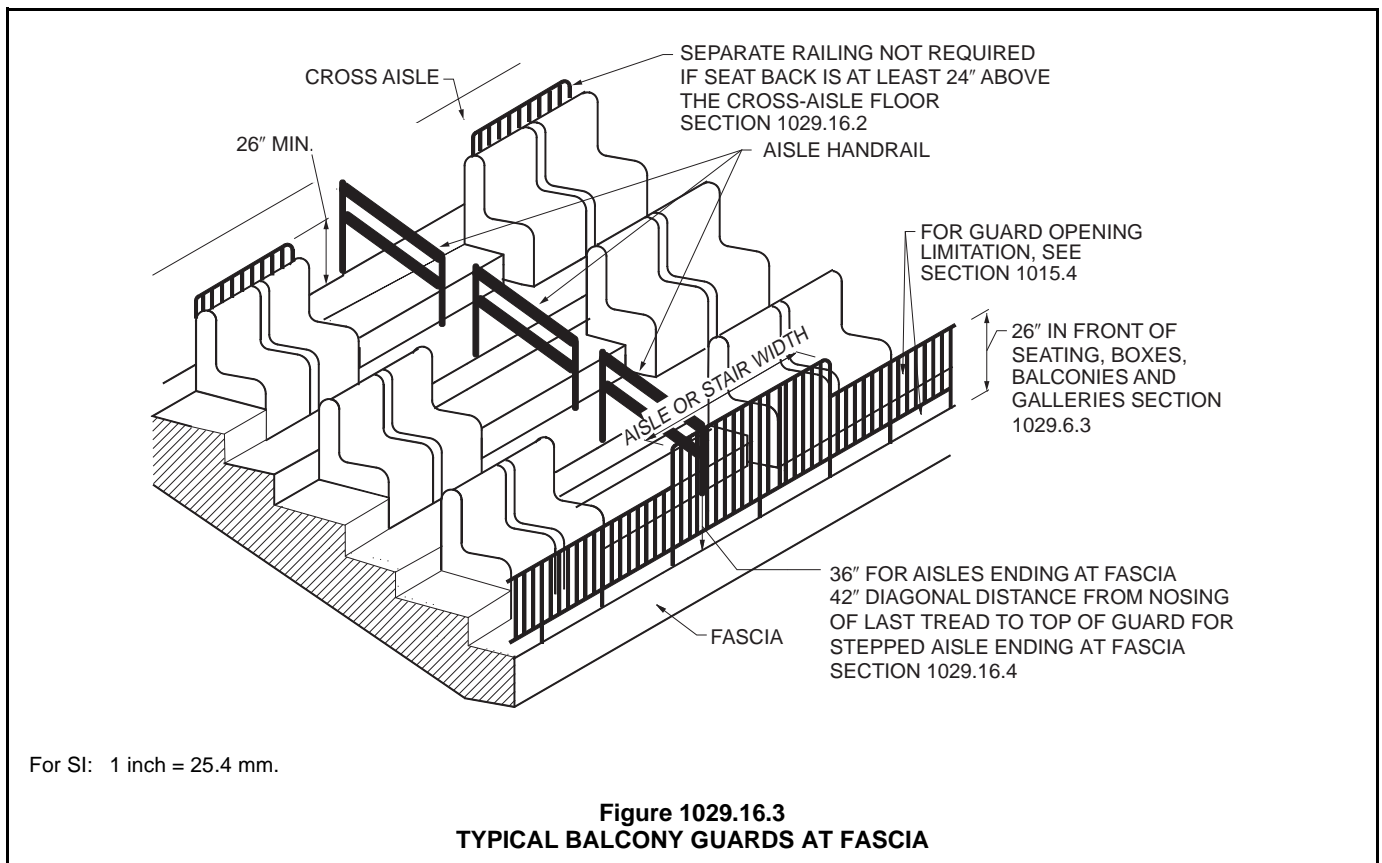
1029.16.3 for an illustration of the requirements in this section). The end result could be a guard with a vertical height of more than 36 inches (914 mm).

**SECTION 1030  
EMERGENCY ESCAPE AND RESCUE**

**1030.1 General.** In addition to the *means of egress* required by this chapter, provisions shall be made for *emergency escape and rescue openings* in Group R-2 occupancies in accordance with Tables 1006.3.2(1) and 1006.3.2(2) and Group R-3 occupancies. *Basements* and sleeping rooms below the fourth story above *grade plane* shall have at least one exterior *emergency escape and rescue opening* in accordance with this section. Where *basements* contain one or more sleeping rooms, *emergency escape and rescue openings* shall be required in each sleeping room, but shall not be required in adjoining areas of the *basement*. Such openings shall open directly into a *public way* or to a *yard* or *court* that opens to a *public way*.

**Exceptions:**

1. *Basements* with a ceiling height of less than 80 inches (2032 mm) shall not be required to have *emergency escape and rescue openings*.
2. *Emergency escape and rescue openings* are not required from *basements* or sleeping rooms that have an *exit door* or *exit access door* that opens directly into a *public way* or to a *yard, court* or exterior exit balcony that opens to a *public way*.



3. *Basements without habitable spaces* and having not more than 200 square feet (18.6 m<sup>2</sup>) in floor area shall not be required to have *emergency escape and rescue openings*.

- ❖ Emergency escape and rescue openings (EERO) are required in single-exit residential buildings where occupants may be sleeping during a potential fire buildup (Groups R-2, R-3 and R-4). Group R-2 apartment buildings permitted to have a single exit from a story are required to have EERO by Table 1006.3.2(1), Note a. Group R-2 congregate residences permitted to have a single exit are required to have an EERO by Table 1006.3.2(2), Note a. All Group R-4 congregate residences would also be required to have EERO because Group R-4 follows Group R-3 provisions unless specifically mentioned otherwise (IBC Section 310.6).

All basements and each bedroom/sleeping room are to be provided with an exterior window or door that meets the minimum size requirements and is operable for emergency escape by methods that are obvious and clearly understood by all users. Sleeping rooms four stories or more above grade are not required to be so equipped, since fire service access at that height, as well as escape through such an opening, may not be practical or reliable. Since single-exit apartment buildings are limited to three stories and most Group R-3 and R-4 buildings are two or three stories, this limit is not applicable very often. Section 1018.3 limits Groups R-3 and R-4 to four stories where using a single open exit access stairway.

The provision for basements is in recognition that they typically have only a single means of egress without alternative routes through standard windows. Many times a basement is finished at a later time; therefore, as a safety precaution; at least one EERO is required in every basement. If bedrooms are provided within the basement, the location and number of EERO are determined by the bedrooms.

It is important to note that this window is only an element of escape and is not part of the means of egress required from the story unless it is a door conforming to normal egress requirements.

Exceptions 1 and 3 are intended to exempt basements that would not be likely to be finished as living space, and thus have sleeping rooms in them.

The intent of Exception 2 is to permit sleeping rooms with a door that has direct access to an exterior-type environment, such as a street or exit balcony, to not have an EERO. The open atmosphere of the escape route would increase the likelihood that the means of egress would be available even with the delayed response time for sleeping residents. This would also exempt walk-out basements that did not include bedrooms.

**1030.2 Minimum size.** *Emergency escape and rescue openings* shall have a minimum net clear opening of 5.7 square feet (0.53 m<sup>2</sup>).

**Exception:** The minimum net clear opening for grade-floor *emergency escape and rescue openings* shall be 5 square feet (0.46 m<sup>2</sup>).

- ❖ The dimensional criteria of the openings are intended to permit fire service personnel (in full protective clothing with a breathing apparatus) to enter from a ladder, as well as permit occupants to escape. The net clear opening area and minimum dimensions are intended to provide a clear opening through which an occupant can pass to escape the building or a fire fighter can pass to enter the building for rescue or fire suppression activities. Since the emergency escape windows must be usable to all occupants, including children and guests, the required opening dimensions must be achieved by the normal operation of the window from the inside (e.g., sliding, swinging or lifting the sash). It is impractical to assume that all occupants can operate a window that requires a special sequence of operations to achieve the required opening size. While most occupants are familiar with the normal operation by which to open the window, children and guests are frequently unfamiliar with any special procedures that may be necessary to remove or tilt the sashes. The time spent in comprehending the special operation unnecessarily delays egress from the bedroom and could lead to panic and further confusion. Thus, windows that achieve the required opening dimensions only through operations such as the removal of sashes or mullions are not permitted. It should be noted that the minimum area cannot be achieved by using both the minimum height and minimum width specified in Section 1030.2.1 (see Commentary Figure 1030.2).

**1030.2.1 Minimum dimensions.** The minimum net clear opening height dimension shall be 24 inches (610 mm). The minimum net clear opening width dimension shall be 20 inches (508 mm). The net clear opening dimensions shall be the result of normal operation of the opening.

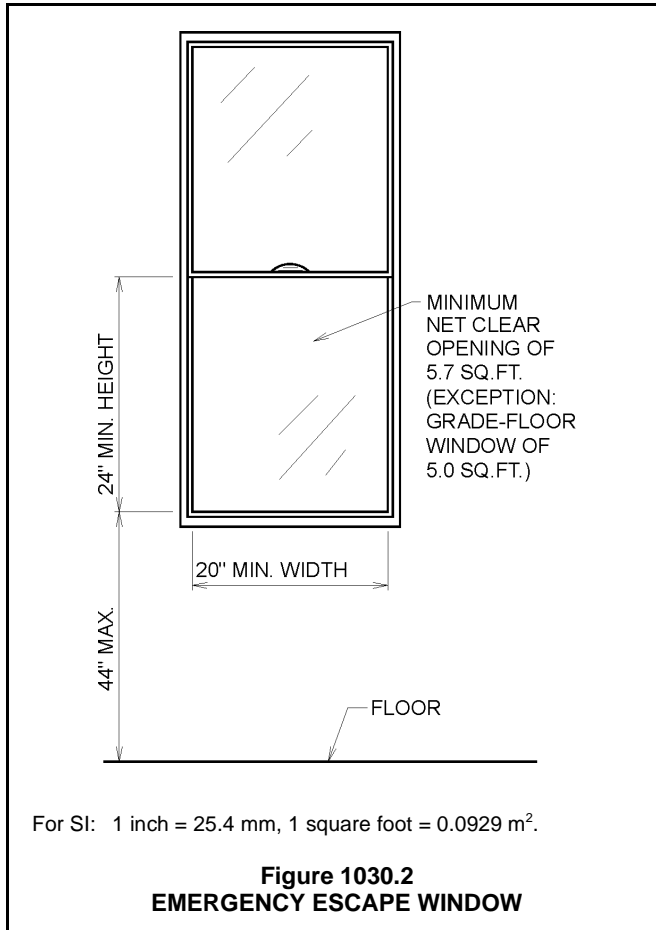
- ❖ Note that both the minimum dimensions in this section and the minimum area requirements in Section 1030.2 apply. Thus, a grade-floor window that is only 24 inches (610 mm) in height must be 30 inches (762 mm) wide to meet the 5-square-foot (0.46 m<sup>2</sup>) area requirement of Section 1030.2 for grade-floor window (see Commentary Figure 1030.2).

**1030.3 Maximum height from floor.** *Emergency escape and rescue openings* shall have the bottom of the clear opening not greater than 44 inches (1118 mm) measured from the floor.

- ❖ This section limits the height of the bottom of the clear opening to 44 inches (1118 mm) or less such

that it can be used effectively as an emergency escape (see Commentary Figure 1030.2).

Windows in Group R-2, R-3 and R-4 dwelling units may also have to meet window-opening limitations because of concerns about child falls (see Section 1015.8). Only some of the window opening-control devices will also work for emergency escape and rescue openings.



**1030.4 Operational constraints.** *Emergency escape and rescue openings* shall be operational from the inside of the room without the use of keys or tools. Bars, grilles, grates or similar devices are permitted to be placed over *emergency escape and rescue openings* provided the minimum net clear opening size complies with Section 1030.2 and such devices shall be releasable or removable from the inside without the use of a key, tool or force greater than that which is required for normal operation of the *emergency escape and rescue opening*. Where such bars, grilles, grates or similar devices are installed in existing buildings, *smoke alarms* shall be installed in accordance with Section 907.2.11 regardless of the valuation of the *alteration*.

❖ If security grilles, decorations or similar devices are installed on escape windows, such items must be readily removable to permit occupant escape without the use of any tools, keys or a force greater than that required for the normal operation of the window. This would include any window fall-prevention devices and

window opening-control devices required by Section 1013.8.

Where bars, grilles, grates or other devices that prevent full operation of the window are placed over the emergency escape and rescue opening, it is important that they are easily removable. Thus, the requirements for ease of operation are the same as required for windows.

Windows in Group R-2, R-3 and R-4 dwelling units may also have to meet window opening limitations because of concerns about child falls (see Section 1015.8). Only some of the window opening-control devices will also work for emergency escape and rescue openings.

Where smoke alarms are not already provided and when items that could possibly slow the opening of emergency escape and rescue windows are installed in existing buildings, smoke alarms must also be installed. Smoke alarms are necessary to provide advance warning of a fire for safety purposes.

**1030.5 Window wells.** An *emergency escape and rescue opening* with a finished sill height below the adjacent ground level shall be provided with a window well in accordance with Sections 1030.5.1 and 1030.5.2.

❖ Emergency escape and rescue openings that are partially or completely below grade need to have window wells so that they can be used effectively (see Commentary Figure 1030.5).

**1030.5.1 Minimum size.** The minimum horizontal area of the window well shall be 9 square feet (0.84 m<sup>2</sup>), with a minimum dimension of 36 inches (914 mm). The area of the window well shall allow the *emergency escape and rescue opening* to be fully opened.

❖ This section specifies the size of the window well that is needed for a rescue person in full protective clothing and breathing apparatus to use the rescue opening. The required 9 square feet (0.84 m<sup>2</sup>) is the size of the window well. Thus, the window well must project away from the plane of the window at least 3 feet (914 mm), and the required dimension in the plane of the window along the wall is also 3 feet (914 mm) (see Commentary Figure 1030.5).

**1030.5.2 Ladders or steps.** Window wells with a vertical depth of more than 44 inches (1118 mm) shall be equipped with an *approved* permanently affixed ladder or steps. Ladders or rungs shall have an inside width of at least 12 inches (305 mm), shall project at least 3 inches (76 mm) from the wall and shall be spaced not more than 18 inches (457 mm) on center (o.c.) vertically for the full height of the window well. The ladder or steps shall not encroach into the required dimensions of the window well by more than 6 inches (152 mm). The ladder or steps shall not be obstructed by the *emergency escape and rescue opening*. Ladders or steps required by this section are exempt from the *stairway* requirements of Section 1011.

❖ This section specifies that a ladder or steps be provided for ease of getting into and out of window wells that are more than 44 inches (1118 mm) deep.

## MEANS OF EGRESS

Usually, ladder rungs are embedded in the wall of the window well. The 44-inch (1118 mm) dimension is the depth of the window well, not the distance from the bottom of the window well to grade. Thus, if the floor of a window well is 40 inches (1016 mm) below grade, but the wall of the window well projects above grade by 6 inches (152 mm), steps or a ladder are required since the vertical depth is 46 inches (1168 mm).

It is important that the ladder not obstruct the operation of the emergency escape window (see Commentary Figure 1030.5).

### SECTION 1031

#### MAINTENANCE OF THE MEANS OF EGRESS

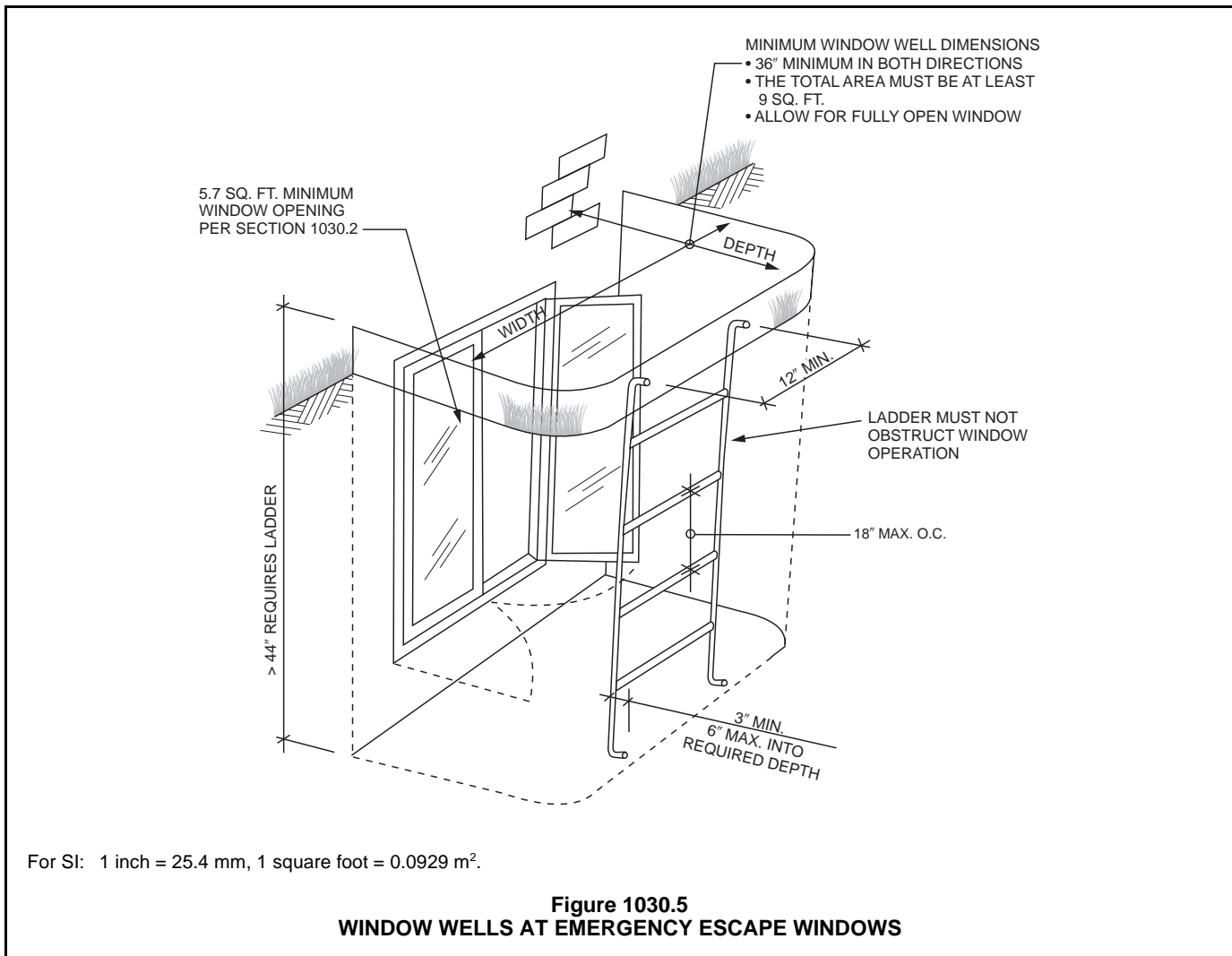
**1031.1 General.** The *means of egress* for buildings or portions thereof shall be maintained in accordance with this section.

❖ This section introduces the provisions for the maintenance of the means of egress in all buildings and structures.

**1031.2 Reliability.** Required *exit accesses*, *exits* and *exit discharges* shall be continuously maintained free from obstructions or impediments to full instant use in the case of fire or other emergency when the building area served by the *means of egress* is occupied. An *exit* or *exit passageway* shall not be used for any purpose that interferes with a *means of egress*.

❖ It is important for safety that the pathway from any point in a building to the exit discharge be kept clear so that occupants can exit the building at any time without obstructions in the egress path. Such obstructions could include storage in the means of egress, which is specifically regulated by IBC Section 315.3.2. Similarly, handrails, stair treads, flooring materials, door hardware and other fixtures and finishes must be maintained in such a way as to prevent them from becoming hazards themselves.

The last sentence of this section provides correlation with Sections 1022.1, 1023.1 and 1024.1, which, in new buildings, prohibit the use of exits, interior exit stairway and ramp enclosures and exit passageway enclosures, respectively, for any purpose other than



a means of egress. However, it is important that an exit, interior exit stairway or ramp enclosure or an exit passageway not be used for any purpose other than as a means of egress throughout the life of the building, not just when the building is built. For example, there is a tendency to use stairway enclosures for storage, furniture, vending machines, copy machines, displays and similar purposes. Such a situation can obstruct the path of exit travel. Further, if the contents consist of combustible materials or ignition sources, the use of the stairway as a means of egress may be jeopardized, creating a hazard to life safety. Note, however, that the restriction is not limited to situations where the contents are combustible because of the potential for obstruction and the inherent difficulties in limiting the materials to noncombustibles (see also commentary, Sections 1022.1, 1023.1 and 1024.1).

It is not the intent of this requirement to prohibit occupants from using the stairway exit passageway as a circulation route during normal operation.

**1031.2.1 Security devices and egress locks.** Security devices affecting *means of egress* shall be subject to approval of the *fire code official*. Security devices and locking arrangements in the means of egress that restrict, control, or delay egress shall be installed and maintained as required by this chapter.

❖ In our society, security is an ever-growing concern, and often the solutions to enhancing the security of buildings conflict with the life-safety concerns of building and fire codes. This section gives the fire code official an important measure of control over the installation or modification of security devices that could adversely effect the egress system of a building. See the commentary to Section 1008 for specifics on the different security hardware options permitted.

While this section focuses on physical impediments or obstructions to exit use, there are also security devices that emit smoke, mist or other confusing or debilitating media that could obscure exits, temporarily disable innocent occupants or result in mistaken false alarms (from passersby seeing the smoke or mist and thinking the building is on fire), which could affect fire fighter egress and safety. See the commentary to IBC Section 316.5 for a discussion of such devices.

**1031.3 Obstructions.** A *means of egress* shall be free from obstructions that would prevent its use, including the accumulation of snow and ice.

❖ Blocked exits are among the most common egress problems. Obstructions, impediments and storage or placement of articles in a manner that prevents access to or reduces the effective width of egress elements are prohibited. Such impediments may be movable or fixed. Maintenance of safe egress conditions implies keeping exits free of storage, decorations or debris that obstruct access or visibility. Complex egress paths may also violate the intent of

this requirement by confusing or obscuring the path of travel. When inspecting, extra care should be taken to follow the egress path occupants must take in the event of an emergency from a number of points in the same manner. Holding open an egress door, thus giving fire unimpeded access to the path of egress, may pose an even greater hazard than blocking an exit.

Accumulations of snow and ice could prevent timely exiting from the building in the case of fire or other emergencies. Generally, if the exit is used regularly, the exit doorway area is kept free of ice and snow. Where a required exit is not used regularly, it may be necessary to protect the exit doorway area from the accumulation of ice and snow, either by construction of overhangs or enclosures, heated slabs or, when approved by the fire code official, by a reliable snow removal program that is aggressively enforced.

**1030.3.1 Group I-2.** In Group I-2, the required clear width for aisles, corridors and ramps that are part of the required means of egress shall comply with Section 1020.2. The facility shall have a plan to maintain the required clear width during emergency situations.

**Exception:** In areas required for bed movement, equipment shall be permitted in the required width where all the following provisions are met:

1. The equipment is low hazard and wheeled.
2. The equipment does not reduce the effective clear width for the means of egress to less than 5 feet (1525 mm).
3. The equipment is limited to:
  - 3.1 Equipment and carts in use;
  - 3.2 Medical emergency equipment;
  - 3.3 Infection control carts; and
  - 3.4 Patient lift and transportation equipment.
4. Medical emergency equipment and patient lift and transportation equipment, when not in use, is required to be located on one side of the corridor.
5. The equipment is limited in number to a maximum of one per patient sleeping room or patient care room within each smoke compartment.

❖ This is a procedural requirement. In a Group I-2 occupancy where beds are moved, the minimum corridor width is 8 feet. It is recognized that certain movable pieces of equipment will be present in the corridor during normal operations of the patient care units. This section limits the types and number of such pieces of equipment and the restrictions the equipment may impose on the means of egress. During emergencies, facilities must have an emergency management plan addressing the steps that must be taken by the facility and responding staff to ensure that the required 8-foot-wide corridor is kept clear of movable obstructions (see IBC Sections 404 and 405). The terminology is consistent with NFPA 101.

**[B] 1031.4 Exit signs.** *Exit* signs shall be installed and maintained in accordance with Section 1011. Decorations, furnishings, equipment or adjacent signage that impairs the visibility of *exit* signs, creates confusion or prevents identification of the *exit* shall not be allowed.

❖ The scoping provisions of Section 1001.1 restrict the applicability of Section 1013 to new construction. This section provides needed application of the provisions of Section 1013 to existing buildings as well. Exit signs are intended to stand out from their immediate background. Clutter and obstructions in the form of drapes, decorations, partitions and other signs may distract attention from properly placed exit signs. Careful attention should be paid to how occupants will view the sign from where they must begin the egress sequence. Certain lighting conditions can obscure the direct viewing and ready identification of exit signs.

**1031.5 Nonexit identification.** Where a door is adjacent to, constructed similar to and can be confused with a *means of egress* door, that door shall be identified with an *approved* sign that identifies the room name or use of the room.

❖ Many times doors have the appearance of being exit doors but do not lead to an egress path. In many cases, these doors only open into rooms with no other way out. In such cases, this section requires that the door be provided with “non-exit” door signage to warn occupants that it is not part of the means of egress. The exact name or use of the room should be indicated, such as “storage,” “mechanical room,” “electrical room” or similar verbiage. Note that this section is not specifically included in the new construction requirements for a building because it is difficult to determine potentially confusing non-exit doors during the plan review process. It is intended for use by the fire code official during maintenance inspections when the confusion becomes apparent.

**1031.6 Finishes, furnishings and decorations.** *Means of egress* doors shall be maintained in such a manner as to be distinguishable from the adjacent construction and finishes such that the doors are easily recognizable as doors. Furnishings, decorations or other objects shall not be placed so as to obstruct *exits*, access thereto, egress therefrom, or visibility thereof. Hangings and draperies shall not be placed over *exit* doors or otherwise be located to conceal or obstruct an *exit*. Mirrors shall not be placed on *exit* doors. Mirrors shall not be placed in or adjacent to any *exit* in such a manner as to confuse the direction of exit.

❖ Similar to Section 1010.1, this section establishes that existing egress doors need to be easily recognizable for immediate use in emergency situations throughout the life of the building. Thus, the code specifies that doors are not to be hidden in such a manner that a person would have trouble seeing where to egress. Displays, furnishings, finishes and decorations are frequently intended to create a mood or atmosphere; however, they often make familiar places confusing even to those who normally occupy

them. Bright lights, vivid colors, mirrors and hanging material may significantly reduce contrast, impede visibility or confuse direction. It is not uncommon for a building owner to refinish the interior of an occupancy and paint or otherwise apply a matching finish to a door and the surrounding wall, making the door indistinguishable. This commonly occurs with murals that are painted on walls of corridors.

Tables, chairs, display cases, coat racks and similar movable objects placed in corridors or aisles may reduce required egress capacity or may require substantial effort to remove or negotiate quickly. Anything that slows egress may also impede access, particularly to fire fighters who may be called to rescue occupants or fight the fire. Similarly, anything that obscures the visibility of exit signs is prohibited by Section 1031.4.

**1031.7 Emergency escape and rescue openings.** Required *emergency escape and rescue openings* shall be maintained in accordance with the code in effect at the time of construction, and the following: Required *emergency escape and rescue openings* shall be operational from the inside of the room without the use of keys or tools. Bars, grilles, grates or similar devices are allowed to be placed over *emergency escape and rescue openings* provided the minimum net clear opening size complies with the code that was in effect at the time of construction and such devices shall be releasable or removable from the inside without the use of a key, tool or force greater than that which is required for normal operation of the *emergency escape and rescue opening*.

❖ In new construction, Section 1030.1 requires that in Group R-2 buildings with a single exit or in Group R-3 and R-4 dwellings, every sleeping room below the fourth story must have at least one operable window or exterior door approved for emergency escape or rescue. This section provides the necessary maintenance and utilization requirements for emergency escape openings.

Maintenance requirements are provided to increase the reliability of the emergency escape elements. Included are allowances to provide the emergency escape elements with security devices that retain the usability of the window or door while allowing a measure of security for the building occupants from intruders. Note that these provisions are applicable only to emergency escape openings required by the applicable building code in force when the building was constructed, in accordance with Section 1104.1.

The same blocking, locking and maintenance restrictions that apply to egress doors apply to emergency escape windows and doors. These egress components are frequently found blocked by furniture, fans and window air conditioners, especially in residential sleeping rooms. Inspections of other means of egress elements should include a look at basement escape windows and doors as well. Mechanical parts of exterior doors and windows are particularly susceptible to wear and tear and should

be the subject of frequent inspections and periodic preventive maintenance. Hinges must swing and handles must turn at all times so that they are ready to function when needed.

Since the emergency escape windows must be usable to all occupants, including children and guests, the required opening dimensions must be achieved by the normal operation of the window from the inside (e.g., sliding, swinging or lifting the sash). It is impractical to assume that all occupants can operate a window requiring a special sequence of operations to achieve the mandated opening size. While most occupants are familiar with the normal operation by which to open the window, children and guests are frequently unfamiliar with special procedures necessary to remove the sashes. The time spent in comprehending the special operation unnecessarily delays egress from the bedroom and could lead to panic and further confusion; thus, windows that achieve the required opening dimensions only by performing operations such as the removal of sashes or mullions are not permitted.

Not only are security devices or accessories frequently added to emergency escape windows to prevent entry, but too often the windows themselves are replaced with others that provide inadequate clearance or improper locking arrangements. Security grille designs are available to deter entry without compromising egress. Security bars, grilles or screens placed over emergency escape windows must also be releasable or removable from the inside without the use of a key, tool or force greater than what is required for normal operation of the window.

**1031.8 Inspection, testing and maintenance.** All two-way communication systems for *areas of refuge* shall be inspected and tested on a yearly basis to verify that all components are operational. When required, the tests shall be conducted in the presence of the *fire code official*. Records of inspection, testing and maintenance shall be maintained.

❖ Since these components are part of the fire protection features of a building, two-way communications systems should be tested in order to verify their operation. Communication is paramount for the occupant using the area of refuge; therefore, it is reasonable to verify the operation of the communication system just as is done for any other fire protection equipment. Many of these systems utilize an “acknowledge” light, and yearly testing would help to eliminate a potential failure of the communication system for something as critical, yet unassuming, as a burned-out bulb. See the commentary to Sections 1009.6.5 and 1009.8 for further discussion of these systems.

**1031.9 Floor identification signs.** The floor identification signs required by Sections 1023.9 and 1104.24 shall be maintained in an *approved* manner.

❖ This section provides correlation with Sections 1023.9 and 1104.24. The requirement for the maintenance

of signs designating floor levels in interior stairway exit enclosures has equal importance in existing buildings. See the commentary to Section 1023.9 for further discussion of these signs.

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# Chapter 11: Construction Requirements for Existing Buildings

## General Comments

This chapter first appeared in the 2009 edition of the code, as Chapter 46. It brings many of the retroactive existing building fire protection and life safety requirements previously found in Chapters 7, 9 and 10 to one location for a more convenient and user-friendly enforcement tool. Requirements for premises identification of buildings remain in Chapter 5 and the existing building interior finish requirements remain in Chapter 8.

Excluding the general provisions and definitions, Chapter 11 is divided into four sections. Section 1103 addresses fire safety requirements for existing buildings. This includes protection of vertical openings in shafts and openings for escalators. Section 1103 also contains provisions requiring automatic sprinkler, standpipe, and fire alarm and detection systems in existing buildings. Section 1104 specifies the minimum means of egress requirements for existing buildings and is based on the provisions previously found in Section 1027. Section 1105 establishes construction require-

ments for existing Group I-2 occupancies. Section 1106 sets forth the requirements for fire department access to outdoor storage of tires, which is retroactive to any existing storage conditions.

Note that Section 1101.4 provides a level of reasonableness for enforcement of this chapter. It is not intended that existing conditions be immediately fixed, rather a process and timeline is worked through with the owner.

## Purpose

The purposes of this chapter are to provide minimum construction requirements for existing buildings and to provide them in one place. Many newer buildings may already meet these requirements and no further action will be necessary. Those that do not meet these minimal construction requirements will need to address those deficiencies. It should be noted that interior finishes for existing buildings are dealt with separately in Chapter 8.

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## SECTION 1101 GENERAL

**1101.1 Scope.** The provisions of this chapter shall apply to existing buildings constructed prior to the adoption of this code.

❖ This section introduces Chapter 11 and indicates that it is applicable to all buildings constructed prior to the code's date of adoption.

**1101.2 Intent.** The intent of this chapter is to provide a minimum degree of fire and life safety to persons occupying existing buildings by providing minimum construction requirements where such existing buildings do not comply with the minimum requirements of the *International Building Code*.

❖ This chapter provides a single location for such requirements. Included is a quick-reference table (see Table 1103.1) to determine if there may be any requirements that would be applicable as the inspector is conducting the inspection. Each of the provisions in the code that refers to retroactive requirements now has a reference to this chapter.

Historically, there has been confusion as to when the construction provisions of Section 102.1 could be applied to an existing building. It has been said that in every case the fire code official must declare a "dis-

tingent hazard"; however, this is not correct. There are specific construction requirements for existing buildings provided by International Code Council® (ICC®) membership to address distinct hazards. Since the determination of a hazard is already accomplished, it is not necessary for the fire code official to repeat the process. Therefore, all of the requirements in Chapter 11 will apply to existing buildings.

Section 102.1, Item 3, also indicates that the retroactive construction provisions referred to are located in Chapter 11, thus clarifying which provisions in the code are actually construction provisions that should be applied to an existing building. Since only the provisions listed in this chapter would apply to an existing facility, all of the other construction provisions in the code apply to new construction. However, as has always been the case, the code official can still exercise judgment and declare a distinct hazard under Section 102.1, Item 4, for other items or operations not addressed in Chapter 11. See the commentary to Section 102.1 for further information.

Section 1104.1 makes it clear that existing buildings must still comply with the code under which the building was built or the minimum egress requirements in Section 1104, whichever is more restrictive.

In this fashion, a building will not be allowed to reduce the egress system protection or design from the original approval. Section 1104 is not as restrictive as requirements for new construction and allows for the continued use of existing buildings when the egress is at an acceptable standard, but not in complete compliance with the *International Building Code*® (IBC®).

**1101.3 Permits.** Permits shall be required as set forth in Sections 105.6 and 105.7 and the *International Building Code*.

❖ See the commentary to Section 105.7 and IBC Section 105.

**1101.4 Owner notification.** When a building is found to be in noncompliance with this chapter, the *fire code official* shall duly notify the *owner* of the building. Upon receipt of such notice, the *owner* shall, subject to the following time limits, take necessary actions to comply with the provisions of this chapter.

❖ See the commentary to Sections 109.3 and 109.3.2.

**1101.4.1 Construction documents.** *Construction documents* necessary to comply with this chapter shall be completed and submitted within a time schedule *approved* by the *fire code official*.

❖ See the commentary to Section 105.4 and its subsections.

**1101.4.2 Completion of work.** Work necessary to comply with this chapter shall be completed within a time schedule *approved* by the *fire code official*.

❖ See the commentary to Section 105.3.1 and IBC Section 105.3.2.

**1101.4.3 Extension of time.** The *fire code official* is authorized to grant necessary extensions of time when it can be shown that the specified time periods are not physically practical or pose an undue hardship. The granting of an extension of time for compliance shall be based on the showing of good cause and subject to the filing of an acceptable systematic plan of correction with the *fire code official*.

❖ See the commentary to Section 105.3.2.

## SECTION 1102 DEFINITIONS

**1102.1 Definitions.** The following terms are defined in Chapter 2:

**DUTCH DOOR.**

**EXISTING.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*® (I-Code®) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

## SECTION 1103 FIRE SAFETY REQUIREMENTS FOR EXISTING BUILDINGS

**1103.1 Required construction.** Existing buildings shall comply with not less than the minimum provisions specified in Table 1103.1 and as further enumerated in Sections 1103.2 through 1103.10.

The provisions of this chapter shall not be construed to allow the elimination of *fire protection systems* or a reduction in the level of fire safety provided in buildings constructed in accordance with previously adopted codes.

### Exceptions:

1. Where a change in fire-resistance rating has been approved in accordance with Section 803.6 of the *International Existing Building Code*.
2. Group U occupancies.

❖ This section reinforces the provisions of Section 1101.1 and points to the table that provides a tabular summary of the requirements of this chapter and how they apply to the various occupancy groups. With respect to existing fire protection systems, this section reinforces the provisions of Section 901.4, which emphasizes the principle that systems installed and maintained in compliance with the codes and standards in effect at the time they were placed in service must remain operational at the same level at all times.

The first exception recognizes an allowance provided in the *International Existing Building Code*® (IEBC®). Section 803.6 of the IEBC allows reductions in fire-resistance-rated construction if an automatic sprinkler system is added to a building. These reductions are required to be consistent with what is required in the IBC and also include extensive documentation and approval from the code official.

The second exception correlates with Table 1103.1, which does not include provisions for Group U occupancies (as defined in Section 202 and IBC Section 312), which are generally miscellaneous structures that do not pose the same life safety hazard as occupancies that are not classified in Group U.

**1103.1.1 Historic buildings.** Facilities designated as historic buildings shall develop a fire protection plan in accordance with NFPA 914. The fire protection plans shall comply with the maintenance and availability provisions in Sections 404.3 and 404.4.

❖ Section 102.6 generally does not require compliance with the code for historic buildings. However, that same section states that such buildings have a fire protection plan as required by this section. This plan will provide minimal ongoing safety for the occupants. This section also references back to the maintenance and availability requirements found in Chapter 4 to make sure the plans remain current and available to occupants and code officials.

TABLE 1103.1  
OCCUPANCY AND USE REQUIREMENTS<sup>a</sup>

SECTION	USE			OCCUPANCY CLASSIFICATION																			
	High-rise	Atrium or covered mall	Under-ground building	A	B	E	F	H-1	H-2	H-3	H-4	H-5	I-1	I-2	I-3	I-4	M	R-1	R-2	R-3	R-4	S	
1103.2	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
1103.3	R	—	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
1103.4.1	R	—	R	—	—	—	—	—	—	—	—	—	—	R	R	—	—	—	—	—	—	—	
1103.4.2	R	—	R	R	R	R	R	R	R	R	R	R	R	—	—	R	R	R	R	—	R	R	
1103.4.3	R	—	R	R	R	R	R	R	R	R	R	R	R	—	—	R	R	R	R	—	R	R	
1103.4.4	—	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
1103.4.5	—	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	
1103.4.6	—	—	—	R	—	R	R	R	R	R	R	R	R	R	R	R	—	R	R	R	R	R	
1103.4.7	—	—	—	R	—	R	R	R	R	R	R	R	R	R	R	R	—	R	R	R	R	R	
1103.4.8	R	—	R	R	R	R	R	R	R	R	R	R	R	—	—	R	R	R	R	R	R	R	
1103.4.9	R	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	—	
1103.5.1	—	—	—	R <sup>c</sup>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
1103.5.2, 1103.5.3 <sup>b</sup>	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	—	
1103.5.4	—	—	—	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	
1103.6.1	R	—	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	—	R	R	
1103.6.2	R	—	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	—	R	R	
1103.7.1	—	—	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
1103.7.2	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	—	—	
1103.7.3	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	—	
1103.7.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	
1103.7.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	
1103.7.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	
1103.7.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	
1103.8	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	R	R	R	R	—	
1103.9	R	—	—	—	—	—	—	—	—	—	—	—	R	R	—	R	—	R	R	R	R	—	
1104	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	
1105	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	—	
1106	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	—	

a. Existing buildings shall comply with the sections identified as “Required” (R) based on occupancy classification or use, or both, whichever is applicable.  
 b. Only applies to Group I-2 Condition 2 as established by the adopting ordinance.  
 c. Only applies to Group A-2 occupancies.  
 R = The building is required to comply.

**1103.2 Emergency responder radio coverage in existing buildings.** Existing buildings that do not have approved radio coverage for emergency responders within the building, based upon the existing coverage levels of the public safety communication systems of the jurisdiction at the exterior of the building, shall be equipped with such coverage according to one of the following:

1. Where an existing wired communication system cannot be repaired or is being replaced, or where not approved in accordance with Section 510.1, Exception 1.
2. Within a time frame established by the adopting authority.

**Exception:** Where it is determined by the fire code official that the radio coverage system is not needed.

❖ This section specifies the requirements for emergency responder radio coverage in existing buildings. When radio coverage is not adequate, Section 510.1, Exception 1, allows for the installation of a wired communication system. However, in existing buildings that have such a system or may have taken that exception, in the event the wired communication system becomes inoperative and cannot be repaired or is undergoing extended repair or replacement, this section allows the fire code official to require the installation of an acceptable system.

Where an existing building is determined to have inadequate radio coverage based on the requirements of Section 510.4, Item 2 of this section allows the fire code official to establish a time frame for compliance with Section 510.1. There are times when prior to construction it will be difficult to confidently assure that radio coverage will not be affected by the building itself. That is the reason these requirements are also applicable to existing facilities.

**1103.3 Existing elevators.** Existing elevators, escalators and moving walks shall comply with the requirements of Sections 1103.3.1 and 1103.3.2.

❖ The following two sections provide retroactive requirements that apply to existing elevators and, to a certain extent, escalators and moving walkways. Note that Section 607 also deals with the ongoing operation and maintenance of elevators in buildings. That section also has requirements related to fire service keys.

**1103.3.1 Elevators, escalators and moving walks.** Existing elevators, escalators and moving walks in Group I-2 Condition 2 occupancies shall comply with ASME A17.3.

❖ This section is specific to Group I-2 Condition 2 occupancies (hospitals). Not only are existing elevators required to comply with ASME A17.3, but escalators and moving walks must also comply. Note that Section 3001.2 of the IBC would require ongoing maintenance of all elevators and conveying systems. This section specifies compliance with ASME A17.3, *Safety Code for Existing Elevators and Escalators*, for such maintenance.

The healthcare industry has historically been

required to comply with regulations set forth by accreditation and certification agencies, such as The Joint Commission. ASME A17.3 has been referenced by guidelines adopted by The Joint Commission for over a decade and this requirement provides correlation of the code with the mandated healthcare industry standard.

The reference to ASME A17.3 requires that existing elevators, escalators, moving walks and their related operating equipment in Group I-2 Condition 2 occupancies comply with a minimum level of safety. Because the occupants of these types of facilities are often incapable of self-preservation, it is essential to provide ASME-mandated features for occupant safety including escalator and moving walk emergency stop buttons and automatic skirt obstruction stop features.

**1103.3.2 Elevator emergency operation.** Existing elevators with a travel distance of 25 feet (7620 mm) or more above or below the main floor or other level of a building and intended to serve the needs of emergency personnel for fire-fighting or rescue purposes shall be provided with emergency operation in accordance with ASME A17.3.

**Exceptions:**

1. Buildings without occupied floors located more than 55 feet (16 764 mm) above or 25 feet (7620 mm) below the lowest level of fire department vehicle access where protected at the elevator shaft openings with additional fire doors in accordance with Section 716.5 of the *International Building Code* and where all of the following conditions are met:
  - 1.1 The doors shall be provided with vision panels of approved fire protection-rated glazing so located as to furnish clear vision of the approach to the elevator. Such glazing shall not exceed 100 square inches (0.065 m<sup>2</sup>) in area.
  - 1.2 The doors shall be held open but be automatic-closing by activation of a fire alarm initiating device installed in accordance with the requirements of NFPA 72 as for Phase I Emergency Recall Operation, and shall be located at each floor served by the elevator; in the associated elevator machine room, control space, or control room; and in the elevator hoistway, where sprinklers are located in those hoistways.
  - 1.3 The doors, when closed, shall have signs visible from the approach area stating: **WHEN THESE DOORS ARE CLOSED OR IN FIRE EMERGENCY, DO NOT USE ELEVATOR. USE EXIT STAIRWAYS.**
2. Buildings without occupied floors located more than 55 feet (16 764 mm) above or 25 feet (7620 mm) below the lowest level of fire department vehicle access where provided with *automatic sprinkler systems* installed in accordance with Section 903.3.1.1 or 903.3.1.2.

3. Freight elevators in buildings provided with both *automatic sprinkler systems* installed in accordance with Section 903.3.1.1 or 903.3.1.2 and not less than one ASME 17.3-compliant elevator serving the same floors.

Elimination of previously installed Phase I emergency recall or Phase II emergency in-car systems shall not be permitted.

- ❖ This section establishes requirements for existing elevators. Existing elevators that travel 25 feet (7620 mm) or more above or below the main level must, as a minimum, be equipped with emergency operation capabilities that comply with ASME A17.3. New elevator installations are held to more restrictive guidelines for increased cost effectiveness and must have both emergency recall (Phase I) and emergency in-car operation (Phase II) to comply with ASME A17.1 for any amount of travel distance, as required by Section 607.1. The ASME standards are safety codes for elevators and escalators: ASME A17.3 for existing elevators and ASME A17.1 for new elevator installations. Automatic fire detection devices provided for Phase I emergency recall operation must be installed in accordance with Section 907.3.3.

There are several exceptions based on the expense of providing Phase I recall and Phase II emergency operation for existing elevators. ASME A17.3, Rule 211.3 (Firefighters' Service—Automatic Elevators) states, "All automatic (nondesignated attendant) operation elevators having a travel of 25 ft (7.62 m) or more above or below the designated level shall conform to the requirements of this Rule."

These changes are needed because of the excessive expense of compliance for many of these retrofits. Application of the mandatory Phase I and Phase II retrofits required by A17.3 triggers complete replacement of the elevator machinery at costs running into the hundreds of thousands of dollars. What is a relatively inexpensive fire safety feature in a new elevator installation can be unreasonably onerous when applied to existing elevators. It is therefore reasonable to codify alternate methods for building owners to meet the intent of the codes. It is important to note that the 25-foot travel threshold for an ASME A17.3 emergency operation retrofit is not mitigated by occupant load; number of stories; elevator use; building fire or smoke compartment conditions; the presence of sprinklers; or any building-specific operational firefighting considerations. For elevators installed prior to the adoption of newer elevator emergency operations features, many existing three-story buildings require retrofits; elevators in nonatmospherically segregated spaces such as low-rise atriums require retrofits; vintage freight elevators, regardless of maintenance condition or the ability of building occupants to access them, require retrofits. The problem of inflexible compliance options is magnified by the division of professional jurisdictions because elevator authorities typically do not have the expertise to

assess fire risk on a total building basis; hence there is a need for the code to scope retroactive fire safety provisions.

By allowing for more affordable or effective alternatives to the Phase I and Phase II retrofits, less opposition should exist to adoption of ASME A17.3 and its other retroactive safety requirements such as safety bulkheads for hydraulic elevators and door restrictors, thereby enhancing overall elevator safety.

The intents of Phase I emergency recall are to prevent elevator users from being discharged at a floor that is engaged in a fire; to prevent occupants from accessing an elevator during a fire; and, in a detected fire condition, to return the elevator car to a designated floor for fire-fighter access for operations and rescue.

The intent of Phase II emergency in-car operation is to provide fire fighters the ability to operate the elevator for fire-fighting operations.

Exception 1 meets the intent of the code by:

- Providing an additional fire door, with a vision panel, between elevator occupants and a fire engaged floor. This protects occupants from car and hoistway doors automatically opening directly to a fire event. The vision panel lets occupants view fire risk and select another floor to travel to for egress. This door provides an additional barrier to smoke and water contamination of the hoistway and improves building compartmentation.
- Providing additional signs on the added door immediately at the elevator opening telling building occupants to not use the elevator when the door is closed. In other words, if you can read the sign you shouldn't use the elevator.
- Recognizing that common fire-fighting operations policy requires fire fighters to use the stairs to address any fire on the sixth floor or lower in a building; meaning that in low-rise buildings immediate fire-fighter access to the elevators is not as critical. The sixth floor of a building typically corresponds to the code's definition of a high-rise building as one with "an occupied floor located more than 75 feet (22 860 mm) above the lowest level of fire department vehicle access." This is broadly recognized as the elevation at which a compromise is achieved between the inherent hazard of using an elevator in a structural fire response and the need to respond in a timely way to the fire.

Exception 1 also tacitly acknowledges that these are not elevators that were ever "intended to serve the needs of emergency personnel for fire-fighting or rescue purposes," as the charging section states.

Locations of fire alarm-initiating devices used to initiate door closing are identical to those used to initiate Phase I operations via reference to NFPA 72 by ASME A17.3.

Exception 2 recognizes that there is no docu-

mented loss of life while in an elevator during a structural fire in a building protected with automatic fire sprinklers. It is reasonable that if an owner has already provided superior fire safety features in an existing building he or she will not be required to retrofit expensive fire safety features of limited value.

For buildings within the scope of the exception that are not already equipped with an automatic sprinkler system, Exception 2 provides an incentive to provide fire sprinklers.

The references to Sections 903.3.1.1 and 903.3.1.2 mean that only a fire sprinkler system installed in accordance with the appropriate technical standard will permit relaxation of the Phase I and Phase II emergency operations requirements.

Fifty-five feet was selected as the upper limit for the floor height of buildings for a couple of reasons. It was suggested that a height limit of roughly four stories would be preferable when considering response factors associated with ascertaining elevator occupant locations and conditions. Since 55 feet is the elevation at which automatic sprinkler protection is triggered, and since it roughly corresponds to four stories, it is offered as a suitable threshold.

Exception 3 recognizes that buildings having another elevator equipped with Phase I and Phase II emergency operations already meet the intent of Phase II fire-fighter operations provisions. The fire sprinkler requirement and the limited passenger use of freight elevators means that the likelihood of life loss in the freight elevator is very low. For buildings without fire sprinklers, this provision provides an incentive to install fire sprinkler systems.

The final paragraph of this section clarifies that previously installed Phase I emergency recall and Phase II emergency in-car operations are not to be removed.

**1103.4 Vertical openings.** Interior vertical openings, including but not limited to *stairways*, elevator hoistways, service and utility shafts, that connect two or more stories of a building, shall be enclosed or protected as specified in Sections 1103.4.1 through 1103.4.10.

❖ Vertical openings that are not properly protected can act as a chimney for smoke, hot gases and products of combustion. Unprotected floor openings have been a major contributing factor in many large loss-of-life fires. This section retroactively requires the enclosure of vertical openings between floors with approved fire barriers. The intent is to increase the level of safety in all buildings by enclosing unprotected floor openings and, thus, removing the avenue for unimpeded fire and smoke spread. In particular, the code is intended to ensure that means of egress in existing multiple-story buildings are given a reasonable level of protection.

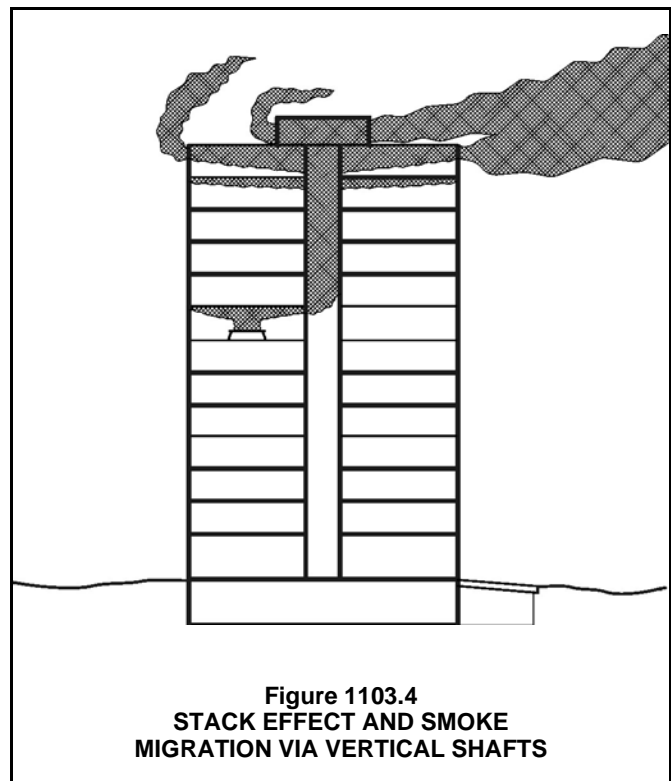
Vertical communication between floors (including stairways, escalator openings, elevator hoistways, trash and laundry chutes, and other types of building service and mechanical shafts) can contribute significantly to fire and smoke spread because of “stack

effect” (see Commentary Figure 1103.4). This section and Sections 1103.4.1 through 1103.4.7 require that interior shafts be enclosed with fire barriers of the fire-resistance rating indicated. These assemblies must be constructed and protected as required by the IBC. The allowance for sprinklers in the various sections recognizes the value of automatic sprinkler systems conforming to Section 903.3.1.1 (NFPA 13 system) or 903.3.1.2 (NFPA 13R system), as applicable.

**1103.4.1 Group I-2 and I-3 occupancies.** In Group I-2 and I-3 occupancies, interior vertical openings connecting two or more stories shall be protected with 1-hour fire-resistance-rated construction.

**Exceptions:**

1. In Group I-2, unenclosed vertical openings not exceeding two connected stories and not concealed within the building construction shall be permitted as follows:
  - 1.1. The unenclosed vertical openings shall be separated from other unenclosed vertical openings serving other floors by a smoke barrier.
  - 1.2. The unenclosed vertical openings shall be separated from corridors by smoke partitions.
  - 1.3. The unenclosed vertical openings shall be separated from other fire or smoke compartments on the same floors by a smoke barrier.



- 1.4. On other than the lowest level, the unenclosed vertical openings shall not serve as a required means of egress.
- 2. In Group I-2, atriums connecting three or more stories shall not require 1-hour fire-resistance-rated construction where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3, and all of the following conditions are met:
  - 2.1. For other than existing approved atriums with a smoke control system, where the atrium was constructed and is maintained in accordance with the code in effect at the time the atrium was created, the atrium shall have a smoke control system that is in compliance with Section 909.
  - 2.2. Glass walls forming a smoke partition or a glass-block wall assembly shall be permitted when in compliance with Condition 2.2.1 or 2.2.2.
    - 2.2.1. Glass walls forming a smoke partition shall be permitted where all of the following conditions are met:
      - 2.2.1.1. Automatic sprinklers are provided along both sides of the separation wall and doors, or on the room side only if there is not a walkway or occupied space on the atrium side.
      - 2.2.1.2. The sprinklers shall be not more than 12 inches (305 mm) away from the face of the glass and at intervals along the glass of not greater than 72 inches (1829 mm).
      - 2.2.1.3. Windows in the glass wall shall be non-operating type.
      - 2.2.1.4. The glass wall and windows shall be installed in a gasketed frame in a manner that the framing system deflects without breaking (loading) the glass before the sprinkler system operates.
      - 2.2.1.5. The sprinkler system shall be designed so

that the entire surface of the glass is wet upon activation of the sprinkler system with-out obstruction.

2.2.2. A fire barrier is not required where a glass-block wall assembly complying with Section 2110 of the *International Building Code* and having a 3/4-hour fire protection rating is provided.

2.3. Where doors are provided in the glass wall, they shall be either self-closing or automatic-closing and shall be constructed to resist the passage of smoke.

3. In Group I-3 occupancies, exit *stairways* or ramps and *exit access stairways* or *ramps* constructed in accordance with Section 408 in the *International Building Code*.

- ❖ This section specifically addresses vertical openings only for Group I-2 and I-3 occupancies. In nursing homes, hospitals and jails, the first response to a fire is to defend in place or move residents, patients or detainees to an adjacent smoke compartment. To maintain the separation needed to limit the spread of smoke, an increased level of protection is required. There are three exceptions to the requirement for 1-hour enclosure of vertical openings (for vertical openings in other occupancies, see Section 1103.4.8).
  - Exceptions 1 and 2 are applicable for Group I-2 occupancies (nursing homes and hospitals). The intent of Exceptions 1 and 2 is to more appropriately address floor openings in existing construction. Without these exceptions, the IBC would allow construction of a floor opening without a 1-hour fire barrier in certain specific cases. This also impacts all historical non-rated floor openings that have been reviewed, approved and maintained. Unrated vertical openings had been allowed in hospitals and nursing homes previously. Atriums have been installed with various types of smoke venting and removal systems over the past few decades. These exceptions attempt, while maintaining an appropriate level of protection, to address general requirements that have been broadly used throughout older editions of the building codes. These exceptions are consistent with federal regulations governing hospitals and nursing homes. It should be remembered that these provisions are retroactive. They apply regardless of whether an alteration is to be undertaken.
  - Exception 3 provides consistency with Exception 1 to Section 1023.2, which allows interior exit stairways in Group I-3 occupancies to be in accordance with Section 408.3.8 of the IBC. Being able to see into and out of a stairway enclosure is an important security feature.

**1103.4.2 Three to five stories.** In other than Group I-2 and I-3 occupancies, interior vertical openings connecting three to five stories shall be protected by either 1-hour fire-resistance-rated construction or an *automatic sprinkler system* shall be installed throughout the building in accordance with Section 903.3.1.1 or 903.3.1.2.

**Exceptions:**

1. Vertical opening protection is not required for Group R-3 occupancies.
2. Vertical opening protection is not required for open parking garages.
3. Vertical opening protection for escalators shall be in accordance with Section 1103.4.5, 1103.4.6 or 1103.4.7.
4. *Exit access stairways* and *ramps* shall be in accordance with Section 1103.4.8.

❖ See the commentary to Section 1103.4. The exceptions are consistent with the exceptions to the shaft enclosure requirements of the IBC. Exception 1 exempts single-family dwellings and small congregate residences from vertical opening enclosures because of occupant familiarity with the premises and the relatively small occupant load. Exception 2 recognizes that it would be impractical and unnecessary to enclose shafts in parking occupancies where open ramps are a fundamental design element. Exception 3 addresses escalator openings and refers to the applicable code sections that apply. Exception 4 recognizes that exit access stairways and ramps have various allowances that would not require enclosure. These allowances are consistent with Chapters 7 of the IBC and 10 (see Section 1103.4.8).

**1103.4.3 More than five stories.** In other than Group I-2 and I-3 occupancies, interior vertical openings connecting more than five stories shall be protected by 1-hour fire-resistance-rated construction.

**Exceptions:**

1. Vertical opening protection is not required for Group R-3 occupancies.
2. Vertical opening protection is not required for open parking garages.
3. Vertical opening protection for escalators shall be in accordance with Section 1103.4.5, 1103.4.6 or 1103.4.7.
4. *Exit access stairways* and *ramps* shall be in accordance with Section 1103.4.8.

❖ See the commentary to Section 1103.4. The exceptions are consistent with the exceptions to the shaft enclosure requirements of the IBC. Exception 1 exempts single-family dwellings and small congregate residences from vertical opening enclosures because of occupant familiarity with the premises and the relatively small occupant load. Exception 2 recognizes that it would be impractical and unnecessary to enclose shafts in parking occupancies where open

ramps are a fundamental design element. Exception 3 addresses escalator openings and refers to the applicable code sections that apply. Exception 4 recognizes that exit access stairways and ramps have various allowances that would not require enclosure. These allowances are consistent with Chapters 7 of the IBC and 10 (see Section 1103.4.8).

**1103.4.4 Atriums and covered malls.** In other than Group I-2 and I-3 occupancies, interior vertical openings in a covered mall building or a building with an atrium shall be protected by either 1-hour fire-resistance-rated construction or an *automatic sprinkler system* shall be installed throughout the building in accordance with Section 903.3.1.1 or 903.3.1.2.

**Exceptions:**

1. Vertical opening protection is not required for Group R-3 occupancies.
2. Vertical opening protection is not required for open parking garages.
3. *Exit access stairways* and *ramps* shall be in accordance with Section 1103.4.8.

❖ See the commentary to Section 1103.4. The exceptions are consistent with the allowances for atrium and mall enclosure requirements of the IBC. Exception 1 exempts single-family dwellings and small congregate residences from vertical opening enclosures because of occupant familiarity with the premises and the relatively small occupant load. Exception 2 recognizes that it would be impractical and unnecessary to enclose shafts in parking occupancies where open ramps are a fundamental design element. Exception 3 recognizes that exit access stairways and ramps have various allowances that would not require enclosure. These allowances are consistent with Chapters 7 and 10 of the IBC and IBC Sections 402 and 404. Escalators within a mall are addressed in Sections 1103.4.5, 1103.4.6 and 1103.4.7 (see Section 1103.4.8).

**1103.4.5 Escalators in Group B and M occupancies.** In Group B and M occupancies, escalators creating vertical openings connecting any number of stories shall be protected by either 1-hour fire-resistance-rated construction or an *automatic sprinkler system* in accordance with Section 903.3.1.1 installed throughout the building, with a draft curtain and closely spaced sprinklers around the escalator opening.

❖ This section addresses escalator openings in Group B and M occupancies and provides the option of either enclosing the vertical opening with 1-hour construction or equipping the building throughout with an NFPA 13 sprinkler system with the vertical opening protected by draft curtains and closely spaced sprinklers. Section 8.15.4.2 of NFPA 13 provides specifications on the construction and installation of the draft curtains (“draftstops” in NFPA 13) and Section 8.15.4.3 provides installation criteria for the automatic sprinklers for protecting the opening. There is no limit to the number of stories connected by vertical openings protected by either option in this section. IBC

Section 712.1.3 contains similar, but more stringent, requirements for escalator openings in new buildings.

**1103.4.6 Escalators connecting four or fewer stories.** In other than Group B and M occupancies, escalators creating vertical openings connecting four or fewer stories shall be protected by either 1-hour fire-resistance-rated construction or an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2 shall be installed throughout the building, and a draft curtain with closely spaced sprinklers shall be installed around the escalator opening.

❖ In other than Group B and M occupancies, escalators creating vertical openings connecting four or fewer stories shall either be protected by 1-hour fire-resistance-rated construction or an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2 shall be installed throughout the building and a draft curtain with closely spaced sprinklers shall be installed around the escalator opening.

This section addresses escalator openings connecting a maximum of four stories in other than Group B and M occupancies. Similar to Section 1103.4.5, it provides the option of either enclosing the vertical opening with 1-hour construction or equipping the building throughout with an NFPA 13 or 13R sprinkler system with the vertical opening protected by draft curtains and closely spaced sprinklers. Section 8.15.4.2 of NFPA 13 provides specifications on the construction and installation of the draft curtains (“draftstops” in NFPA 13) and Section 8.15.4.3 provides installation criteria for the automatic sprinklers for protecting the opening also see commentary, Section 1103.4. IBC Section 712.1.3.1 contains similar, but more stringent, requirements for escalator openings in new buildings.

**1103.4.7 Escalators connecting more than four stories.** In other than Group B and M occupancies, escalators creating vertical openings connecting five or more stories shall be protected by 1-hour fire-resistance-rated construction.

❖ This section addresses escalator openings connecting five stories or more in other than Group B and M occupancies and provides no option to enclosing the vertical opening with 1-hour construction (see commentary, Section 1103.4). IBC Section 712.1.3 contains similar, but more stringent, requirements for escalator openings in new buildings.

**1103.4.8 Occupancies other than Group I-2 and I-3.** In other than Group I-2 and I-3 occupancies, floor openings containing *exit access stairways* or *ramps* that do not comply with one of the conditions listed in this section shall be protected by 1-hour fire-resistance-rated construction.

1. *Exit access stairways* and *ramps* that serve, or atmospherically communicate between, only two stories. Such interconnected stories shall not be open to other stories.
2. In Group R-1, R-2 or R-3 occupancies, *exit access stairways* and *ramps* connecting four stories or less serving and contained within an individual *dwelling unit* or *sleeping unit* or live/work unit.

3. *Exit access stairways* and *ramps* in buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, where the area of the vertical opening between stories does not exceed twice the horizontal projected area of the *stairway* or *ramp*, and the opening is protected by a draft curtain and closely spaced sprinklers in accordance with NFPA 13. In other than Group B and M occupancies, this provision is limited to openings that do not connect more than four stories.

4. *Exit access stairways* and *ramps* within an atrium complying with the provisions of Section 404 of the *International Building Code*.

5. *Exit access stairways* and *ramps* in open parking garages that serve only the parking garage.

6. *Exit access stairways* and *ramps* serving open-air seating complying with the exit access travel distance requirements of Section 1029.7 of the *International Building Code*.

7. *Exit access stairways* and *ramps* serving the balcony, gallery or press box and the main assembly floor in occupancies such as theaters, places of religious worship, auditoriums and sports facilities.

❖ Vertical openings in Group I-2 and I-3 occupancies are specifically addressed in Section 1103.4.1. This section addresses vertical openings in other occupancies. There are many provisions for new construction in Chapter 10 that permit exit access stair floor openings without a fire rated enclosure. Without this section, many of these permitted floor openings would be required to be fire rated by this chapter. In addition, a building constructed under this code in full compliance with Chapter 10 would be in violation of Sections 1103.4 through 1103.4.7 upon issuance of the certificate of occupancy if these allowances were not provided. Clearly it was not the intent for Chapter 11 to contradict Chapter 10. This section notes all of the current conditions that allow an unenclosed exit access stair or ramp. All of these conditions originate from Section 1019. It is important to note that this section and these conditions only apply to exit access stairways and ramps. This section does not apply to exit stairways. Exit stairways are not exempted from enclosure.

**1103.4.9 Waste and linen chutes.** In Group I-2 occupancies, existing waste and linen chutes shall comply with Sections 1103.4.9.1 through 1103.4.9.5.

❖ This section is intended to clarify the allowable use and construction of chutes and incinerators in Group I-2 occupancies (hospitals and nursing homes). These items are used as integral parts of the operation of a healthcare facility, especially the waste or linen chutes. Some incinerators are still in use, but the requirements found in Sections 1103.4.9.1 through 1103.4.9.5 seek to separate them from other vertical openings, especially a trash chute, by requiring a separate discharge room from the incinerator.

Waste and linen chutes in other occupancies are addressed in Section 1103.4.8.

**1103.4.9.1 Enclosure.** Chutes shall be enclosed with 1-hour fire-resistance-rated construction. Opening protectives shall be in accordance with Section 716 of the *International Building Code* and have a fire protection rating of not less than 1 hour.

❖ At minimum, chutes must be enclosed with 1-hour fire-resistance-rated construction. This is consistent with Section 713.4 of the IBC for shaft enclosures for chutes connecting three stories or less. Openings other than chute access doors addressed in Section 1103.4.9.2 must meet IBC Section 716 requirements.

**1103.4.9.2 Chute intakes.** Chute intakes shall comply with Section 1103.4.9.2.1 or 1103.4.9.2.2.

❖ This section focuses on where chutes can be accessed throughout a building. There are two configurations addressed. The first, in Section 1103.4.9.2.1, addresses access from the corridor. Section 1103.4.9.2.2 then addresses chute intakes accessed from a chute intake room.

**1103.4.9.2.1 Chute intake direct from corridor.** Where intake to chutes is direct from a *corridor*, the intake opening shall be equipped with a chute-intake door in accordance with Section 716 of the *International Building Code* and having a fire protection rating of not less than 1 hour.

❖ In facilities that predate current requirements, some chute doors open into corridors. As it is not practical to reconstruct such chutes to meet modern standards, this section aims to directly address that situation by defining requirements for the chutes' safe maintenance. This configuration has a more direct effect on the safety of the occupants than those chute intakes addressed in Section 1103.4.9.2.2. Therefore, the opening must be in accordance with Section 716 of the IBC and be rated for at least 1 hour.

**1103.4.9.2.2 Chute intake via a chute-intake room.** Where the intake to chutes is accessed through a chute-intake room, the room shall be enclosed with 1-hour fire-resistance-rated construction. Opening protectives for the intake room shall be in accordance with Section 716 of the *International Building Code* and have a fire protection rating of not less than 3/4 hour. Opening protective for the chute enclosure shall be in accordance with Section 1103.4.9.1.

❖ This configuration provides a layer of protection to the building occupants by first entering a room that is protected with 1-hour fire-resistance-rated construction. The door rating is only required to be 3/4 hour versus 1 hour as required in Section 1103.4.9.2.1. The door for the chute intake itself would still be required to be 1 hour.

**1103.4.9.3 Automatic sprinkler system.** Chutes shall be equipped with an *approved automatic sprinkler system* in accordance with Section 903.2.11.2.

❖ This section would retroactively require compliance with Section 903.2.11.2 for sprinkler placement within the chute.

**1103.4.9.4 Chute discharge rooms.** Chutes shall terminate in a dedicated chute discharge room. Such rooms shall be separated from the remainder of the building by not less than 1-hour fire-resistance-rated construction. Opening protectives shall be in accordance with Section 716 of the *International Building Code* and have a fire protection rating of not less than 1 hour.

❖ This section provides minimal requirements for protection of the chute discharge room. This provides a minimal separation requirement for existing chute discharge rooms. This is consistent with the requirements in Section 713.13.4 of the IBC for shafts connecting three stories or less in new construction. The rating of the door must also be 1 hour.

**1103.4.9.5 Chute discharge protection.** Chute discharges shall be equipped with a self-closing or automatic-closing opening protective in accordance with Section 716 of the *International Building Code* and having a fire protection rating of not less than 1 hour.

❖ This section requires that the chute discharge room continue the protection of the enclosure through opening protection. The discharge must also have a 1-hour fire protection rating and be self or automatically closing. This is consistent with the requirement of IBC Section 713.13.4 that the opening protection have the same rating as the enclosure. The opening must also be self closing or automatic closing.

**1103.4.10 Flue-fed incinerators.** Existing flue-fed incinerator rooms and associated flue shafts shall be protected with 1-hour fire-resistance-rated construction and shall not have other vertical openings connected with the space other than the associated flue. Opening protectives shall be in accordance with Section 716 of the *International Building Code* and have a fire protection rating of not less than 1 hour.

❖ Because of regulation from the EPA and other entities, flue-fed incinerators are frequently found abandoned or otherwise unused in existing buildings. This requirement is intended to separate and protect any potential hazard of inactive incinerator systems from the rest of the building.

**1103.5 Sprinkler systems.** An *automatic sprinkler system* shall be provided in existing buildings in accordance with Sections 1103.5.1 through 1103.5.3.

❖ This section introduces the retroactive sprinkler requirements of Sections 1103.5.1 through 1103.5.3.

**1103.5.1 Group I-2.** In Group I-2, an *automatic sprinkler system* shall be provided in accordance with Section 1105.8.

❖ This section is merely a pointer to the sprinkler requirements for Group I-2 occupancies found in Section 1105.8. Section 1105.8 requires an automatic sprinkler system to be retroactively installed in Group I-2 occupancies from the story containing the Group I-2 to the level of exit discharge. This requirement is less restrictive than what is found in Section 1103.5.2.

**1103.5.2 Group I-2 Condition 2.** In addition to the requirements of Section 1103.5.2, existing buildings of Group I-2

Condition 2 occupancy shall be equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1. The *automatic sprinkler system* shall be installed as established by the adopting ordinance.

❖ This section is specific to hospitals and is more restrictive than the requirements of Sections 1103.5.1 and 1105.8. Instead of requiring the installation of an automatic sprinkler system from the story containing the Group I-2 Condition 2 occupancy to the level of exit discharge, this section requires the building to be equipped throughout with an automatic sprinkler system. This requirement, however, is based on the adopting ordinance establishing a date by which the automatic sprinkler system will be installed. Sprinkler systems are a vital safety system that protects building systems and components.

To ensure continuous operation in healthcare facilities, the installation of automatic sprinkler systems needs to be carefully planned so as to not adversely affect patient health. Accessing and exposing ceiling spaces can create conditions leading to infection and possibly death to patients with compromised immune systems. In many situations, hospitals may not be able to appropriately retrofit the installation of a fire suppression system; in those situations, a time frame is needed to replace facilities. The period for adoption of this proposed requirement has been left to the local authority having jurisdiction. Coordinating the timeframe for adoption with federal requirements is recommended. It is currently anticipated that the Centers for Medicaid and Medicare (the federal authority having jurisdiction) will require retroactive installation of automatic sprinkler systems in hospitals by the year 2021. However, the exact time frame was uncertain at the time of development of this requirement. Facilities will require lead time to meet this standard without adversely affecting the health of patients and disrupting patient care. These are the same factors that a jurisdiction should consider when choosing a date for adoption.

It should be also clear that this change is a separate measure that must be taken in addition to the current requirement. It is not intended to allow a facility to have a time frame for installing the current requirement (although jurisdictions may choose to do this). Nor is it intended to imply that the entire building containing a hospital should install an automatic sprinkler system immediately. At a minimum, a 3-year time frame is recommended for implementation of this requirement. This considers the process planning, capital approval, regulatory approval, design and installation of the sprinkler system. The capital-planning piece of a large-scale initiative such as a building-wide sprinkler system, normally spans multiple fiscal years.

**1103.5.3 Pyroxylin plastics.** An *automatic sprinkler system* shall be provided throughout existing buildings where cellulose nitrate film or pyroxylin plastics are manufactured, stored or handled in quantities exceeding 100 pounds (45 kg). Vaults located within buildings for the storage of raw pyrox-

ylin shall be protected with an *approved automatic sprinkler system* capable of discharging 1.66 gallons per minute per square foot (68 L/min/m<sup>2</sup>) over the area of the vault.

❖ This section requires an approved automatic fire-extinguishing system in existing buildings used for the manufacture and storage of pyroxylin plastics. Cellulose nitrate (pyroxylin) plastics pose unusual and substantial fire risks. Pyroxylin plastics are the most dangerous and unstable of all plastic compounds. The chemically bound oxygen in their structure permits them to burn vigorously in the absence of atmospheric oxygen. Although these compounds produce approximately the same amount of energy as paper when they burn, pyroxylin plastics burn at a rate as much as 15 times greater than comparable common combustibles. When burning, these materials release highly flammable and toxic combustion byproducts. Consequently, cellulose nitrate fires are very difficult to control. Although this section specifies a sprinkler threshold quantity of 100 pounds (45 kg), the need for additional fire protection should be considered for pyroxylin plastics in any amount.

Although the code includes cellulose nitrate “film” in its requirements, cellulose nitrate motion picture film has not been used in the United States since the 1950s. All motion picture film produced since that time is what is typically called “safety film.” Consequently, the only application for this section relative to motion picture film is where it may be used in laboratories or storage vaults that are dedicated to film restoration and archives. The protection of these facilities is addressed in Sections 306.2 and 6504.2.

Even though this section would permit an approved fire-extinguishing system in existing structures containing pyroxylin plastics, vaults must be protected by an approved automatic sprinkler system with a density of 1.66 gpm/ft<sup>2</sup> (68 L/min/m<sup>2</sup>) over the entire area of the vault. The high sprinkler density recognizes the need to immerse the pyroxylin plastics in water to counteract the vigorous burn rate of these materials.

Note that in Table 1103.1, on the row for Section 1103.5.3, an “R” appears for all occupancy groups. In previous editions of the code, this table row reflected the rationale of the table’s author of “anticipating” (guessing) where pyroxylin plastics might be used or found when, in actuality, it could be applicable to any or all occupancy groups. Even the text of this section does not list specific occupancies. Therefore, an “R” now appears in all occupancy group cells on the Section 1103.5.3 row.

**1103.6 Standpipes.** Existing structures shall be equipped with standpipes installed in accordance with Section 905 where required in Sections 1103.6.1 and 1103.6.2. The *fire code official* is authorized to approve the installation of manual standpipe systems to achieve compliance with this section where the responding fire department is capable of providing the required hose flow at the highest standpipe outlet.

❖ This section recognizes that some existing buildings do not have a standpipe system and introduces the

minimum requirements for existing buildings. In place of a standpipe system that has a water supply capable of supplying the system demand automatically, this section would permit the fire code official to approve the use of a manual standpipe system in an existing building if adequate hose flow is available when the fire department charges the system. The standpipe system may be either a manual dry or a manual wet system.

**1103.6.1 Existing multiple-story buildings.** Existing buildings with occupied floors located more than 50 feet (15 240 mm) above the lowest level of fire department access or more than 50 feet (15 240 mm) below the highest level of fire department access shall be equipped with standpipes.

❖ Although it would be inappropriate to require a standpipe system in an existing building to be designed based on the requirements of Section 905.3 for new construction, this section establishes a maximum height limitation for existing buildings regardless of occupancy beyond which a standpipe is required. The system is to be installed in accordance with Section 905. Many existing buildings may also not be equipped with an automatic sprinkler system. This section will, at least, provide some means of manual fire suppression in buildings where exterior fire department access is limited.

**1103.6.2 Existing helistops and heliports.** Existing buildings with a rooftop helistop or heliport located more than 30 feet (9144 mm) above the lowest level of fire department access to the roof level on which the helistop or heliport is located shall be equipped with standpipes in accordance with Section 2007.5.

❖ A heliport or helistop on a new or existing building is a distinct hazard that can involve flammable fuels and combustible cargo and present an immediate rescue situation. In the event of an emergency, rapid deployment of hand hose lines will be necessary to attack a resulting fire, effectuate rescue and to protect exposures and the remainder of the building. This section specifies that when existing buildings have a helistop or heliport on a rooftop location more than 30 feet (9144 mm) above the lowest level of fire department vehicle access, a standpipe system is required throughout the building, not just a hose connection at the roof level. This is critical in fire-fighting operations because, many times, the connection below the rooftop level may be needed to gain access to the roof. If the only connection is on the roof, it is of no use if the fire fighters cannot get to it. Additionally, a heliport includes fueling operations. It is entirely possible for a spill to not only affect the rooftop, but also floors below as the liquid fuel spreads. The standpipe system will again be utilized in these situations. Note that this section refers to Section 2007.5 for design and standpipe hose connection location for the rooftop heliport or helistop. See the commentary to Sections 905.3.6 and 2007.5 for further information.

**1103.7 Fire alarm systems.** An *approved* fire alarm system shall be installed in existing buildings and structures in accordance with Sections 1103.7.1 through 1103.7.7 and provide occupant notification in accordance with Section 907.5 unless other requirements are provided by other sections of this code.

**Exception:** Occupancies with an existing, previously *approved* fire alarm system.

❖ This section specifies the occupancy conditions when an approved fire alarm system is retroactively required in an existing building. These systems must, upon activation, provide occupant notification throughout the area protected by the system unless other alternative provisions, such as an emergency voice/alarm communication system, are allowed.

The exception recognizes the infeasibility of requiring existing, previously approved fire alarm systems to conform to current code requirements. The existing fire alarm system must be adequately tested and maintained in accordance with Section 901.6 and shown not to create a hazard.

A common concern in the application of the exception is in the scoping of the condition. Where the building is in use and continues in use as it was before, the exception is quite clear that no modifications are required if the existing system has been previously approved, regardless of how long ago that may have been. If there is an addition to the building, the addition must meet the requirements for new work and tie into the existing system if the existing system is capable of adequately handling the new devices. The addition is only adding devices and does not require the existing system to be upgraded.

If the building is altered, the alarm system must be altered in accordance with its original installation. For example, if the existing system does not include visual notification devices and the alteration includes remodeling to existing toilet rooms, there is no requirement for installing visual devices in the remodeled toilet rooms. If, on the other hand, the existing system is not capable of receiving new devices or relocated existing devices, then the replacement of the existing panel must be considered since the altered system would be less effective than before the alteration.

**1103.7.1 Group E.** A fire alarm system shall be installed in existing Group E occupancies in accordance with Section 907.2.3.

**Exceptions:**

1. A manual fire alarm system is not required in a building with a maximum area of 1,000 square feet (93 m<sup>2</sup>) that contains a single classroom and is located not closer than 50 feet (15 240 mm) from another building.
2. A manual fire alarm system is not required in Group E occupancies with an *occupant load* less than 50.

❖ Group E occupancies are limited to educational purposes through the 12th grade. Because of the typical age and maturity of the occupants, more time may be needed to safely evacuate the building. The require-

ment for retroactive installation of, at least, a fire alarm system recognizes that many existing, previously approved nonsprinklered educational facilities would most likely require sprinklers under current code provisions (see Section 903.2.3).

Although not limited to this use condition, Exception 1 recognizes the current use of mobile trailer-type facilities on site as additional educational classroom facilities. This exception does not exempt the main building, but it would exempt these auxiliary buildings of limited size that do not present an exposure hazard because of the required separation distance.

Exception 2 would exempt small day care centers that serve children older than 2 years of age, a small Sunday school classroom at a church or similar limited educational use areas (see commentary, Section 907.2.3).

**1103.7.2 Group I-1.** An automatic fire alarm system shall be installed in existing Group I-1 facilities in accordance with Section 907.2.6.1.

**Exception:** Where each sleeping room has a *means of egress* door opening directly to an exterior egress balcony that leads directly to the *exits* in accordance with Section 1021, and the building is not more than three stories in height.

❖ Group I-1 facilities are assumed to have more than 16 occupants who, because of their age, mental disability or other reasons, must live in a supervised environment 24 hours a day. This section would require existing Group I-1 occupancies to have an approved fire alarm system as required by Section 907.2.6.1.

The exception recognizes the increased degree of life safety resulting from having direct access to the exterior from the sleeping rooms. The occupants are not forced to evacuate through the interior of the building during a potential fire. The exterior egress balconies must be sufficiently open to the atmosphere and constructed to minimize the accumulation of smoke and toxic gases.

**1103.7.3 Group I-2.** In Group I-2, an automatic fire alarm system shall be installed in accordance with Section 1105.9.

❖ This section is simply a pointer to the specific requirements for Group I-2 occupancies found in Section 1105. Section 1105.9 addresses the need for a fire alarm system. See the commentary to Section 1105.9.

**1103.7.4 Group I-3.** An automatic and manual fire alarm system shall be installed in existing Group I-3 occupancies in accordance with Section 907.2.6.3.

❖ Because occupants may be restrained, leading to difficulties in evacuating, an approved fire alarm system is required in existing Group I-3 occupancies. The system must comply with Section 907.2.6.3 (see commentary, Section 907.2.6.3).

**1103.7.5 Group R-1.** A fire alarm system and smoke alarms shall be installed in existing Group R-1 occupancies in accordance with Sections 1103.7.5.1 through 1103.7.5.2.1.

❖ This section introduces the retroactive fire alarm system and smoke alarm requirements for Group R-1 transient occupancies such as hotels, motels, and boarding houses.

**1103.7.5.1 Group R-1 hotel and motel manual fire alarm system.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in existing Group R-1 hotels and motels more than three stories or with more than 20 *sleeping units*.

**Exceptions:**

1. Buildings less than two stories in height where all *sleeping units*, attics and crawl spaces are separated by 1-hour fire-resistance-rated construction and each *sleeping unit* has direct access to a *public way*, *egress court* or yard.

2. Manual fire alarm boxes are not required throughout the building where the following conditions are met:

2.1. The building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.

2.2. The notification appliances will activate upon sprinkler water flow.

2.3. Not less than one manual fire alarm box is installed at an *approved* location.

❖ This section specifies the conditions when a fire alarm system is required in existing Group R-1 hotels and motels. The two main criteria are independent of each other in that a fire alarm system is required if the building is more than three stories above grade, regardless of the number of sleeping units, or contains 20 sleeping units, regardless of the number of stories. Occupants of these types of Group R-1 facilities are assumed to be more transient than the occupants of Group R-1 boarding and rooming houses regulated by Section 907.2.8.

Exception 1 recognizes the increased level of life safety afforded by adequate compartmentation using 1-hour fire-resistance-rated construction between sleeping units and direct exterior access for egress.

Exception 2 does not omit fire alarm systems but, rather, permits them to be initiated automatically by sprinkler system water flow switches in lieu of manual fire alarm boxes. The sprinkler system is to be equipped with local audible alarms that can be heard throughout the building and at least one manual fire alarm box installed at an approved location.

The exceptions do not affect the independent provision in Section 1103.8 for single- or multiple-station smoke alarms.

**1103.7.5.1.1 Group R-1 hotel and motel automatic smoke detection system.** An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be installed in existing Group R-1 hotels

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and motels throughout all interior *corridors* serving sleeping rooms not equipped with an *approved*, supervised sprinkler system installed in accordance with Section 903.

**Exception:** An automatic smoke detection system is not required in buildings that do not have interior *corridors* serving *sleeping units* and where each sleeping unit has a *means of egress* door opening directly to an *exit* or to an exterior *exit access* that leads directly to an *exit*.

- ❖ This section requires an automatic smoke detection system within interior corridors serving unsprinklered sleeping rooms. Such systems make use of smoke detectors for alarm initiation, in accordance with Section 907.4.3, with one exception.

The exception provides that automatic smoke detection is not required in motels and hotels that do not have interior corridors and in which sleeping units have a door opening directly to an exterior exit access that leads directly to the exits. The intent of the exception is that the exit access from the sleeping unit door be exterior and not require reentering the building prior to entering the exit. Since the exit access is outside, the need for detectors other than in sleeping units is greatly reduced. Unlike Exception 1 to Section 1103.7.5.1, exit balconies and exterior stairs serving sleeping units are allowed.

**1103.7.5.2 Group R-1 boarding and rooming houses manual fire alarm system.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in existing Group R-1 boarding and rooming houses.

**Exception:** Buildings less than two stories in height where all *sleeping units*, attics and crawl spaces are separated by 1-hour fire-resistance-rated construction and each *sleeping unit* has direct access to a *public way*, *egress court* or *yard*.

- ❖ Group R-1 boarding and rooming houses are still assumed to be transient residential occupancies even though the functional use of a boarding and rooming house is different from that of a typical hotel or motel. Boarding and rooming houses tend to have more extended living arrangements and border on being classified as Group R-2 facilities. For this reason, this section requires Group R-1 boarding and rooming houses to be equipped with a manual fire alarm system regardless of the height of the building or number of sleeping rooms.

The exception recognizes the increased level of life safety afforded by adequate compartmentation using 1-hour fire-resistance-rated construction between sleeping units and direct exterior access for egress.

**1103.7.5.2.1 Group R-1 boarding and rooming houses automatic smoke detection system.** An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be installed in existing Group R-1 boarding and rooming houses throughout all interior *corridors* serving *sleeping units* not equipped with

an *approved*, supervised sprinkler system installed in accordance with Section 903.

**Exception:** Buildings equipped with single-station smoke alarms meeting or exceeding the requirements of Section 907.2.11.1 and where the fire alarm system includes not less than one manual fire alarm box per floor arranged to initiate the alarm.

- ❖ This section requires an automatic smoke detection system within interior corridors serving unsprinklered sleeping rooms. Such systems make use of smoke detectors for alarm initiation, in accordance with Section 907.4.3, with one exception.

The exception provides that automatic fire detectors are not required in boarding and rooming houses where single-station smoke alarms complying with the minimum requirements of Section 907.2.11.1 and at least one manual fire alarm box per floor are installed. The single-station smoke alarms give the desired early warning notification to occupants and the manual fire alarm box is an additional means to activate the occupant notification system.

**1103.7.6 Group R-2.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in existing Group R-2 occupancies more than three stories in height or with more than 16 *dwelling* or *sleeping units*.

### Exceptions:

1. Where each living unit is separated from other contiguous living units by *fire barriers* having a *fire-resistance rating* of not less than  $\frac{3}{4}$  hour, and where each living unit has either its own independent *exit* or its own independent stairway or ramp discharging at grade.
2. A separate fire alarm system is not required in buildings that are equipped throughout with an *approved* supervised *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2 and having a local alarm to notify all occupants.
3. A fire alarm system is not required in buildings that do not have interior *corridors* serving *dwelling units* and are protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, provided that *dwelling units* either have a *means of egress* door opening directly to an exterior *exit access* that leads directly to the *exits* or are served by open-ended *corridors* designed in accordance with Section 1027.6, Exception 3.
4. A fire alarm system is not required in buildings that do not have interior *corridors* serving *dwelling units*, do not exceed three stories in height and comply with both of the following:
  - 4.1. Each *dwelling unit* is separated from other contiguous *dwelling units* by *fire barriers*

having a *fire-resistance rating* of not less than  $\frac{3}{4}$  hour.

- 4.2. Each *dwelling unit* is provided with hard-wired, interconnected smoke alarms as required for new construction in Section 907.2.11.

- ❖ This section specifies the conditions when a manual fire alarm system is required in existing Group R-2 apartment buildings based on height or the number of dwelling or sleeping units. Occupants of Group R-2 facilities tend to be more permanent than those in Group R-1 facilities.

Exception 1 recognizes the increased degree of life safety afforded by compartmentation using fire-resistance-rated construction and independent means of egress (see Section 907.2.9).

As indicated in Exception 2, existing buildings that are fully sprinklered in accordance with NFPA 13 or 13R do not need a manual fire alarm system if local alarms will sound upon activation of the sprinkler system. The exception essentially eliminates the need for manual fire alarm boxes if evacuation alarms can still be heard throughout the building upon sprinkler system water flow. Other alarm-initiating devices would similarly not be required if the water flow device will initiate the appropriate alarm. This exception does not affect the independent provision in Section 907.2.11.

Exception 3 mirrors Section 907.2.9, Exception 3, and recognizes the superior fire record of sprinklered multiple-family occupancies by allowing omission of a fire alarm system when a building is fully sprinklered, has no interior egress corridors and provides direct exterior egress from each dwelling unit. Note that in such buildings, rated fire separations are still required between units.

Exception 4 provides a reasonable alternative to retrofitting a manual fire alarm system in existing Group R-2 occupancy buildings not exceeding three stories in height and having exits that lead directly to the outside. Fire risk in apartments tends to be greatest for occupants inside the dwelling unit where a fire originates, and money spent to retrofit firesafety equipment in apartments is better spent within dwelling units, as opposed to common areas.

Countless existing apartment buildings have only a single smoke alarm in the common area. The code does not require retrofitting sleeping rooms with smoke alarms when such alarms weren't required at the time of construction. The lack of smoke alarms in bedrooms, and particularly the lack of interconnecting alarm signals, increases the risk of injury or death in a unit of fire origin and other units that experience smoke infiltration. An additional consequence may be delayed recognition of a fire event, which increases the risk of harm to other building occupants and may delay notification of the fire department. This exception also requires minimal separation from other units.

**1103.7.7 Group R-4.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in existing Group R-4 residential care/assisted living facilities in accordance with Section 907.2.10.1.

**Exceptions:**

1. Where there are interconnected smoke alarms meeting the requirements of Section 907.2.11 and there is not less than one manual fire alarm box per floor arranged to continuously sound the smoke alarms.
2. Other manually activated, continuously sounding alarms *approved by the fire code official*.

- ❖ Existing Group R-4 residential care/assisted living facilities must have a manual fire alarm system. Group R-4 residential care/assisted living facilities are defined in Section 202 as residential occupancies with more than five, but not more than 16, occupants living in a supervised environment.

Exception 1 allows the omission of the fire alarm system if installed interconnected smoke alarms can be manually activated by at least one manual fire alarm box on each floor.

Exception 2 allows the fire code official to approve alternative means of manually activating the alarms in place of a manual fire alarm box.

**1103.8 Single- and multiple-station smoke alarms.** Single- and multiple-station smoke alarms shall be installed in existing Group I-1 and R occupancies in accordance with Sections 1103.8.1 through 1103.8.3.

- ❖ This section introduces the requirements for the installation of smoke alarms in existing Group I-1 and R occupancies. These requirements recognize the benefit of installing smoke alarms in existing structures, but provide several exceptions for buildings that are not undergoing substantial renovations. These provisions also correlate with Section 704.2 of the *International Property Maintenance Code*® (IPMC®) for single- or multiple-station smoke alarm requirements for existing Group R dwellings.

**1103.8.1 Where required.** Existing Group I-1 and R occupancies shall be provided with single-station smoke alarms in accordance with Section 907.2.11. Interconnection and power sources shall be in accordance with Sections 1103.8.2 and 1103.8.3, respectively.

**Exceptions:**

1. Where the code that was in effect at the time of construction required smoke alarms and smoke alarms complying with those requirements are already provided.
2. Where smoke alarms have been installed in occupancies and dwellings that were not required to have them at the time of construction, additional smoke alarms shall not be required provided that the existing smoke alarms comply with requirements that were in effect at the time of installation.

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3. Where smoke detectors connected to a fire alarm system have been installed as a substitute for smoke alarms.
- ❖ This section requires that Group I-1 and R occupancies be provided with single-station smoke alarms where they are not already provided. Reference is made to the new building requirements of Section 907.2.11 for the primary requirements; however, interconnection and power supply are more specifically addressed for existing buildings in Sections 1103.8.2 and 1103.8.3. Therefore, the basic requirement is that smoke alarms need to be provided in all locations required by Section 907.2.11, but several modified requirements related to interconnection of alarms and power supply are provided, recognizing the impracticality of such installations in existing conditions. Three exceptions are also provided to address possible scenarios where smoke alarms have already been installed but the installation does not meet the current code requirements, recognizing that the intent of the code is to permit existing smoke alarm installations to continue unchanged where they meet the code that was in effect at the time they were installed.

Exception 1 indicates that smoke alarms installed and maintained in accordance with the applicable code at the time of construction can continue unchanged. Exception 2 indicates that smoke alarms that were not required by the code at the time of construction, but were later installed can continue when they meet the requirements of the applicable code at the time of installation. Exception 3 indicates that smoke detectors connected to a fire alarm system may be used in lieu of smoke alarms.

In summary, this section requires the installation of smoke alarms in Group I-1 and R occupancies that do not currently have any smoke alarms. It does not require compliance with the current smoke alarm requirements if the building already has smoke alarms meeting requirements that were applicable when they were installed. The focus here is not to have the owner replace or revise his or her smoke alarms any time the code requirements for new construction change.

**1103.8.2 Interconnection.** Where more than one smoke alarm is required to be installed within an individual *dwelling* or *sleeping unit*, the smoke alarms shall be interconnected in such a manner that the activation of one alarm will activate all of the alarms in the individual unit. Physical interconnection of smoke alarms shall not be required where listed wireless alarms are installed and all alarms sound upon activation of one alarm. The alarm shall be clearly audible in all bedrooms over background noise levels with all intervening doors closed.

### Exceptions:

1. Interconnection is not required in buildings that are not undergoing *alterations*, repairs or construction of any kind.

2. Smoke alarms in existing areas are not required to be interconnected where *alterations* or repairs do not result in the removal of interior wall or ceiling finishes exposing the structure, unless there is an attic, crawl space or *basement* available that could provide access for interconnection without the removal of interior finishes.

- ❖ This section, like Section 907.2.11.5, requires that when multiple-station smoke alarms are present, they are to be interconnected and be audible over background noises. This section also includes language that would allow listed wireless alarms to substitute for wired interconnection of the smoke alarms in both new and existing construction, making it clear that listed wireless systems comply with the code. Historically, while some code officials have not recognized wireless interconnection of smoke alarms as meeting the code requirement for interconnection, most have accepted them as their use has proliferated and their reliability shown. See the commentary to Section 907.2.11.5 for further information on interconnection.

Exception 1 does not require interconnection where the building is not undergoing any construction or repairs. Exception 2 clarifies to what extent the building must be undergoing construction before interconnection is required. Generally, the exceptions try to be reasonable based on the practicality of such installations; therefore, unless areas such as attics or crawl spaces can still be utilized while the interior finishes are being removed (e.g., drywall removed, exposing the studs), interconnection would not be required. Such renovations may only be limited to portions of a structure; therefore, complete interconnection may not be practical or possible. The intent is that additional walls, etc., should not be removed solely to interconnect the smoke alarms. Battery-powered alarms, as allowed by Section 1103.8.3, may be required to be interconnected when a building is not supplied by a commercial power source.

**1103.8.3 Power source.** Single-station smoke alarms shall receive their primary power from the building wiring provided that such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms with integral strobes that are not equipped with battery backup shall be connected to an emergency electrical system. Smoke alarms shall emit a signal when the batteries are low. Wiring shall be permanent and without a disconnecting switch other than as required for overcurrent protection.

### Exceptions:

1. Smoke alarms are permitted to be solely battery operated in existing buildings where construction is not taking place.
2. Smoke alarms are permitted to be solely battery operated in buildings that are not served from a commercial power source.
3. Smoke alarms are permitted to be solely battery operated in existing areas of buildings undergoing

*alterations* or repairs that do not result in the removal of interior walls or ceiling finishes exposing the structure, unless there is an attic, crawl space or *basement* available that could provide access for building wiring without the removal of interior finishes.

- ❖ This section requires both a primary power supply from the building wiring, as well as a supervised battery backup. Wiring must be permanent and supplied from a circuit that is properly overcurrent-protected, but without any on-off switching capability. Currently, there are some smoke alarms on the market that have an integral visual alarm notification component (a strobe light) that do not have a built-in battery for the strobe. Thus, if the power for the building fails, the smoke detection and audible signal of the device may still operate, but the strobe will not. It is critical for rooms that may house those with hearing impairments and are equipped with these smoke alarms that the strobe be as reliable as the audible signal element. This section resolves that concern by requiring such smoke alarms to be connected to an emergency electrical system for the required backup power in accordance with Section 604.

This section is very similar to Section 907.2.11.2. The primary differences are the exceptions.

Exception 1 allows the use of batteries as the sole power source if no construction or related repairs are occurring in the building.

Exception 2 allows the use of batteries as the sole power source if there is no other power source available (i.e., the building is without an electric utility connection).

Exception 3 clarifies to what extent the building must be undergoing construction before connection to the building wiring is required. Generally, the exceptions try to be reasonable based on the practicality of such installations; therefore, unless areas such as attics or crawl spaces can be utilized for interstitial access for wiring while the interior finishes are being removed (e.g., drywall removed, exposing the studs), connection to the building wiring would not be required. Such renovations may only be limited to portions of a structure; therefore, adding permanent wiring may not be practical or possible. The intent is that additional walls, etc., should not be removed solely to connect the smoke alarms to the building wiring.

**1103.9 Carbon monoxide alarms.** Existing Group I-1, I-2, I-4 and R occupancies shall be equipped with carbon monoxide alarms in accordance with Section 915, except that the carbon monoxide alarms shall be allowed to be solely battery operated.

- ❖ This section requires CO alarms in accordance with the requirements of Section 915. Section 915 provides very specific requirements on placement. However, these CO alarms for existing buildings are permitted to be battery powered. This recognizes the need for such protection and the practicality of provid-

ing it in existing buildings. Also note that Section 915 addresses Group E occupancies. This section does not address Group E occupancies. See the commentary to Section 915 for more detail on alarm requirements and placement.

**1103.10 Medical gases.** Medical gases stored and transferred in health-care-related facilities shall be in accordance with Chapter 53.

- ❖ This section requires compliance with Chapter 53 compressed gases when medical gases are stored and transferred in existing healthcare related facilities. This will address several different types of occupancies including Group I-2 and ambulatory care facilities but can also address facilities such as a small dentist office. It was considered necessary to make sure that all existing facilities comply with these requirements to meet CMS guidelines. A general reference was made since the medical gas requirements of Section 5306 are only one aspect of the regulation of compressed gases.

## SECTION 1104

### MEANS OF EGRESS FOR EXISTING BUILDINGS

**1104.1 General.** *Means of egress* in existing buildings shall comply with the minimum egress requirements where specified in Table 1103.1 as further enumerated in Sections 1104.2 through 1104.25, and the building code that applied at the time of construction. Where the provisions of this chapter conflict with the building code that applied at the time of construction, the most restrictive provision shall apply. Existing buildings that were not required to comply with a building code at the time of construction shall comply with the minimum egress requirements where specified in Table 1103.1 as further enumerated in Sections 1104.2 through 1104.25.

- ❖ The primary concept of this section is to require existing buildings to comply with the specific means of egress requirements for new buildings except as modified by this section. Where an item is specifically addressed by Section 1104, the requirements of this section are intended to be special allowances for existing buildings to not fully meet the requirements for new buildings in Sections 1003 through 1030.

For example, the guard height requirements in Section 1104.6 include exceptions for the guard height requirement for new buildings in Section 1015.2. The requirements for existing buildings in Section 1104 are intended to be the same or less stringent than the comparable provisions for new buildings in Sections 1003 through 1030.

This section applies to most existing buildings. However, where a building has been built to meet the requirements of the building code in effect at the time of construction and, in the opinion of the fire code official, the means of egress is not hazardous, the building would meet the intent of this section. As such, none of the specific requirements in this section would apply.

## CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

In the absence of any evidence of compliance with a building code at the time the building was constructed, all provisions of Sections 1104.1 through 1104.25 apply. See Chapter 14 of the IEBC for a performance-based compliance alternative analysis regimen for existing buildings, especially Sections 1401.6.11 through 1401.6.15, which deal with the means of egress analysis. Chapter 19 of the ICC *Performance Code*<sup>®</sup> (ICC PC<sup>®</sup>) also provides a performance approach to means of egress evaluation.

**1104.2 Elevators, escalators and moving walks.** Elevators, escalators and moving walks shall not be used as a component of a required *means of egress*.

**Exceptions:**

1. Elevators used as an *accessible means of egress* where allowed by Section 1009.4.
2. Previously *approved* elevators, escalators and moving walks in existing buildings.

❖ This section is the same as Section 1003.7, except Exception 2 is added. Thus, an escalator or moving walk could be used as part of the required means of egress in an existing building if it had been previously approved by the fire code official.

**1104.3 Exit sign illumination.** Exit signs shall be internally or externally illuminated. The face of an exit sign illuminated from an external source shall have an intensity of not less than 5 footcandles (54 lux). Internally illuminated signs shall provide equivalent luminance and be *listed* for the purpose.

**Exception:** *Approved* self-luminous signs that provide evenly illuminated letters shall have a minimum luminance of 0.06 foot-lamberts (0.21 cd/m<sup>2</sup>).

❖ This section is the same as Section 1013.3 for new buildings, except that Section 1013.3 includes an exception to illumination for tactile signs. The same exception should apply for existing buildings.

**1104.4 Power source.** Where emergency illumination is required in Section 1104.5, exit signs shall be visible under emergency illumination conditions.

**Exception:** *Approved* signs that provide continuous illumination independent of external power sources are not required to be connected to an emergency electrical system.

❖ This section requires that exit signs serving the occupancies listed in Section 1104.5 be illuminated during the use of emergency power for the means of egress. The comparable section for new buildings is Section 1013.6.3. Exit signs for all new building occupancies must be illuminated at all times and have an emergency power source.

**1104.5 Illumination emergency power.** Where *means of egress* illumination is provided, the power supply for *means of egress* illumination shall normally be provided by the premises' electrical supply. In the event of power supply fail-

ure, illumination shall be automatically provided from an emergency system for the following occupancies where such occupancies require two or more *means of egress*:

1. Group A having 50 or more occupants.

**Exception:** Assembly occupancies used exclusively as a place of worship and having an *occupant load* of less than 300.

2. Group B buildings three or more stories in height, buildings with 100 or more occupants above or below a *level of exit discharge* serving the occupants or buildings with 1,000 or more total occupants.
3. Group E in interior *exit access* and *exit stairways* and *ramps, corridors*, windowless areas with student occupancy, shops and laboratories.
4. Group F having more than 100 occupants.

**Exception:** Buildings used only during daylight hours and that are provided with windows for natural light in accordance with the *International Building Code*.

5. Group I.
6. Group M.

**Exception:** Buildings less than 3,000 square feet (279 m<sup>2</sup>) in gross sales area on one story only, excluding mezzanines.

7. Group R-1.

**Exception:** Where each *sleeping unit* has direct access to the outside of the building at grade.

8. Group R-2.

**Exception:** Where each *dwelling unit* or *sleeping unit* has direct access to the outside of the building at grade.

9. Group R-4.

**Exception:** Where each *sleeping unit* has direct access to the outside of the building at ground level.

❖ Section 1008.3 requires emergency power for emergency egress lighting in all new buildings along aisles, corridors and stairways leading through or from spaces where two or more means of egress are required. This section requires emergency power for emergency egress lighting only for the listed occupancy conditions for existing buildings.

**1104.5.1 Emergency power duration and installation.** Emergency power for *means of egress* illumination shall be provided in accordance with Section 604. In other than Group I-2, emergency power shall be provided for not less than 60 minutes for systems requiring emergency power. In Group I-2, essential electrical systems shall comply with Sections 1105.5.1 and 1105.5.2.

❖ A 90-minute emergency power duration for emergency egress lighting is required by Section 1008.3 for new buildings. The emergency power system for

emergency egress lighting in existing buildings in other than Group I-2 occupancies, however, is to provide power for at least 60 minutes. This duration is consistent with Section 1104.1 and with the new building requirements of at least one of the legacy building codes. In Group I-2 occupancies, a reference is made to the specific requirements found in Section 1105. More specifically, Section 1105.5.1 requires 90 minutes of power for emergency egress lighting and exit signs. Section 1105.5.2 requires that essential electrical power complies with NFPA 99, which covers a much wider use of emergency power needed in hospitals. See the commentary to Sections 1105.5.1 and 1105.5.2.

**1104.6 Guards.** Guards complying with this section shall be provided at the open sides of *means of egress* that are more than 30 inches (762 mm) above the floor or grade below.

❖ Where guards are required in this section, the requirements are the same as in Section 1015 for new buildings (see commentary, Section 1015.1). Sections 1104.6.1 and 1104.6.2 do provide allowances for the height and opening limitations that are less than required for new construction.

**1104.6.1 Height of guards.** Guards shall form a protective barrier not less than 42 inches (1067 mm) high.

**Exceptions:**

1. Existing guards on the open side of exit access and exit *stairways* and *ramps* shall be not less than 30 inches (760 mm) high.
2. Existing *guards* within *dwelling units* shall be not less than 36 inches (910 mm) high.
3. Existing *guards* in assembly seating areas.

❖ Guard height in new construction is typically 42 inches (1067 mm) minimum. In the legacy codes, there were allowances for guards to have the top rail at the height required for handrails when the guard was along a stairway or ramp (except for Group E). Exception 1 is in recognition of that allowance. Exceptions 2 and 3 are in recognition of the lower guard heights allowed within dwelling units (Section 1015.3 Exceptions 1, 2 and 3) and with assembly seating (Section 1029.16) for new construction.

**1104.6.2 Opening limitations.** Open *guards* shall have balusters or ornamental patterns such that a 6-inch-diameter (152 mm) sphere cannot pass through any opening up to a height of 34 inches (864 mm).

**Exceptions:**

1. At elevated walking surfaces for access to, and use of, electrical, mechanical or plumbing systems or equipment, guards shall have balusters or be of solid materials such that a sphere with a diameter of 21 inches (533 mm) cannot pass through any opening.
2. In occupancies in Group I-3, F, H or S, the clear distance between intermediate rails measured at right

angles to the rails shall not exceed 21 inches (533 mm).

3. *Approved* existing open guards.

❖ Generally, this section allows maximum openings of 6 inches (152 mm) versus the maximum openings of 4 inches (102 mm) allowed by Section 1015.4. Exception 1 mirrors Section 1015.4, Exception 3, and Exception 2 mirrors Section 1015.4, Exception 4.

**1104.7 Size of doors.** The minimum width of each door opening shall be sufficient for the *occupant load* thereof and shall provide a clear width of not less than 28 inches (711 mm). Where this section requires a minimum clear width of 28 inches (711 mm) and a door opening includes two door leaves without a mullion, one leaf shall provide a clear opening width of 28 inches (711 mm). In ambulatory care facilities, doors serving as *means of egress* from patient treatment rooms or patient sleeping rooms shall provide a clear width of not less than 32 inches (813 mm). In Group I-2, *means of egress* doors where used for the movement of beds shall provide a clear width not less than 41½ inches (1054 mm). The maximum width of a swinging door leaf shall be 48 inches (1219 mm) nominal. The height of door openings shall be not less than 80 inches (2032 mm).

**Exceptions:**

1. The minimum and maximum width shall not apply to door openings that are not part of the required *means of egress* in occupancies in Groups R-2 and R-3.
2. Door openings to storage closets less than 10 square feet (0.93 m<sup>2</sup>) in area shall not be limited by the minimum width.
3. Width of door leaves in revolving doors that comply with Section 1010.1.1 shall not be limited.
4. Door openings within a *dwelling unit* shall be not less than 78 inches (1981 mm) in height.
5. Exterior door openings in *dwelling units*, other than the required *exit* door, shall be not less than 76 inches (1930 mm) in height.
6. *Exit access* doors serving a room not larger than 70 square feet (6.5 m<sup>2</sup>) shall be not less than 24 inches (610 mm) in door width.
7. Door closers and door stops shall be permitted to be 78 inches (1980 mm) minimum above the floor.

❖ Generally, this section requires doors to be at least 28 inches (711 mm) wide versus the minimum width of 32 inches (813 mm) for new construction in Section 1010.1.1. The 32-inch clear width for patient treatment or sleeping within ambulatory care facilities is based on the nature of the activities within the space. In Group I-2 occupancies, the need to move patients in beds requires a width of 41½ inches, consistent with new construction requirements. Other doors within ambulatory care facilities and Group I-2 occupancies could use the 28-inch width allowance.

The other provisions and exceptions in this section are the same as those in Section 1010.1.1 for new construction. Exceptions 2, 8, 9 and 10 of Section 1010.1.1 are not included in this section. Exception 2 is not needed since these provisions for existing buildings only require a 28-inch-wide (711 mm) door. Exception 8 relates to accessibility requirements that are not intended to be retroactively applied except within the context of the IEBC. Exceptions 9 and 10 are newer exceptions that have not been addressed in these retroactive provisions.

**1104.8 Opening force for doors.** The opening force for interior side-swinging doors without closers shall not exceed a 5-pound (22 N) force. The opening forces do not apply to the force required to retract latch bolts or disengage other devices that hold the door in a closed position. For other side-swinging, sliding and folding doors, the door latch shall release when subjected to a force of not more than 15 pounds (66 N). The door shall be set in motion when subjected to a force not exceeding 30 pounds (133 N). The door shall swing to a full-open position when subjected to a force of not more than 50 pounds (222 N). Forces shall be applied to the latch side.

❖ This section is similar to Section 1010.1.3. The allowance for fire doors to have a greater opening force in new construction has a broader context in this section, which allows for all doors with closers to not meet the 5-pound opening force. The maximum door-operating force in this section is less restrictive than that required in Section 1010.1.3 for new construction.

**1104.9 Revolving doors.** Revolving doors shall comply with the following:

1. A revolving door shall not be located within 10 feet (3048 mm) of the foot or top of *stairways* or escalators. A dispersal area shall be provided between the *stairways* or escalators and the revolving doors.
2. The revolutions per minute for a revolving door shall not exceed those shown in Table 1104.9.
3. Each revolving door shall have a conforming side-hinged swinging door in the same wall as the revolving door and within 10 feet (3048 mm).

**Exceptions:**

1. A revolving door is permitted to be used without an adjacent swinging door for street-floor elevator lobbies provided a stairway, escalator or door from other parts of the building does not discharge through the lobby and the lobby does not have any occupancy or use other than as a means of travel between elevators and a street.
  2. Existing revolving doors where the number of revolving doors does not exceed the number of swinging doors within 20 feet (6096 mm).
- ❖ This section is comparable with Section 1010.1.4.1 for new buildings. The capability of collapsing to a width of 36 inches (914 mm) in Condition 2 of Section

1010.1.4.1 for new construction does not apply to existing revolving doors. The two exceptions in this section are not allowed for new construction.

**TABLE 1104.9  
REVOLVING DOOR SPEEDS**

INSIDE DIAMETER (feet-inches)	POWER-DRIVEN-TYPE SPEED CONTROL (rpm)	MANUAL-TYPE SPEED CONTROL (rpm)
6-6	11	12
7-0	10	11
7-6	9	11
8-0	9	10
8-6	8	9
9-0	8	9
9-6	7	8
10-0	7	8

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

❖ Table 1008.1.4.1 for new construction has a wider range of door sizes and often has a slower maximum speed allowance than this table.

**1104.9.1 Egress component.** A revolving door used as a component of a *means of egress* shall comply with Section 1104.9 and all of the following conditions:

1. Revolving doors shall not be given credit for more than 50 percent of the required egress capacity.
2. Each revolving door shall be credited with not more than a 50-person capacity.
3. Revolving doors shall be capable of being collapsed when a force of not more than 130 pounds (578 N) is applied within 3 inches (76 mm) of the outer edge of a wing.

❖ This section is similar to Section 1014.1.4.1.1 for new construction.

**1104.10 Stair dimensions for existing stairways.** Existing *stairways* in buildings shall be permitted to remain if the rise does not exceed 8 1/4 inches (210 mm) and the run is not less than 9 inches (229 mm). Existing *stairways* can be rebuilt.

**Exception:** Other *stairways* approved by the *fire code official*.

❖ This section includes a much less stringent criterion for stairway treads and risers than that in Section 1011.5.2. This section also allows existing stairways to be rebuilt. The tread and riser dimensions of the rebuilt stairway have additional allowances in Section 1104.10.1.

**1104.10.1 Dimensions for replacement stairways.** The replacement of an existing *stairway* in a structure shall not be required to comply with the new *stairway* requirements of Section 1009 where the existing space and construction will not allow a reduction in pitch or slope.

❖ This section is consistent with Section 403.1 of the IEBC. The intent of this section is that where an existing stairway was built with a steeper rise/run ratio

than permitted in the current code, the stairway can be replaced with the existing configuration. Enlarging the opening to achieve the current rise/run ratio and headroom would be considered technically infeasible. The principle is that not allowing for this option could result in stairways that were not maintained because they could not be brought up to current codes.

**1104.11 Winders.** Existing winders shall be allowed to remain in use if they have a minimum tread depth of 6 inches (152 mm) and a minimum tread depth of 9 inches (229 mm) at a point 12 inches (305 mm) from the narrowest edge.

❖ In new construction, winders are only permitted within dwelling units and along curved or spiral stairways (Sections 1011.5.3, 1011.9 and 1011.10). The tread size allowances for existing stairways are smaller than permitted for curved stairways.

**1104.12 Curved stairways.** Existing curved *stairways* shall be allowed to continue in use, provided the minimum depth of tread is 10 inches (254 mm) and the smallest radius shall be not less than twice the width of the *stairway*.

❖ For other than certain residential occupancies, this section has fewer requirements than Section 1011.9 for new construction. The relaxed requirements of the exception of Section 1011.9 apply to Group R-3 occupancies and individual dwelling units in Group R-2 occupancies.

**1104.13 Stairway handrails.** *Stairways* shall have *handrails* on at least one side. *Handrails* shall be located so that all portions of the *stairway* width required for egress capacity are within 44 inches (1118 mm) of a *handrail*.

**Exception:** *Aisle stairs* provided with a center *handrail* are not required to have additional *handrails*.

❖ Handrails are required on both sides, with certain exceptions, for new construction compared to the requirement for one side in this section. The 44-inch (1118 mm) dimension in this section is an increase from the 30-inch (762 mm) dimension in Section 1014.9 for new construction. Handrails for assembly occupancies in new construction are covered in Section 1029.15. See Section 1014 for handrail requirements for new construction.

**1104.13.1 Height.** *Handrail* height, measured above *stair* tread nosings, shall be uniform, not less than 30 inches (762 mm) and not more than 42 inches (1067 mm).

❖ The allowable range of handrail height installation in this section is broader than the 34 inches (834 mm) up to 38 inches (965 mm) allowed for new construction in Section 1014.2. This is in recognition of previous allowances for the handrail to be the top rail of a guard. This is still permitted for new construction in assembly seating (see Section 1029.15, Exception 2).

**1104.14 Slope of ramps.** *Ramp* runs utilized as part of a *means of egress* shall have a running slope not steeper than one unit vertical in 10 units horizontal (10-percent slope).

The slope of other *ramps* shall not be steeper than one unit vertical in eight units horizontal (12.5-percent slope).

❖ The slope of means of egress ramps for new construction in Section 1012.2 is a maximum of 1:12. The steeper ramps of 1:8 slope in assembly aisles, as permitted by Section 1029.13 for new construction, should also apply to existing construction.

**1104.15 Width of ramps.** Existing *ramps* are permitted to have a minimum width of 30 inches (762 mm) but not less than the width required for the number of occupants served as determined by Section 1005.1. In Group I-2, *ramps* serving as a *means of egress* and used for the movement of patients in beds shall comply with Section 1105.5.4.

❖ Ramps for new construction in Section 1012.5.1 are required to have a minimum clear width of 36 inches (914 mm) between handrails compared to the 30-inch (762 mm) minimum ramp width requirement in this section (see commentary, Section 1012.5.1). This section also references the more specific requirements for Group I-2 occupancies in Section 1105.5.4. The minimum width required by that section is 48 inches. See the commentary to Section 1105.5.4.

**1104.16 Fire escape stairways.** Fire escape *stairways* shall comply with Sections 1104.16.1 through 1104.16.7.

❖ This section and the referenced sections provide detailed requirements for fire escape stairways. Fire escape stairways are allowed as a required means of egress only in an existing building, according to Section 405 of the IEBC. Sections 1104.16.1 through 1104.16.7 of the code are similar to Sections 405.1 through 405.5 of the IEBC.

**1104.16.1 Existing means of egress.** Fire escape *stairways* shall be permitted in existing buildings but shall not constitute more than 50 percent of the required *exit* capacity.

❖ Fire escapes are limited to serving 50 percent of the required exit capacity because they have minimum usability and are not appropriate for use by persons with limited physical capability.

**1104.16.2 Protection of openings.** Openings within 10 feet (3048 mm) of fire escape *stairways* shall be protected by opening protectives having a minimum  $\frac{3}{4}$ -hour *fire protection rating*.

**Exception:** In buildings equipped throughout with an *approved automatic sprinkler system*, opening protection is not required.

❖ It is important that openings in the vicinity of a fire escape are protected so that the fire escape will be usable during a fire. The exception for a sprinkler system takes into account the control of the fire by the sprinkler system.

**1104.16.3 Dimensions.** Fire escape *stairways* shall meet the minimum width, capacity, riser height and tread depth as specified in Section 1104.10.

❖ The riser height and tread depth requirement is the same as for existing stairways. The limits are speci-

fied in Section 1104.10; however, the minimum width and occupant capacity are not specified.

**1104.16.4 Access.** Access to a fire escape *stairway* from a *corridor* shall not be through an intervening room. Access to a fire escape *stairway* shall be from a door or window meeting the criteria of Section 1005.1. Access to a fire escape *stairway* shall be directly to a balcony, landing or platform. These shall not be higher than the floor or window sill level and not lower than 8 inches (203 mm) below the floor level or 18 inches (457 mm) below the window sill.

❖ This section establishes the arrangement of the fire escape to the building so that the fire escape can be easily reached. Access is not permitted through a room because the room could pose an unacceptable hazard or be locked. The elevation limits of the exterior landing, balcony or platform are to make the fire escape easily accessible.

**1104.16.5 Materials and strength.** Components of fire escape *stairways* shall be constructed of noncombustible materials. Fire escape *stairways* and balconies shall support the dead load plus a live load of not less than 100 pounds per square foot (4.78 kN/m<sup>2</sup>). Fire escape *stairways* and balconies shall be provided with a top and intermediate *handrail* on each side.

❖ The noncombustible construction requirement is so that the fire escape will be available for use during a fire. The loading of 100 pounds per square foot (psf) (4.78 kN/m<sup>2</sup>) anticipates that a number of persons will be using the fire escape at the same time. To verify the ongoing viability of fire escape stairways, Section 1104.16.5.1 requires tests or field surveys to validate the capacity.

**1104.16.5.1 Examination.** Fire escape *stairways* and balconies shall be examined for structural adequacy and safety in accordance with Section 1104.16.5 by a registered design professional or others acceptable to the *fire code official* every 5 years, or as required by the *fire code official*. An inspection report shall be submitted to the *fire code official* after such examination.

❖ Fire escape stairways are typically prohibited in new construction but do constitute a means of egress component in many existing, multistory buildings. Neither the IBC nor the code contain a specific definition as to what actually constitutes fire escape stairways, and in previous editions of the codes no frequency for their inspection was established. This section establishes an inspection frequency for fire escape stairways and balconies erected on existing buildings. By design, fire escape stairways present a concern to code officials because the stairways, ladders, balconies and mechanical fasteners are commonly constructed of carbon or galvanized steel, which will rust, and this reduces their strength if they are not properly maintained. The evaluation is necessary to confirm that this exterior stairway egress component satisfies a minimum design load requirement prescribed in Section 1104.16.5; is properly maintained; and available for service in the event of an

emergency that requires the occupants to egress the building.

Unless otherwise specified by the fire code official, an inspection of fire escape stairways and their balconies is required every 5 years to verify compliance with the structural requirements of Section 1104.16.5. The individual evaluating fire escapes is required to be a registered design professional as defined in Chapter 2 or an individual approved by the fire code official, and a report of the inspection must be provided to the fire code official.

**1104.16.6 Termination.** The lowest balcony shall not be more than 18 feet (5486 mm) from the ground. Fire escape *stairways* shall extend to the ground or be provided with counterbalanced *stairs* reaching the ground.

**Exception:** For fire escape *stairways* serving 10 or fewer occupants, an *approved* fire escape ladder is allowed to serve as the termination.

❖ This section controls the elevation of the lowest fire escape balcony. For fire escapes that serve 10 or fewer people, a ladder from the lowest balcony to the ground is permitted. In all other cases, the lower balcony is to be served by fire escape stairways. The counterbalance keeps the fire escape stairway up and off ground level when not in use.

**1104.16.7 Maintenance.** Fire escape *stairways* shall be kept clear and unobstructed at all times and shall be maintained in good working order.

❖ This section prohibits using the fire escape for outdoor storage or any other activity that could block its full and instant use. Fire escapes must be kept in good condition so they will be available for use (also see Section 1031.7).

**1104.17 Corridor construction.** Corridors serving an occupant load greater than 30 and the openings therein shall provide an effective barrier to resist the movement of smoke. Transoms, louvers, doors and other openings shall be kept closed or be self-closing. In Group I-2, corridors in areas housing patient sleeping or care rooms shall comply with Section 1105.4.

**Exceptions:**

1. *Corridors* in occupancies other than in Group H, that are equipped throughout with an *approved automatic sprinkler system*.
2. *Corridors* in occupancies in Group E where each room utilized for instruction or assembly has not less than one-half of the required *means of egress* doors opening directly to the exterior of the building at ground level.
3. *Corridors* that are in accordance with the *International Building Code*.

❖ This section relates to Section 1020.1 for new construction. This section requires the corridors to be an effective barrier to resist the movement of smoke. Section 1020.1 for new construction requires that corridors have a fire-resistance rating. Generally, solid

walls and doors that would resist smoke migration are the focus of this section. The walls or doors need not have a fire-resistance rating.

A pointer is provided to the requirements for Group I-2 occupancies in areas where such occupancies contain patient sleeping and care. Section 1105.4 provides specific requirements related to the separation requirements, allowable openings. See the commentary to Section 1105.4.

**1104.17.1 Corridor openings.** Openings in *corridor* walls shall comply with the requirements of the *International Building Code*.

**Exceptions:**

1. Where 20-minute fire door assemblies are required, solid wood doors not less than 1.75 inches (44 mm) thick or insulated steel doors are allowed.
  2. Openings protected with fixed wire glass set in steel frames.
  3. Openings covered with 0.5-inch (12.7 mm) gypsum wallboard or 0.75-inch (19.1 mm) plywood on the room side.
  4. Opening protection is not required where the building is equipped throughout with an *approved automatic sprinkler system*.
- ❖ This section makes reference to the IBC requirements for corridor openings. Section 1020.1 specifies that corridors required to be fire-resistance rated are to be constructed according to Section 708 of the IBC for fire partitions. Section 708.6 of the IBC refers to Section 716 of the IBC for protected openings in smoke partitions. Thus, Section 716 of the IBC applies to existing buildings where a fire-resistance-rated corridor would be required for new construction, except where one of the exceptions in this section applies. The exceptions in this section provide a number of practical alternatives for existing buildings.

**1104.18 Dead end corridors.** Where more than one exit or exit access doorway is required, the *exit access* shall be arranged such that dead ends do not exceed the limits specified in Table 1104.18. In Group I-2, in smoke compartments containing patient sleeping rooms and treatment rooms, dead end *corridors* shall be in accordance with Section 1105.5.6.

**Exception:** A dead-end passageway or *corridor* shall not be limited in length where the length of the dead-end passageway or *corridor* is less than 2.5 times the least width of the dead-end passageway or *corridor*.

- ❖ This section references Table 1104.18 for the dead-end corridor limits for existing buildings. The dead-end limit for new construction is in Section 1020.4. That section includes the same exception that is in this section for existing buildings. Dead-end corridors are not a concern for conditions where the exception is satisfied because travel is not limited to a single path. Generally, the dead-end travel limits in Table 1104.18 are more liberal than those in Section 1020.4 for new construction. Note that Table 1104.18 refers

to Section 1105.5.6 for Group I-2 occupancies with regard to dead-end corridor limits.

**TABLE 1104.18.** See page 11-24.

- ❖ This table contains the existing building limits for common path of travel, dead-end limit and travel distance limits. See the commentary to Sections 1104.18, 1104.19 and 1104.20 for a discussion regarding the table.

**1104.19 Exit access travel distance.** *Exits* shall be located so that the maximum length of exit access travel, measured from the most remote point to an *approved exit* along the natural and unobstructed path of egress travel, does not exceed the distances given in Table 1104.18.

- ❖ This section references Table 1104.18 for the exit access travel distance limits for existing buildings. The travel distance limits for new construction are in Section 1017.1. Generally, the travel distance limits in Table 1104.18 for existing construction are the same as those in Table 1017.2 for new construction, except for Group H and I occupancies.

**1104.20 Common path of egress travel.** The *common path of egress travel* shall not exceed the distances given in Table 1104.18.

- ❖ This section refers to Table 1104.18 for the common path of egress travel for existing buildings. The common path of egress travel limits for new construction are in Section 1006.2.1. Generally, the limits in Table 1104.18 for existing construction are the same as in Section 1006.2.1 for new construction.

**1104.21 Stairway discharge identification.** An interior *exit stairway* or *ramp* that continues below its *level of exit discharge* shall be arranged and marked to make the direction of egress to a *public way* readily identifiable.

**Exception:** *Stairways* that continue one-half story beyond their *levels of exit discharge* need not be provided with barriers where the *exit discharge* is obvious.

- ❖ The requirements of this section are less stringent than the discharge identification requirements for new construction in Section 1023.8. The new construction provisions require that a barrier be placed within the stairway to prevent persons from unintentionally continuing into the levels below the exit discharge. The exception in this section is also not included in the requirements for new construction.

**1104.22 Exterior stairway protection.** *Exterior exit stairways* shall be separated from the interior of the building as required in Section 1027.6. Openings shall be limited to those necessary for egress from normally occupied spaces.

**Exceptions:**

1. Separation from the interior of the building is not required for buildings that are two stories or less above grade where the *level of exit discharge* serving such occupancies is the first story above grade.
2. Separation from the interior of the building is not required where the exterior *stairway* is served by an

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exterior balcony that connects two remote exterior stairways or other approved exits, with a perimeter that is not less than 50 percent open. To be considered open, the opening shall be not less than 50 percent of the height of the enclosing wall, with the top of the opening not less than 7 feet (2134 mm) above the top of the balcony.

3. Separation from the interior of the building is not required for an exterior stairway located in a building or structure that is permitted to have unenclosed interior stairways in accordance with Section 1023.

4. Separation from the open-ended corridors of the building is not required for exterior stairways provided that:

4.1. The open-ended corridors comply with Section 1020.

4.2. The open-ended corridors are connected on each end to an exterior exit stairway complying with Section 1027.

4.3. At any location in an open-ended corridor where a change of direction exceeding 45 degrees (0.79 rad) occurs, a clear opening of not less than 35 square feet (3 m<sup>2</sup>) or an exterior stairway shall be provided. Where clear openings are provided, they shall be located so as to minimize the accumulation of smoke or toxic gases.

❖ The exterior stairway requirements of this section are similar to those for new construction in Section 1027.1, except for Exception 1. Exception 1 in this section applies to all two-story buildings where the level of the exit discharge is the first story above

**TABLE 1104.18  
COMMON PATH, DEAD-END AND TRAVEL DISTANCE LIMITS (by occupancy)**

OCCUPANCY	COMMON PATH LIMIT		DEAD-END LIMIT		TRAVEL DISTANCE LIMIT	
	Unsprinklered (feet)	Sprinklered (feet)	Unsprinklered (feet)	Sprinklered (feet)	Unsprinklered (feet)	Sprinklered (feet)
Group A	20/75 <sup>a</sup>	20/75 <sup>a</sup>	20 <sup>b</sup>	20 <sup>b</sup>	200	250
Group B <sup>h</sup>	75	100	50	50	200	300
Group E	75	75	20	50	200	250
Group F-1, S-1 <sup>d, h</sup>	75	100	50	50	200	250
Group F-2, S-2 <sup>d, h</sup>	75	100	50	50	300	400
Group H-1	25	25	0	0	75	75
Group H-2	50	100	0	0	75	100
Group H-3	50	100	20	20	100	150
Group H-4	75	75	20	20	150	175
Group H-5	75	75	20	50	150	200
Group I-1	75	75	20	50	200	250
Group I-2	Notes e, g	Notes e, g	Note f	Note f	150	200 <sup>c</sup>
Group I-3	100	100	NR	NR	150 <sup>c</sup>	200 <sup>c</sup>
Group I-4 (Day care centers)	NR	NR	20	20	200	250
Group M (Covered or open mall)	75	100	50	50	200	400
Group M (Mercantile)	75	100	50	50	200	250
Group R-1 (Hotels)	75	75	50	50	200	250
Group R-2 (Apartments)	75	125	50	50	200	250
Group R-3 (One- and two-family)	NR	NR	NR	NR	NR	NR
Group R-4 (Residential care/assisted living)	NR	NR	NR	NR	NR	NR
Group U <sup>h</sup>	75	100	20	50	300	400

NR = No requirements.

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>.

a. 20 feet for common path serving 50 or more persons; 75 feet for common path serving less than 50 persons.

b. See Section 1029.9.5 for dead-end aisles in Group A occupancies.

c. This dimension is for the total travel distance, assuming incremental portions have fully utilized their allowable maximums. For travel distance within the room, and from the room exit access door to the exit, see the appropriate occupancy chapter.

d. See the *International Building Code* for special requirements on spacing of doors in aircraft hangars.

e. In Group I-2, separation of exit access doors within a care recipient sleeping room, or any suite that includes care recipient sleeping rooms, shall comply with Section 1105.5.7.

f. In Group I-2, in smoke compartments containing care recipient sleeping rooms and treatment rooms, dead-end corridors shall comply with Section 1105.5.6.

g. In Group I-2 Condition 2, care recipient sleeping rooms, or any suite that includes care recipient sleeping rooms, shall comply with Section 1105.6.

h. Where a tenant space in Group B, S and U occupancies has an occupant load of not more than 30, the length of a common path of egress travel shall not be more than 100 feet.

grade. In new buildings, Group R-1 and R-2 occupancies would not be allowed to apply this exception. Exception 3 has been deleted from the new construction requirements. Exception 4 does not have requirements for the building to be sprinklered or a reference to Section 1023.7 for exterior walls.

**1104.23 Minimum aisle width.** The minimum clear width of *aisles* shall be:

1. Forty-two inches (1067 mm) for aisle stairs having seating on each side.

**Exception:** Thirty-six inches (914 mm) where the *aisle* serves less than 50 seats.

2. Thirty-six inches (914 mm) for stepped *aisles* having seating on only one side.

**Exceptions:**

1. Thirty inches (760 mm) for catchment areas serving not more than 60 seats.
2. Twenty-three inches (584 mm) between a stepped aisle *handrail* and seating where an *aisle* does not serve more than five rows on one side.

3. Twenty inches (508 mm) between a stepped *aisle handrail* or *guard* and seating where the *aisle* is subdivided by the *handrail*.

4. Forty-two inches (1067 mm) for level or ramped *aisles* having seating on both sides.

**Exception:** Thirty-six inches (914 mm) where the *aisle* serves less than 50 seats.

5. Thirty-six inches (914 mm) for level or ramped *aisles* having seating on only one side.

**Exception:** Thirty inches (760 mm) for catchment areas serving not more than 60 seats.

6. In Group I-2, where *aisles* are used for movement of patients in beds, *aisles* shall comply with Section 1105.5.8.

❖ Items 1 through 5 in this section primarily provide the minimum aisle widths for assembly seating. Similar requirements for new construction are in Section 1029.9.1. Several of the exceptions in this section allow for narrower aisles than permitted in Section 1029.9.1; thus, the requirements for existing buildings are less stringent than those for new construction. Item 6 of this section is a pointer to the specific aisle requirements for Group I-2 occupancies where aisles are used for movement of people. See the commentary to Section 1105.5.8.

**1104.24 Stairway floor number signs.** Existing *stairways* shall be marked in accordance with Section 1023.9.

❖ This section requires that existing stairs be marked in the same manner as new stairways (see commentary, Section 1023.9). The signage includes important information for people evacuating the building as well emergency responders.

**1104.25 Egress path markings.** Existing high-rise buildings of Group A, B, E, I, M and R-1 occupancies shall be provided with luminous *egress* path markings in accordance with Section 1025.

**Exception:** Open, unenclosed stairwells in historic buildings designated as historic under a state or local historic preservation program.

❖ This section requires that luminous exit path markings be provided in existing buildings on the same basis as in new buildings to facilitate rapid egress and assist in full building evacuation. The text is based on Recommendations 17 and 18 of the National Institute of Standards and Technology's (NIST) report on the World Trade Center (WTC) tragedy. In New York City, after the first bombing of the WTC, requirements were instituted to require exit path markings in vertical exit enclosures in new and existing buildings. This section is taken directly from those requirements.

The marking requirement is only applicable to those buildings that have occupied floors exceeding 75 feet (22 860 mm) above the lowest level of fire department vehicle access. The cost impact on existing buildings is minor when considering the life safety benefit. Therefore, it is logical and affordable to provide existing high-rise buildings with the same protections afforded new high-rise structures.

Historically, code requirements for high-rise buildings were written under the assumption that the building would be evacuated floor by floor. In most instances, in a building with a full suppression system, only the floor where the fire is located and the floors immediately above and below would be evacuated. Acts of terrorism and accidental incidents, such as power failures, have made it necessary to consider design for full building evacuation that is as rapid as possible. This may be made necessary in response to events both within and outside the building. This provision is intended to facilitate the most rapid possible full building evacuation. See the commentary to Section 1025 for a more complete discussion of luminous egress path markings.

The exception takes into account the aesthetics and possible natural light in an open, unenclosed stairway in a historic building. Also, since the requirement is only applicable to high-rise buildings, the requirement would have limited application in historic structures.

## SECTION 1105 CONSTRUCTION REQUIREMENTS FOR EXISTING GROUP I-2

**1105.1 General.** Existing Group I-2 shall meet all of the following requirements:

1. The minimum fire safety requirements in Section 1103.
2. The minimum mean of egress requirements in Section 1104.

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3. The additional egress and construction requirements in Section 1105.

Where the provisions of this chapter conflict with the construction requirements that applied at the time of construction, the most restrictive provision shall apply.

❖ This section provides minimum requirements for existing Group I-2 occupancies. The intent is to increase the minimum safety requirements because of the fragile and sensitive populations within these facilities. These requirements are meant to be applied retroactively. These provisions align with the current approach by the Center for Medicaid and Medicare Services (CMS), the federal authority having jurisdiction. Hospitals are required by CMS to have a life safety survey on a regular basis. If the facility does not meet certain life safety minimums, they are required to upgrade their existing facility. This code change will align the code with those CMS minimum requirements and will hopefully lead to industry consolidation. These retroactive requirements are provided to assist code officials and surveyors during the ongoing regular inspection of hospital facilities and are consistent with the inspections required by federal laws for certification and reimbursement. The requirements reflect consideration of the minimum previously approved construction methods and provide jurisdictions the ability to adopt minimum retroactive provisions that have been vetted by the industry as well as code officials. In addition, these provisions are consistent with current national standards used by the federal government, providing a more uniform level of safety and eliminating many of the current code conflicts for existing facilities.

Several sources were reviewed to determine what the appropriate minimum bar should be, including the current building and fire codes, current CMS guidelines, and previous versions of the model codes. On all issues, enforcement agencies and the regulated facilities weighed in to ensure that these requirements were both necessary and achievable.

This particular section provides scoping for these provisions. Areas in hospitals and nursing homes not in patient care areas will use the general provisions in Sections 1103 and 1104. More restrictive provisions for hospitals or nursing homes are listed in Section 1105. As stated in the general comments at the beginning of this chapter and the commentary to Sections 1101.2 and 1103.5.2, where the buildings must upgrade, consideration of allowable time frames and procedures will need to be worked out between the authority having jurisdiction and those responsible for repairs and alterations in the nursing homes and hospitals.

**1105.2 Construction.** Group I-2 Condition 2 shall not be located on a floor level higher than the floor level limitation in Table 1105.2 based on the type of construction.

❖ Section 1105.2 is a retroactive limitation for the allowable height based on construction type because it is a

key component of the regulatory approval for a health care facility. While most, if not all, existing hospitals were built to comply with these minimum construction requirements, many were built using methods that predated the current construction type matrix. The allowance for the occupancies, as stipulated in Table 1105.2, are less than that for new construction and are consistent with what is currently mandated for licensure for healthcare facilities.

**1105.3 Incidental uses in existing Group I-2.** Incidental uses associated with and located within existing single-occupancy or mixed-occupancy Group I-2 buildings and that generally pose a greater level of risk to such occupancies shall comply with the provisions of Sections 1105.3.1 through 1105.3.3.2.1. Incidental uses in Group I-2 occupancies are limited to those listed in Table 1105.3.

❖ Incidental use area provisions are applicable to new construction in Section 509 of the IBC; however, similar provisions are needed for existing Group I-2 occupancies since the hazards posed by such rooms or spaces are no different for existing buildings than for new. Section 1105.3 and Table 1105.3 are very similar to and based upon IBC Section 509 and Table 509, except that references to occupancies other than Group I-2 are not included. The basic requirements proposed for incidental uses in existing healthcare occupancies rely on the provisions of the IBC for specifics of construction and protection. Sections 1105.3.1 through 1105.3.3.2.1 are based on IBC Sections 509.2 through 509.4.2.1. These provisions will provide correlation with not only the IBC but also with the operational and CMS program standards for existing Group I-2 occupancies.

This specific section establishes the scope of Section 1105.3 and its applicability to Group I-2 occupancies. Incidental uses are rooms or areas that constitute special hazards or risks to life safety that are not typically addressed by the provisions for the occupancy group in which they occur, even though such rooms or areas may functionally be an extension of the primary use. Only those rooms or areas indicated in Table 1105 are to be regulated as incidental uses. Incidental uses can be located within both single-occupancy and mixed-occupancy buildings. The concern is that those areas designated as incidental uses pose a risk to the remainder of the building, and as such, some degree of protection is required. The nature of these incidental uses is such that they are small areas not frequented by building occupants, in which a fire could get underway and go unnoticed for a longer time than in a more frequently occupied part of the building.

**1105.3.1 Occupancy classification.** Incidental uses shall not be individually classified in accordance with Section 302.1 of the *International Building Code*. Incidental uses shall be included in the building occupancies within which they are located.

❖ Consistent with the IBC, this section expressly states that incidental uses are not considered as separate

and distinct occupancy classifications but, rather, are classified the same as the occupancies in which they are located. As an example, a waste and linen collection room in a hospital would be classified as a portion of the Group I-2 occupancy even though it may present a level of hazard more akin to a Group S-1 occupancy.

**1105.3.2 Area limitations.** Incidental uses shall not occupy more than 10 percent of the building area of the story in which they are located.

❖ The proposed floor area limitation of 10 percent for incidental uses emphasizes the ancillary nature of such rooms and areas and correlates with the IBC. Each incidental use would be limited to a maximum floor area of 10 percent of the floor area of the story in which it is located. Where there are two or more tenants located on the same story, the 10-percent limitation is based on the floor area of each individual tenant space rather than that of the entire story. The application of the limit on a tenant-by-tenant basis is consistent with the concept of incidental uses typically being ancillary only to a portion of the building (i.e., the specific tenant occupancy).

**1105.3.3 Separation and protection.** The incidental uses listed in Table 1105.3 shall be separated from the remainder

of the building or equipped with an *automatic sprinkler system*, or both, in accordance with the provisions of that table.

❖ In addition to identifying those rooms or areas that warrant regulation as incidental uses, Table 1105.3 also indicates the required degree of protection or separation. The requirements identified in Table 1105.3 vary depending on the incidental use. In some cases, a specific type of separation and/or protection is required, while in others there is an option.

**1105.3.3.1 Separation.** Where Table 1105.3 specifies a fire-resistance-rated separation, the incidental uses shall be separated from the remainder of the building in accordance with Section 509.4.1 of the *International Building Code*.

❖ Where a fire-resistance rated separation would be required, the incidental use would need to be separated from other portions of the building in accordance with assemblies complying with the IBC.

**1105.3.3.2 Protection.** Where Table 1105.3 permits an *automatic sprinkler system* without a fire-resistance-rated separation, the incidental uses shall be separated from the remainder of the building by construction capable of resisting the passage of smoke in accordance with Section 509.4.2 of the *International Building Code*.

❖ In this section, where Table 1105.1 would allow protection by an automatic sprinkler system without a

**TABLE 1105.2  
FLOOR LEVEL LIMITATIONS FOR GROUP I-2 CONDITION 2**

CONSTRUCTION TYPE	AUTOMATIC SPRINKLER SYSTEM	ALLOWABLE FLOOR LEVEL <sup>a</sup>			
		1	2	3	4 or more
IA	Note b	P	P	P	P
	Note c	P	P	P	P
IB	Note b	P	P	P	P
	Note c	P	P	P	P
IIA	Note b	P	P	P	NP
	Note c	P	NP	NP	NP
IIB	Note b	P	P	NP	NP
	Note c	NP	NP	NP	NP
IIIA	Note b	P	P	NP	NP
	Note c	P	NP	NP	NP
IIIB	Note b	P	NP	NP	NP
	Note c	NP	NP	NP	NP
IV	Note b	P	P	NP	NP
	Note c	NP	NP	NP	NP
VA	Note b	P	P	NP	NP
	Note c	NP	NP	NP	NP
VB	Note b	P	NP	NP	NP
	Note c	NP	NP	NP	NP

P = Permitted; NP = Not permitted.

a. Floor level shall be counted based on the number of stories above grade.

b. The building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

c. The building is equipped with an automatic sprinkler system in accordance with Section 1105.8.

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fire-resistance-rated separation, the construction enclosing the incidental use would still need to resist the passage of smoke. Construction details for resisting the passage of smoke are provided in the IBC. Note that this requirement is not specifying a smoke partition. The smoke partition requirements in IBC Section 710 are specific requirements that must be directly referenced.

**1105.3.3.2.1 Protection limitation.** Except as otherwise specified in Table 1105.2 for certain incidental uses, where an *automatic sprinkler system* is provided in accordance with Table 1105.3, only the space occupied by the incidental use need be equipped with such a system.

❖ This section makes it clear that the sprinkler systems stipulated in Table 1105.3 would be required for the incidental use area only.

**1105.4 Corridor construction.** In Group I-2, in areas housing patient sleeping or care rooms, *corridor* walls and the opening protectives therein shall provide a barrier designed to resist the passage of smoke in accordance with Sections 1105.4.1 through 1105.4.7.

❖ The focus of this section is specifically for corridor construction in patient care and sleeping room areas in Group I-2 occupancies. The construction of corridors is intended to provide protection that will resist the passage of smoke. The provisions address the type of materials required, fire resistance rating requirements, opening protection and corridor wall continuity.

Existing corridor construction should primarily be evaluated for its ability to resist or limit the transfer of smoke, regardless of the code at the time of construction. This is consistent with the defend-in-place scenario for patient protection during a fire event (see Section 405). Corridor walls, even if they were built 60 years ago, should be regularly assessed to confirm that they minimize the transfer of smoke. This section describes some criteria by which this can be assessed.

**1105.4.1 Materials.** The walls shall be of materials permitted by the building type of construction.

❖ This section simply requires that the materials used to construct the corridors be consistent with the type of construction. If it is a noncombustible construction (Type I or II), the walls must be constructed in accordance with Table 601 of the IBC unless Section 603 of the IBC provides any exceptions.

**1105.4.2 Fire-resistance rating.** Unless required elsewhere in this code, corridor walls are not required to have a fire-resistance rating.

❖ The key with corridor walls is more about the resistance of the passage of smoke and less about the fire resistance. This section clarifies that these walls are not required to be fire-resistance rated unless another requirement, such as for a smoke barrier or incidental use area separation, would prompt such fire-resistance rating.

**TABLE 1105.3  
INCIDENTAL USES IN EXISTING GROUP I-2 OCCUPANCIES**

ROOM OR AREA	SEPARATION AND/OR PROTECTION
Furnace room where any piece of equipment is over 400,000 Btu per hour input	1 hour or provide automatic sprinkler system
Rooms with boilers where the largest piece of equipment is over 15 psi and 10 horsepower	1 hour or provide automatic sprinkler system
Refrigerant machinery room	1 hour or provide automatic sprinkler system
Hydrogen fuel gas rooms, not classified as Group H	2 hours
Incinerator rooms	2 hours and provide automatic sprinkler system
Paint shops not classified as Group H	2 hours; or 1 hour and provide automatic sprinkler system
Laboratories and vocational shops, not classified as Group H	1 hour or provide automatic sprinkler system
Laundry rooms over 100 square feet	1 hour or provide automatic sprinkler system
Patient rooms equipped with padded surfaces	1 hour or provide automatic sprinkler system
Physical plant maintenance shops	1 hour or provide automatic sprinkler system
Waste and linen collection rooms with containers with total volume of 10 cubic feet or greater	1 hour or provide automatic sprinkler system
Storage rooms greater than 100 square feet	1 hour or provide automatic sprinkler system
Stationary storage battery systems having a liquid electrolyte capacity of more than 50 gallons for flooded lead-acid, nickel cadmium or VRLA, or more than 1,000 pounds for lithium-ion and lithium metal polymer used for facility standby power, emergency power or uninterruptible power supplies	2 hours

For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square inch (psi) = 6.9 kPa, 1 British thermal unit (Btu) per hour = 0.293 watts, 1 horsepower = 746 watts, 1 gallon = 3.785 L.

**1105.4.3 Corridor wall continuity.** *Corridor* walls shall extend from the top of the foundation or floor below to one of the following:

1. The underside of the floor or roof sheathing, deck or slab above.
  2. The underside of a ceiling above where the ceiling membrane is constructed to limit the passage of smoke.
  3. The underside of a lay-in ceiling system where the ceiling system is constructed to limit the passage of smoke and where the ceiling tiles weigh not less than 1 pound per square foot (4.88 kg/m<sup>2</sup>) of tile.
- ❖ As discussed in Section 1105.4.2, providing a barrier is the key to corridor effectiveness. Section 1105.4.2 does not require a fire-resistance rating for existing corridors, but the separation that the corridor provides needs to be continuous to a point where the separated spaces are protected. This section provides three solutions to achieve this. The first focuses simply on extending all the way to the floor or roof sheathing, deck or slab above. The other options allow the separation to stop at the finished ceiling. The conditions of ending the separation at the ceiling membrane are conditioned on the ceiling being able to resist the passage of smoke. In the case of lay-in ceilings they must also meet the minimum weight requirement to increase the likelihood that they will stay in place.

**1105.4.4 Openings in corridor walls.** Openings in *corridor* walls shall provide protection in accordance with 1105.4.4.1 through 1105.4.4.3.

❖ Openings in corridor walls present the largest failures of such separations. This section addresses both windows and doors located in corridor walls. Again, these provisions are intended to address the condition of existing walls and may not be consistent with new construction.

**1105.4.4.1 Windows.** Windows in *corridor* walls shall be sealed to limit the passage of smoke, or the window shall be automatic-closing upon detection of smoke, or the window opening shall be protected by an automatic closing device that closes upon detection of smoke.

**Exception:** In smoke compartments not containing patient sleeping rooms, pass-through windows or similar openings shall be permitted in accordance with Section 1105.4.4.3.

❖ Windows must effectively employ one of the three following methods to resist the passage of smoke:

- Proper sealing.
- Automatic closing on detection of smoke (smoke detection system).
- Automatic closing by automatic closing device (single-station smoke detector).

The exception addresses lower risk areas where no patient sleeping rooms are present.

**1105.4.4.2 Doors.** Doors in *corridor* walls shall comply with Sections 1105.4.4.2.1 through 1105.4.4.2.3.

❖ This section addresses various different issues related to doors in corridor walls. These provisions provide some basic safety while providing flexibility in existing hospitals. As with the other provisions, these requirements and allowances are consistent with federal compliance requirements.

**1105.4.4.2.1 Louvers.** Doors in *corridor* walls shall not include louvers, transfer grills or similar openings.

**Exception:** Doors shall be permitted to have louvers, transfer grills or similar openings at toilet rooms or bathrooms; storage rooms that do not contain storage of flammable or combustible material; and storage rooms that are not required to be separated as incidental uses.

❖ Louvers, transfer grilles or similar openings present an increased risk of smoke passing into protected spaces. Therefore, these openings are generally prohibited. The exception addresses spaces where passage of smoke presents a reduced risk as such spaces are not typically occupied or their occupancy is limited.

**1105.4.4.2.2 Corridor doors.** Doors in *corridor* walls shall limit the transfer of smoke by complying with the following:

1. Doors shall be constructed of not less than 1<sup>3</sup>/<sub>4</sub> inch-thick (44 mm) solid bonded-core wood or capable of resisting fire not less than 1/3 hour.

**Exception:** Corridor doors in buildings equipped throughout with an automatic sprinkler system.

2. Frames for side-hinged swinging doors shall have stops on the sides and top to limit transfer of smoke.
3. Where provided, vision panels in doors shall be a fixed glass window assembly installed to limit the passage of smoke. Existing wired glass panels with steel frames shall be permitted to remain in place.
4. Door undercuts shall not exceed 1 inch (25 mm).
5. Doors shall be positive latching with devices that resist not less than 5 pounds (22.2 N). Roller latches are prohibited.
6. Mail slots or similar openings shall be permitted in accordance with Section 1105.4.4.3.

❖ This section provides the list of necessary requirements that existing doors in corridors must meet. Often the criteria provide some allowances not given for new construction. All criteria must be addressed if applicable.

Item 1 requires a door to be of substantial construction in nonsprinklered buildings. Either a 1/3-hour fire-rated door is required or an equivalent door is prescribed. The exception allows no rating for the door in buildings equipped throughout with an automatic sprinkler system.

Item 2 requires frames to have stops on the sides and top to minimize the transfer of smoke on swinging doors.

Item 3 addresses vision panels. This item allows wired glass panels in steel frames to continue to be used where they would not be allowed in new construction.

Item 4 minimizes door undercuts to 1 inch to prevent additional smoke passage.

Item 5 addresses how such doors are required to latch. Roller latches are prohibited as they may be compromised during a fire event and lead to the door opening.

Item 6 is consistent with Section 1105.4.4.3 and allows mail slots or similar openings under certain conditions for doors in corridors.

**1105.4.4.2.3 Dutch doors.** Where provided, dutch doors shall comply with Section 1105.4.4.2.2. In addition, dutch doors shall be equipped with latching devices on either the top or bottom leaf to allow leaves to latch together. The space between the leaves shall be protected with devices such as astragals to limit the passage of smoke.

❖ Dutch doors have been used in health care facilities for many years for various necessary operational reasons. While the IBC does not specifically speak of dutch doors, their use is not prohibited but must meet the requirements contained in IBC Section 407.3, including positive latching and limiting the transfer of smoke. This section provides clarity for existing installations by giving specific guidance on the minimum acceptable requirements, including positive latching and smoke transfer, for their use in corridor walls. A definition is provided in Section 202 for further clarity.

**1105.4.4.2.4 Self- or automatic-closing doors.** Where self- or automatic-closing doors are required, closers shall be maintained in operational condition.

❖ This section is provided to make sure that self- or automatic-closing doors continue to be operational. If automatic-closing doors that are no longer operational are propped open, the function of the corridor is reduced. It is important to note that this section does not require self-closing or automatic-closing doors; it is simply requiring that they be maintained.

**1105.4.4.3 Openings in corridor walls and doors.** In other than smoke compartments containing patient sleeping rooms, mail slots, pass-through windows or similar openings shall not be required to be protected where the aggregate area of the openings between the *corridor* and a room are not greater than 80 square inches (51 613 mm<sup>2</sup>) and are located with the top edge of any opening not higher than 48 inches above the floor.

❖ This section is essentially an exception for existing mail slot, pass-through and similar openings that are commonly found in hospitals. These are needed for privacy, medication security and other operational needs. The restrictions on their location are consistent with federal requirements.

**1105.4.5 Penetrations.** The space around penetrating items shall be filled with an *approved* material to limit the passage of smoke.

❖ Penetrations, though smaller than door and window openings, can create locations for smoke to pass through and must be addressed. Group I-2 occupancies often have many pipes penetrating walls that must be addressed. Many smaller openings can lead to a larger overall area of smoke passage.

**1105.4.6 Joints.** Joints shall be filled with an *approved* material to limit the passage of smoke.

❖ Similar to penetrations, joints that are formed at the intersections of walls and floor/ceiling assemblies and roof assemblies can create other avenues of smoke passage. If not addressed, these small openings can lead to a hazard during building fires.

**1105.4.7 Ducts and air transfer openings.** The space around a duct penetrating a smoke partition shall be filled with an *approved* material to limit the passage of smoke. Air transfer openings in smoke partitions shall be provided with a smoke damper complying with Section 717.3.2.2 of the *International Building Code*.

**Exception:** Where the installation of a smoke damper will interfere with the operation of a required smoke control system in accordance with Section 909, approved alternative protection shall be utilized.

❖ Anytime a duct penetrates a wall, the space around the duct must be minimally protected to prevent smoke passage during fire. Group I-2 occupancies may have complex HVAC systems that can lead to a multitude of ducts passing through walls. Air transfer openings through corridor walls need to be protected with smoke dampers in accordance with IBC Section 717.3.2.2 unless such dampers will affect the performance of a smoke control system.

**1105.5 Means of egress.** In addition to the *means of egress* requirements in Section 1104, Group I-2 facilities shall meet the *means of egress* requirements in Section 1105.5.1 through 1105.5.8.

❖ These provisions are intended to provide minimal means of egress requirements specific to Group I-2 occupancies, where these occupancies work on a defend-in-place strategy and the needs are unique. Sections 1105.5.1 through 1105.5.8 address a variety of issues, such as exit signs, emergency illumination, door size, corridor width, dead ends and exit separation.

**1105.5.1 Exit signs and emergency illumination.** The power system for exit signs and emergency illumination for the *means of egress* shall provide power for not less than 90 minutes and consist of storage batteries, unit equipment or an on-site generator.

❖ Existing hospitals must provide 90 minutes of power for exit signs and emergency illumination. However,

this power can be provided via storage batteries where this would not be permitted by Exception 2 to Section 1013.6.3 for new buildings.

**1105.5.2 Emergency power for operational needs.** The essential electrical system shall be capable of supplying services in accordance with NFPA 99.

❖ This section takes the provisions of Section 1104.5.1 further by adding requirements from and references to NFPA 99. Similar to Section 604.3, it requires facility owners or operators to analyze the hazards in their particular region and prepare accordingly.

**1105.5.3 Size of door.** Means of egress doors used for the movement of patients in beds shall provide a minimum clear width of 41½ inches (1054 mm). The height of the door opening shall be not less than 80 inches (2032 mm).

**Exceptions:**

1. Door closers and door stops shall be permitted to be 78 inches (1981 mm) minimum above the floor.
2. In Group I-2 Condition 1, existing means of egress doors used for the movement of patients in beds that provide a minimum clear width of 32 inches (813 mm) shall be permitted to remain.

❖ This section is consistent with Section 1104.7. It follows the format and requirements of Section 1010.1.1. There are two exceptions that allow the door closers and door stops to not meet the door-opening height. This is a reasonable allowance for existing buildings and is consistent with Exception 5 to Section 1010.1.1, which allows door-opening heights in dwelling units and sleeping units to be 78 inches. The second exception provides flexibility to Group I-2 Condition 1 occupancies such as nursing homes, which do not depend upon these door widths being available as frequently for bed movement.

**1105.5.4 Ramps.** In areas where *ramps* are used for movement of patients in beds, the clear width of the *ramp* shall be not less than 48 inches (1219 mm).

❖ This section, which is referenced from Section 1104.15, provides the width necessary for ramps in Group I-2 occupancies where beds are being moved. Section 1104.15 only requires a 30-inch width.

**1105.5.5 Corridor width.** In areas where *corridors* are used for movement of patients in beds, the clear width of the *corridor* shall be not less than 48 inches (1219 mm).

❖ This section is consistent with the width required for ramps in Section 1105.5.4 and is focused on the width required for the movement of beds. The requirement of 48 inches clear width is less restrictive than that required of new construction in Section 1020.2. New Group I-2 occupancies are required a 96-inch clear width.

**1105.5.6 Dead-end corridors.** In smoke compartments containing patient sleeping rooms and treatment rooms, dead-end

*corridors* shall not exceed 30 feet (9144 mm) unless approved by the *fire code official*.

❖ The dead-end corridor requirements are specific to Group I-2 occupancies. Typically in new construction the dead-end corridor would be limited to 20 feet. This provides more flexibility but is consistent with the CMS requirements.

**1105.5.7 Separation of exit access doors.** Patient sleeping rooms, or any suite that includes patient sleeping rooms, of more than 1,000 square feet (92.9 m<sup>2</sup>) shall have not less than two exit access doors placed a distance apart equal to not less than one-third of the length of the maximum overall diagonal dimension of the patient sleeping room or suite to be served, measured in a straight line between exit access doors.

❖ This requirement addresses the need for exit separation in larger patient sleeping rooms and suites. Once they become large enough, the need for two exits becomes more important. This section is less restrictive than Section 1007.1.1 by only requiring ⅓ the diagonal of the space versus ½. This requirement may result in the need for an additional exit access door in such spaces.

**1105.5.8 Aisles.** In areas where *aisles* are used for movement of patients in beds, the clear width of the *aisle* shall be not less than 48 inches (1219 mm).

❖ This requirement is consistent with the widths established for ramps and corridors in Sections 1105.5.4 and 1105.5.5, respectively. Again, this width is associated with areas where bed movement will occur.

**1105.6 Smoke compartments.** Smoke compartments shall be provided in existing Group I-2 Condition 2, in accordance with Sections 1105.6.1 through 1105.6.4.

❖ Smoke compartments are a key component of the defend-in-place strategy, a strategy where occupants are protected from fire without relocation, used in healthcare facilities to limit the movement of smoke. These compartments act as safe locations for patients by preventing the spread of smoke. Through compartmentalization, patients may remain safely in their rooms as fire suppression systems and fire responders extinguish the fire. Under severe fire conditions that threaten the immediate compartment area, patients may be evacuated horizontally to the safety of an adjacent compartment on the same floor. Being able to do this is critical since, because of the health status of many patients, their evacuation from the building might put them in danger. The proper design, construction and application of smoke compartments will provide added protection, buy valuable time and save lives of critically ill patients before a total evacuation may become necessary.

These requirements are provided to assist code officials and surveyors during the ongoing regular inspection of hospital facilities. These inspections are required by federal laws for certification and reim-

bursement. These requirements consider the minimum previously approved construction methods. This is consistent with the federal requirements to which these facilities are currently held. Sections 1105.6.1 through 1105.6.6 provide all the necessary elements for existing facilities.

**1105.6.1 Design.** Smoke barriers shall be provided to subdivide each story used for patients sleeping with an occupant load of more than 30 patients into not fewer than two smoke compartments.

❖ The defend-in-place concept is a basic minimum level of safety for these facilities. Every facility should be equipped with at least two smoke compartments for temporary relocation of patients. This section addresses acceptable configurations of smoke barrier walls and smoke barriers in existing hospitals for each story with sleeping rooms accommodating 30 or more patients.

**1105.6.1.1 Refuge areas.** Refuge areas shall be provided within each smoke compartment. The size of the refuge area shall accommodate the occupants and care recipients from the adjoining smoke compartment. Where a smoke compartment is adjoined by two or more smoke compartments, the minimum area of the refuge area shall accommodate the largest occupant load of the adjoining compartments.

The size of the refuge area shall provide the following:

1. Not less than 30 net square feet (2.8 m<sup>2</sup>) for each care recipient confined to a bed or stretcher.
2. Not less than 15 square feet (1.4 m<sup>2</sup>) for each resident in a Group I-2 using mobility assistance devices.
3. Not less than 6 square feet (0.56 m<sup>2</sup>) for each occupant not addressed in Items 1 and 2.

Areas of spaces permitted to be included in the calculation of the refuge area are *corridors*, sleeping areas, treatment rooms, lounge or dining areas and other low-hazard areas.

❖ This section addresses adequate sizing of refuge areas. IBC Section 407.5.1 also includes requirements for sizing refuge areas. Otherwise, the provisions are fairly consistent.

**1105.6.2 Smoke barriers.** Smoke barriers shall be constructed in accordance with Section 709 of the *International Building Code*.

**Exceptions:**

1. Existing smoke barriers are permitted to remain where the existing smoke barrier has a minimum fire-resistance rating of 1/2 hour.
2. Smoke barriers shall be permitted to terminate at an atrium enclosure in accordance with Section 404.6 of the *International Building Code*.

❖ Generally, compliance with the IBC is required for smoke barriers. However, the intent of the first exception is to bring noncompliant smoke barriers to at least 1/2-hour fire-resistance rating. Previously approved smoke barriers are not intended to be

reduced to 1/2 hour. Chapter 7 requires maintenance of approved construction. The second exception addresses termination of the smoke barrier. Typically, smoke barriers are required to terminate at outside walls.

**1105.6.3 Opening protectives.** Openings in smoke barriers shall be protected in accordance with Section 716 of the *International Building Code*. Opening protectives shall have a minimum fire-protection-rating of 1/3 hour.

**Exception:** Existing wired glass vision panels in doors shall be permitted to remain.

❖ This section addresses doors in smoke barriers in existing Group I-2 occupancies. This section requires compliance as applicable with Section 716. The rating of doors is required to be a minimum of 20 minutes. Openings in doors with wired glass are permitted to remain.

**1105.6.4 Penetrations.** Penetrations of smoke barriers shall comply with the *International Building Code*.

**Exception:** Approved existing materials and methods of construction.

❖ Penetrations, as with corridor construction, can be numerous and lead to smoke movement from one smoke compartment to another. This section requires that such penetrations be dealt with in accordance with the IBC. Sealing penetrations is a reasonable requirement to increase patient safety. There is some flexibility provided if such penetrations have already been addressed to the satisfaction of the fire code official.

**1105.6.5 Joints.** Joints made in or between smoke barriers shall comply with the *International Building Code*.

**Exception:** Approved existing materials and methods of construction.

❖ Joints formed by the intersection of smoke barriers and floor/ceiling and roof assemblies can often create gaps where smoke can spread. This simply requires compliance with the IBC to protect those joints. Similar to Section 1105.6.4 addressing penetrations, there is some flexibility provided if such joints have already been addressed to the satisfaction of the fire code official.

**1105.6.6 Duct and air transfer openings.** Penetrations in a smoke barrier by duct and air transfer openings shall comply with Section 717 of the *International Building Code*.

**Exception:** Where existing duct and air transfer openings in smoke barriers exist without smoke dampers, they shall be permitted to remain. Any changes to existing smoke dampers shall be submitted for review and approved in accordance with Section 717 of the *International Building Code*.

❖ Similar to penetrations and joints, where ducts and air transfer openings penetrate a smoke barrier they must be sealed in accordance with the IBC. IBC Section 717.5.5 requires a smoke damper unless Exception 2 to that section is met. Exception 2 to Section

717.5.5 recognizes a fully ducted system in a building equipped throughout with an automatic sprinkler system. See the commentary to IBC Section 717.5.5. The application of that exception is limited to Group I-2 Condition 2 occupancies.

The exception to this section recognizes that existing duct and air transfer openings may be permitted to remain without smoke dampers. Any modification of existing smoke dampers would have to go through the normal process for making an alteration to existing construction. The exception is not intended to allow the removal of existing smoke dampers but instead allow the continuance of existing conditions that did not require them.

**1105.7 Group I-2 care suites.** Care suites in existing Group I-2 Condition 2 occupancies shall comply with Sections 407.4.3 through 407.4.3.6.2 of the *International Building Code*.

❖ This proposal defines the requirements for care suites (both sleeping and nonsleeping) that are an integral design concept for many areas within a hospital. Typical uses include intensive care units, operating rooms, emergency departments and imaging departments. The suites allow for better and safer care than non-suite options. These provisions deal with common paths of travel, separation of exit access doors, and number of doors passed through (i.e., previously intervening rooms) in suites. See the commentary to Sections 407.4.3 through 407.4.3.6.2 of the IBC.

**1105.8 Group I-2 automatic sprinkler system.** An *automatic sprinkler system* installed in accordance with Section 903.3.1.1 shall be provided throughout existing Group I-2 fire areas. The sprinkler system shall be provided throughout the floor where the Group I-2 occupancy is located, and in all floors between the Group I-2 occupancy and the *level of exit discharge*.

❖ This section requires that an automatic sprinkler system be provided on the floor containing the Group I-2 occupancy and all floors between that level and the level of exit discharge. This is a general requirement for all Group I-2 occupancies. Automatic sprinkler protection of existing Group I-2 occupancies is of critical importance due to the nature of the occupants. In Group I-2 occupancies, the occupants are, by definition, considered not capable of self-preservation. The evacuation difficulties associated with these occupants create the need to incorporate a defend-in-place philosophy of fire protection in occupancies in Group I-2. For this reason, all such existing occupancies are to be protected with an automatic sprinkler system.

This is an especially important requirement for nursing homes. An NFPA report, *Facilities that Care for the Aged Including Nursing Homes and Residential Board and Care*, states, "The death rate per 1,000 fires was 82 percent lower when automatic suppression systems were present." The report further states,

"Residents of these facilities are particularly vulnerable. The risk increases with increasing age. Consequently, the aged are considered a high-risk population. Institutional facilities that care for older adults must work diligently to prevent fires and to train staff and to equip the property (e.g., active systems) for effective response should a fire occur."

Note that Section 1103.5.3 requires an automatic sprinkler system be installed throughout the entire building containing a group I-2 Condition 2 occupancy. See the commentary to Section 1103.5.3 for more discussion on the intended application of that section.

**1105.9 Group I-2 automatic fire alarm system.** An automatic fire alarm system shall be installed in existing Group I-2 occupancies in accordance with Section 907.2.6.2.

**Exception:** Manual fire alarm boxes in patient sleeping areas shall not be required at *exits* if located at all nurses' control stations or other constantly attended staff locations, provided such stations are visible and continuously accessible and that travel distances required in Section 907.5.2.1 are not exceeded.

❖ Because care recipients may be incapable of self-evacuation and thus would rely on staff for assistance, an approved fire alarm system is required in existing Group I-2 occupancies. The system must comply with Section 907.2.6.2 (see commentary, Section 907.2.6.2). Note that Section 1105.8 requires sprinkler protection in existing Group I-2 occupancies and that the requirements of this section are in addition thereto. This provision is not intended to override the allowances for "private mode" in Section 907.2.6.2. Typical audible and visible alarms could be a detriment in some areas of a hospital, such as where patients are undergoing procedures.

**1105.10 Essential electrical systems.** Essential electrical systems in Group I-2 Condition 2 occupancies shall be in accordance with Sections 1105.10.1 and 1105.10.2.

❖ Both requirements within Sections 1105.10.1 and 1105.10.2 are specific to Group I-2 Condition 2 occupancies. This section addresses the requirements related to the needs of essential power and the reassessment to ensure that current installations will still meet the needs of the hospitals they support.

**1105.10.1 Where required.** In Group I-2 Condition 2 occupancies where life support is being provided, an essential electrical system shall be provided in accordance with NFPA 99.

❖ This section requires existing Group I-2 Condition 2 occupancies to provide essential electrical systems where life support is being provided. This section would require any buildings that would not be addressed by CMS but have similar risks to provide these necessary power resources. Buildings that are already approved through CMS are required to provide essential power.

## CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

**1105.10.2 Installation and duration.** In Group I-2 Condition 2 occupancies, the installation and duration of operation of existing essential electrical systems shall be based on a hazard vulnerability analysis conducted in accordance with NFPA 99.

❖ This section requires a reassessment of the essential electrical systems based on a hazard vulnerability analysis to make sure that the systems meet the needs of the facilities for emergencies. This requirement would apply whether or not the facility is being altered or has been damaged. If “substantial improvement” of the building occurs, per the IBC and IEBC definition, ASCE 24 would require this analysis. The flood provision section addresses such concerns as the location of equipment in a flood plain.

### SECTION 1106 REQUIREMENTS FOR OUTDOOR OPERATIONS

**1106.1 Tire storage yards.** Existing tire storage yards shall be provided with fire apparatus access roads in accordance with Sections 1106.1.1 and 1106.1.2.

❖ This section introduces the fire apparatus access provisions that follow.

**1106.1.1 Access to piles.** Access roadways shall be within 150 feet (45 720 mm) of any point in the storage yard where storage piles are located not less than 20 feet (6096 mm) from any storage pile.

❖ See the commentary to Section 3406.2.

**1106.1.2 Location within piles.** Fire apparatus access roads shall be located within all pile clearances identified in Section 3405.4 and within all fire breaks required in Section 3405.5.

❖ See the commentary to Sections 3405.4 and 3405.5.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code.

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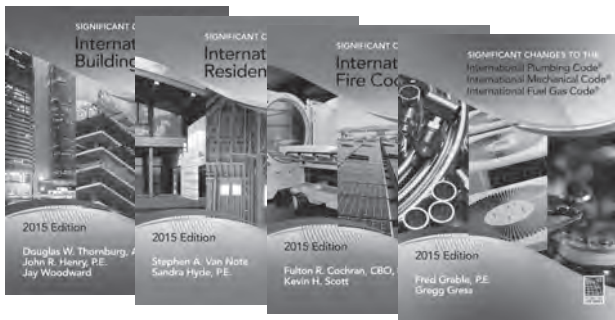
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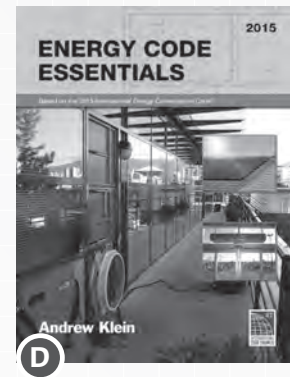
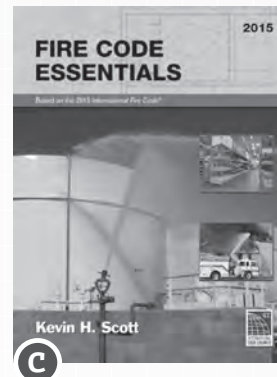
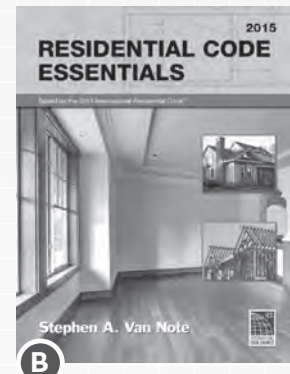
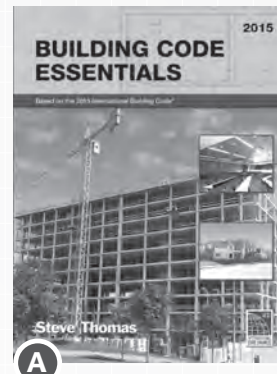
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# PREFACE

The principal purpose of the Commentary is to provide a basic volume of knowledge and facts relating to building construction as it pertains to the regulations set forth in the 2015 *International Fire Code*. The person who is serious about effectively designing, constructing and regulating buildings and structures will find the Commentary to be a reliable data source and reference to almost all components of the built environment.

As a follow-up to the *International Fire Code*, we offer a companion document, the *International Fire Code Commentary—Volume II*. Volume II covers Chapters 20 through 80 and Appendices A through M of the 2015 *International Fire Code*. The basic appeal of the Commentary is thus: it provides in a small package and at reasonable cost thorough coverage of many issues likely to be dealt with when using the *International Fire Code* — and then supplements that coverage with historical and technical background. Reference lists, information sources and bibliographies are also included.

Throughout all of this, effort has been made to keep the vast quantity of material accessible and its method of presentation useful. With a comprehensive yet concise summary of each section, the Commentary provides a convenient reference for regulations applicable to the construction of buildings and structures. In the chapters that follow, discussions focus on the full meaning and implications of the code text. Guidelines suggest the most effective method of application, and the consequences of not adhering to the code text. Illustrations are provided to aid understanding; they do not necessarily illustrate the only methods of achieving code compliance.

The format of the Commentary includes the full text of each section, table and figure in the code, followed immediately by the commentary applicable to that text. At the time of printing, the Commentary reflects the most up-to-date text of the 2015 *International Fire Code*. Each section's narrative includes a statement of its objective and intent, and usually includes a discussion about why the requirement commands the conditions set forth. Code text and commentary text are easily distinguished from each other. All code text is shown as it appears in the *International Fire Code*, and all commentary is indented below the code text and begins with the symbol ❖.

Readers should note that the Commentary is to be used in conjunction with the *International Fire Code* and not as a substitute for the code. The Commentary is advisory only; the code official alone possesses the authority and responsibility for interpreting the code.

Comments and recommendations are encouraged, for through your input, we can improve future editions. Please direct your comments to the Codes and Standards Development Department at the Chicago District Office.

The International Code Council would like to extend its thanks to the following individuals for their contributions to the technical content of this commentary:

Jeff Hugo  
Elley Klausbruckner



## Arrangement and Format of the 2015 IFC

Before applying the requirements of the IFC it is beneficial to understand its arrangement and format. The IFC, like other codes published by the International Code Council, is arranged and organized to follow sequential steps that generally occur during a plan review or inspection. The 2015 IFC is organized into seven Parts as illustrated in the tables below. Each Part represents a broad subject matter and includes the chapters that logically fit under the subject matter of each Part. It is also foreseeable that additional chapters will need to be added in the future as regulations for new processes or operations are developed. Accordingly, the reorganization was designed to accommodate such future chapters by providing reserved (unused) chapters in several of the Parts. This will allow the subject matter parts to be conveniently and logically expanded without requiring a major renumbering of the IFC chapters.

<b>2015 ORGANIZATION OF THE IFC</b>	
<b>Parts and Chapters</b>	<b>Subject Matter</b>
Part I – Chapters 1 and 2	Administrative and definitions
Part II – Chapters 3 and 4	General safety provisions
Part III – Chapters 5 through 11	Building and equipment design features
Part III – Chapters 12 through 19	Reserved for future use
Part IV – Chapters 20 through 37	Special occupancies and operations
Part IV – Chapters 38 through 49	Reserved for future use
Part V – Chapters 50 through 67	Hazardous materials
Part V – Chapters 68 through 79	Reserved for future use
Part VI – Chapter 80	Referenced standards
Part VII – Appendices A through M	Adoptable and informational appendices

The IFC requirements for fire-resistive construction, interior finish, fire protection systems, means of egress and construction safeguards are directly correlated to the chapters containing parallel requirements in the IBC, as follows:

<b>IFC Chapter</b>	<b>Subject</b>
7	Fire and smoke protection features
8	Interior finish, decorative materials and furnishings
9	Fire protection systems
10	Means of egress
33	Fire safety during construction and demolition



# LEGISLATION

The *International Codes* are designed and promulgated to be adopted by reference by legislative action. Jurisdictions wishing to adopt the 2015 *International Fire Code Commentary* as an enforceable set of regulations for the safeguarding of life and property from fire and explosion hazards arising from the storage, handling and use of hazardous substances, materials and devices, and from conditions hazardous to life or property in the occupancy of buildings and premises should ensure that certain factual information is included in the adopting legislation at the time adoption is being considered by the appropriate governmental body. The following sample adoption legislation addresses several key elements, including the information required for insertion into the code text.

## SAMPLE LEGISLATION FOR ADOPTION OF THE *INTERNATIONAL FIRE CODE* ORDINANCE NO. \_\_\_\_\_

A[N] [ORDINANCE/STATUTE/REGULATION] of the [NAME OF JURISDICTION] adopting the 2015 edition of the *International Fire Code*, regulating and governing the safeguarding of life and property from fire and explosion hazards arising from the storage, handling and use of hazardous substances, materials and devices, and from conditions hazardous to life or property in the occupancy of buildings and premises in the [NAME OF JURISDICTION]; providing for the issuance of permits and collection of fees therefor; repealing [ORDINANCE/STATUTE/REGULATION] No. \_\_\_\_\_ of the [NAME OF JURISDICTION] and all other ordinances or parts of laws in conflict therewith.

The [GOVERNING BODY] of the [NAME OF JURISDICTION] does ordain as follows:

**Section 1.** That a certain document, three (3) copies of which are on file in the office of the [TITLE OF JURISDICTION'S KEEPER OF RECORDS] of [NAME OF JURISDICTION], being marked and designated as the *International Fire Code*, 2015 edition, including Appendix Chapters [FILL IN THE APPENDIX CHAPTERS BEING ADOPTED] (see *International Fire Code* Section 101.2.1, 2015 edition), as published by the International Code Council, be and is hereby adopted as the Fire Code of the [NAME OF JURISDICTION], in the State of [STATE NAME] regulating and governing the safeguarding of life and property from fire and explosion hazards arising from the storage, handling and use of hazardous substances, materials and devices, and from conditions hazardous to life or property in the occupancy of buildings and premises as herein provided; providing for the issuance of permits and collection of fees therefor; and each and all of the regulations, provisions, penalties, conditions and terms of said Fire Code on file in the office of the [NAME OF JURISDICTION] are hereby referred to, adopted, and made a part hereof, as if fully set out in this legislation, with the additions, insertions, deletions and changes, if any, prescribed in Section 2 of this ordinance.

**Section 2.** That the following sections are hereby revised:

Section 101.1. Insert: [NAME OF JURISDICTION]

Section 109.4. Insert: [OFFENSE, DOLLAR AMOUNT, NUMBER OF DAYS]

Section 111.4. Insert: [DOLLAR AMOUNT IN TWO LOCATIONS]

**Section 3.** That the geographic limits referred to in certain sections of the 2015 *International Fire Code* are hereby established as follows:

Section 5704.2.9.6.1 (geographic limits in which the storage of Class I and Class II liquids in above-ground tanks outside of buildings is prohibited): [JURISDICTION TO SPECIFY]

Section 5706.2.4.4 (geographic limits in which the storage of Class I and Class II liquids in above-ground tanks is prohibited): [JURISDICTION TO SPECIFY]

Section 5806.2 (geographic limits in which the storage of flammable cryogenic fluids in stationary containers is prohibited): [JURISDICTION TO SPECIFY]

Section 6104.2 (geographic limits in which the storage of liquefied petroleum gas is restricted for the protection of heavily populated or congested areas): [JURISDICTION TO SPECIFY]

**Section 4.** That [ORDINANCE/STATUTE/REGULATION] No. \_\_\_\_\_ of [NAME OF JURISDICTION] entitled [FILL IN HERE THE COMPLETE TITLE OF THE LEGISLATION OR LAWS IN EFFECT AT THE PRESENT TIME SO THAT THEY WILL BE REPEALED BY SPECIFIC REFERENCE] and all other ordinances or parts of laws in conflict herewith are hereby repealed.

**Section 5.** That if any section, subsection, sentence, clause or phrase of this legislation is, for any reason, held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this ordinance. The [GOVERNING BODY] hereby declares that it would have passed this law, and each section, subsection, clause or phrase thereof, irrespective of the fact that any one or more sections, subsections, sentences, clauses and phrases be declared unconstitutional.

**Section 6.** That nothing in this legislation or in the Fire Code hereby adopted shall be construed to affect any suit or proceeding impending in any court, or any rights acquired, or liability incurred, or any cause or causes of action acquired or existing, under any act or ordinance hereby repealed as cited in Section 4 of this law; nor shall any just or legal right or remedy of any character be lost, impaired or affected by this legislation.

**Section 7.** That the [JURISDICTION'S KEEPER OF RECORDS] is hereby ordered and directed to cause this legislation to be published. (An additional provision may be required to direct the number of times the legislation is to be published and to specify that it is to be in a newspaper in general circulation. Posting may also be required.)

**Section 8.** That this law and the rules, regulations, provisions, requirements, orders and matters established and adopted hereby shall take effect and be in full force and effect [TIME PERIOD] from and after the date of its final passage and adoption.

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# Chapter 20: Aviation Facilities

### General Comments

Safe and efficient operation of airports, heliports and aircraft service facilities requires a comprehensive understanding of fire safety and aviation activities. The principal nonflight operational hazards associated with aviation involve fuel, facilities and operations. Conflicts have developed in recent years between airport security and life safety requirements because of an increased concern about air piracy and terrorism. The Federal Aviation Administration (FAA) regulates airport and air carrier security operations. These regulations strictly limit access to the air operations area. Unauthorized individuals must be prevented from entering air operations areas during all operating conditions, including emergencies in the terminal building. Concurrently, airport designs have traditionally included large unconfined

areas for the movement of people and their belongings. Because most contemporary passenger terminal buildings resemble covered malls, Section 402 of the *International Building Code*® (IBC®) permits passenger transportation terminals to comply with the requirements for a covered mall building and, in fact, includes them in the definition of “Covered mall building.”

### Purpose

Chapter 20 specifies minimum requirements for the fire-safe operation of airports, heliports and helistops. Safe use of flammable and combustible liquids during fueling and maintenance operations is emphasized. Availability of portable Class B:C-rated fire extinguishers for prompt control or suppression of incipient fires is required.

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### SECTION 2001 GENERAL

**2001.1 Scope.** Airports, heliports, helistops and aircraft hangars shall be in accordance with this chapter.

❖ This chapter discusses fire and life safety in the ground environment modes. These modes include aircraft maintenance, aircraft refueling, aircraft hangars, helistops and heliports.

**2001.2 Regulations not covered.** Regulations not specifically contained herein pertaining to airports, aircraft maintenance, aircraft hangars and appurtenant operations shall be in accordance with nationally recognized standards.

❖ If a regulation is not addressed in this chapter, one must go to a recognized standard for the regulation. Ground operations must be conducted in accordance with recognized standards.

**2001.3 Permits.** For permits to operate aircraft-refueling vehicles, application of flammable or combustible finishes and hot work, see Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued (see commentary, Section 105.6 for a general

discussion of operations requiring a permit). The three operations listed in this section pose possible fire hazards because an ignition source close to them would create a hazardous situation. The operations must be reviewed for safety concerns and requirements.

### SECTION 2002 DEFINITIONS

**2002.1 Definitions.** The following terms are defined in Chapter 2:

**AIRCRAFT OPERATION AREA (AOA).**

**AIRPORT.**

**HELIPORT.**

**HELISTOP.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*® (I-Code®) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

**SECTION 2003  
GENERAL PRECAUTIONS**

**2003.1 Sources of ignition.** Open flames, flame-producing devices and other sources of ignition shall not be permitted in a hangar, except in *approved* locations or in any location within 50 feet (15 240 mm) of an aircraft-fueling operation.

❖ Smoking and carrying any open-flame device within 50 feet (15 240 mm) of any fueling operation is prohibited because of flammable vapors that are likely to be present during fueling operations. Electrical equipment on aircraft is usually not approved for use in hazardous (classified) locations, and disconnection of electrical devices often produces sparks, possibly igniting flammable vapor-air mixtures. Consequently, fueling operations must be discontinued before connecting or disconnecting these devices.

**2003.2 Smoking.** Smoking shall be prohibited in aircraft-refueling vehicles, aircraft hangars and aircraft operation areas used for cleaning, paint removal, painting operations or fueling. “No Smoking” signs shall be provided in accordance with Section 310.

**Exception:** Designated and *approved* smoking areas.

❖ An aircraft hangar is simply a building that provides weather protection and shop space during aircraft maintenance and storage. In the maintenance process, many hazards are present. Smoking is prohibited in all areas where an aircraft is located because of the potential presence of fuel vapors. The exception gives the fire code official the authority to evaluate and approve designated smoking areas.

**2003.3 Housekeeping.** The aircraft operation area (AOA) and related areas shall be kept free from combustible debris at all times.

❖ Housekeeping should be a daily practice. The level of fire safety is greatly improved when areas are kept clean and neat. Make sure that all generated waste is removed from the building and safely disposed of each day. Additionally, keeping the areas in which aircraft operate free from debris reduces the likelihood of foreign object damage (FOD) to aircraft engines that could result in engine damage or catastrophic engine failure.

**2003.4 Fire department access.** Fire apparatus access roads shall be provided and maintained in accordance with Chapter 5. Fire apparatus access roads and aircraft parking positions shall be designed in a manner so as to preclude the possibility of fire vehicles traveling under any portion of a parked aircraft.

❖ Access by emergency vehicles is an important factor. Fire apparatus access roads must be wide enough, well-marked and unobstructed in accordance with Section 503. The access roads should also be arranged so there is no confusion over where emergency vehicles are to go in the event of a fire or rescue emergency in a building, on a runway or in an aircraft. Space between aircraft must be large

enough to allow emergency response equipment access to buildings and the aircraft.

**2003.5 Dispensing of flammable and combustible liquids.** The dispensing, transferring and storage of flammable and *combustible liquids* shall be in accordance with this chapter and Chapter 57. Aircraft motor vehicle fuel-dispensing facilities shall be in accordance with Chapter 23.

❖ Section 2006 gives guidelines for dispensing fuel into an aircraft. Section 5706 also gives guidelines for dispensing flammable and combustible liquids. Chapter 23 applies when small general aviation-type aircraft and airport service vehicles are brought to a fueling station instead of being fueled from a vehicle. See the commentary to Section 202 for the definition of “Aircraft motor-vehicle fuel-dispensing facility.”

**2003.6 Combustible storage.** Combustible materials stored in aircraft hangars shall be stored in *approved* locations and containers.

❖ Combustible materials storage is to be confined to cutoff rooms or approved metal containers with tight-fitting, self-closing or automatic-closing lids to limit the fuel load readily exposed within the hangar. Approved containers provided for oily rags and similar wastes are to be supplied throughout service areas and emptied every day. Combustible materials should be removed from the building as soon as possible.

**2003.7 Hazardous material storage.** Hazardous materials shall be stored in accordance with Chapter 50.

❖ Chapter 50 contains the requirements for storing hazardous materials. Requirements in Chapters 51 through 67 also apply to specific materials.

**SECTION 2004  
AIRCRAFT MAINTENANCE**

**2004.1 Transferring flammable and combustible liquids.** Flammable and *combustible liquids* shall not be dispensed into or removed from a container, tank, vehicle or aircraft except in *approved* locations.

❖ Due to hazards presented by aviation fuels, as discussed in Section 2006, it is necessary that all storage, transfer or dispensing of flammable and combustible liquids be completed outside of and away from structures. This includes the emptying of fuel tanks and the rooftop refueling of helicopters. The large, undivided areas of aircraft hangars coupled with the dollar value of a single aircraft present an unusually high value at risk of loss due to a single fire incident, thus reinforcing the need for the strict regulation of fuels. Dispensing systems generally involve the transfer of liquid from fixed piping systems, drums or 5-gallon (19 L) cans into smaller end-use containers. Because the release of some vapor is practically unavoidable, dispensing must take place in designated areas.

**2004.2 Application of flammable and combustible liquid finishes.** The application of flammable or Class II *combustible liquid* finishes is prohibited unless both of the following conditions are met:

1. The application of the liquid finish is accomplished in an *approved* location.
  2. The application methods and procedures are in accordance with Chapter 24.
- ❖ Application of flammable finishes must comply with Chapter 24. Most exterior aircraft painting is performed using spray apparatus, frequently in aircraft hangars. Usually, control of ignition sources, ventilation and the considerable volume of aircraft hangars is relied on to minimize the hazards typically associated with spraying in more confined areas where vapor-air mixtures can rapidly create an explosive mixture. Small parts and subassemblies should be removed and painted in approved spray booths or areas complying with the requirements of Chapter 24. Exterior painting should not be performed in aircraft hangars not protected throughout by approved automatic fire suppression systems. If systems are inoperable, exterior spray painting is not permitted; only interior painting using water-based products is permitted. Like small exterior parts and subassemblies, application of flammable finishes to removable interior components should be limited to approved spray booths or spray rooms.

**2004.3 Cleaning parts.** Class IA flammable liquids shall not be used to clean aircraft, aircraft parts or aircraft engines. Cleaning with other flammable and *combustible liquids* shall be in accordance with Section 5705.3.6.

- ❖ Class I flammable liquids with flash points below 100°F (38°C) must not be used for cleaning that typically liberates large quantities of flammable vapor and may leave a flammable residue that is easily ignited. Removable parts should be cleaned in approved parts-cleaning machines already tested and labeled for such a purpose. The hazards associated with cleaning an aircraft, aircraft parts and aircraft engines with Class IA flammable liquids are fires and explosions, potentially causing damaged property and loss of life. Section 5005.3.6 gives requirements for cleaning with Class I, II and IIIA liquids.

**2004.4 Spills.** Sections 2004.4.1 through 2004.4.3 shall apply to spills of flammable and *combustible liquids* and other hazardous materials. Fuel spill control shall also comply with Section 2006.11.

- ❖ The following procedures should be adhered to in the event a spill occurs. The specific requirements for fuel spill prevention are found in Section 2006.11.

**2004.4.1 Cessation of work.** Activities in the affected area not related to the mitigation of the spill shall cease until the

spilled material has been removed or the hazard has been mitigated.

- ❖ All ongoing activity must stop in the area of a spill until the spill has been cleaned up and removed, since those ongoing activities may cause an ignition to occur. The area should be clear of all hazards before work is resumed.

**2004.4.2 Vehicle movement.** Aircraft or other vehicles shall not be moved through the spill area until the spilled material has been removed or the hazard has been mitigated.

- ❖ The movement of vehicles may create an ignition source for the flammable liquids that spilled. Stopping all movement of vehicles reduces the possibility of a fire or an explosion significantly.

**2004.4.3 Mitigation.** Spills shall be reported, documented and mitigated in accordance with the provisions of this chapter and Section 5003.3.

- ❖ Any fuel spill, whatever the amount, must be reported to the proper authorities and documented to record the spill details and what was done to clean up the spill. Chapter 50 gives specific procedures for handling a spill.

**2004.5 Running engines.** Aircraft engines shall not be run in aircraft hangars except in *approved* engine test areas.

- ❖ An approved engine test area should have proper ventilation, engine noise control and be separated from other areas of operation. Running engines could create ignition sources that could cause fire or explosions, as well as ventilation and noise hazards for the surrounding employees.

**2004.6 Open flame.** Repairing of aircraft requiring the use of open flames, spark-producing devices or the heating of parts above 500°F (260°C) shall only be done outdoors or in an area complying with the provisions of the *International Building Code* for a Group F-1 occupancy.

- ❖ No heat-producing, welding, cutting or blow-torch devices should be used inside hangars. Their use is restricted to areas that meet the requirements of a Group F-1 occupancy in the *International Mechanical Code*® (IMC®). Flare pots and other open-flame lights are also included in this category.

**2004.7 Other aircraft maintenance.** Maintenance, repairs, modifications, or construction performed upon aircraft not addressed elsewhere in this code shall be conducted in accordance with NFPA 410.

- ❖ Aircraft maintenance is often a hazardous procedure due to the inherent hazards of aircraft. NFPA 410 specifies minimum safety requirements to be performed during specific maintenance operations such as fuel or oxygen system maintenance, aircraft cleaning and hazardous operations such as defueling. It provides additional fire-safety requirements to sup-

plement the procedures already regulated by this chapter, as well as additional fire protection requirements for other specified procedures not regulated by this chapter. See the commentary to Section 102.7 for information on the proper application of referenced standards.

**SECTION 2005  
PORTABLE FIRE EXTINGUISHERS**

**2005.1 General.** Portable fire extinguishers suitable for flammable or *combustible liquid* and electrical-type fires shall be provided as specified in Sections 2005.2 through 2005.6 and Section 906. Extinguishers required by this section shall be inspected and maintained in accordance with Section 906.

❖ Portable fire extinguishers (PFEs) must be approved for use on Class B and C fires. Placement and distribution of PFEs should conform to NFPA 10, NFPA 407 and Section 906 of the code. Generally, PFEs are required in the immediate vicinity of all flammable and combustible liquid storage; use and dispensing; welding and cutting; spray finishing and other maintenance operations, as well as on aircraft fueler and service vehicles.

It should be noted that Sections 2005.2, 2005.4, 2005.5 and 2005.6 specifically require B:C-rated PFEs on vehicles and in locations that are in close proximity to aircraft. This is because it has been reported by the National Safety Council that A:B:C-rated PFE chemicals pose a severe aircraft damage problem. While A:B:C-rated PFEs generally have an excellent fire-fighting capability and track record, the monoammonium-phosphate chemical extinguishing agent is highly corrosive to aluminum. This agent will melt and flow when it comes into contact with heated surfaces and, once it comes into contact with hot aluminum and works its way into the structural joints and crevices, it cannot be flushed out as the B:C dry-chemical agents can. Cleanup following use of an A:B:C-rated PFE on an aircraft could require disassembly of the aircraft to remove every remnant of the chemical to prevent hidden corrosion damage that could lead to structural failure.

**2005.2 On towing vehicles.** Vehicles used for towing aircraft shall be equipped with not less than one *listed* portable fire extinguisher complying with Section 906 and having a minimum rating of 20-B:C.

❖ Tow motors and other towing vehicles must be equipped with a PFE that is readily available if a fire occurs away from a service, maintenance or boarding area.

**2005.3 On welding apparatus.** Welding apparatus shall be equipped with not less than one *listed* portable fire extinguisher complying with Section 906 and having a minimum rating of 2-A:20-B:C.

❖ Consistent with Section 3504.2.6, a PFE is required on all welding apparatus so that it is readily available

during welding or cutting operations outside a welding or cutting shop area.

**2005.4 On aircraft fuel-servicing tank vehicles.** Aircraft fuel-servicing tank vehicles shall be equipped with not less than two *listed* portable fire extinguishers complying with Section 906, each having a minimum rating of 20-B:C. A portable fire extinguisher shall be readily accessible from either side of the vehicle.

❖ Fuel-servicing tank vehicles for aircraft must have a PFE on each side of the vehicle. Both extinguishers must be easily accessible and not be obstructed. Each PFE must be effective for the extinguishment of a flammable liquid fire and also be effective for energized electrical components (see Commentary Figure 2006.3 – note the PFE on each side of the rear bumper).

**2005.5 On hydrant fuel-servicing vehicles.** Hydrant fuel-servicing vehicles shall be equipped with not less than one *listed* portable fire extinguisher complying with Section 906, and having a minimum rating of 20-B:C.

❖ Hydrant fuel-servicing vehicles must be equipped with one PFE that is effective for the extinguishment of a flammable liquid fire and is also effective for energized electrical components.

**2005.6 At fuel-dispensing stations.** Portable fire extinguishers at fuel-dispensing stations shall be located such that pumps or dispensers are not more than 75 feet (22 860 mm) from one such extinguisher. Fire extinguishers shall be provided as follows:

1. Where the open-hose discharge capacity of the fueling system is not more than 200 gallons per minute (13 L/s), not less than two *listed* portable fire extinguishers complying with Section 906 and having a minimum rating of 20-B:C shall be provided.
2. Where the open-hose discharge capacity of the fueling system is more than 200 gallons per minute (13 L/s) but not more than 350 gallons per minute (22 L/s), not less than one *listed* wheeled extinguisher complying with Section 906 and having a minimum extinguishing rating of 80-B:C, and a minimum agent capacity of 125 pounds (57 kg), shall be provided.
3. Where the open-hose discharge capacity of the fueling system is more than 350 gallons per minute (22 L/s), not less than two *listed* wheeled extinguishers complying with Section 906 and having a minimum rating of 80-B:C each, and a minimum capacity agent of 125 pounds (57 kg) of each, shall be provided.

❖ This section requires PFEs with ratings based on the anticipated discharge rate of a broken or ruptured fuel hose. NFPA 407 contains requirements for the inspection and maintenance of an aircraft fueling hose, including daily pre-use inspection and removal from service of obviously defective hoses. Despite these inspections, however, hoses and fittings can and do fail for a variety of reasons (e.g., unnoticed physical damage, coupling and fitting failure, over-pressure rupture, etc.), resulting in a flailing hose,

“open butt” discharge of fuel under the full pressure of the fueling system. Such uncontrolled fuel discharge could flow under the aircraft; fueling vehicles; passenger stairs or ramps; baggage-handling equipment or in close proximity to building openings. If a hose were to rupture on top of an aircraft wing or a flailing hose were to spray fuel on vehicles, baggage carts, etc., the resulting hazard would increase beyond a simple spill fire. The large amount of property damage and potential for loss of life requires that sufficient PFEs of an adequate size be located in the fueling area. (Note: the PFEs required by this section are in addition to others required on vehicles that may be present in the fuel area.)

Considerations in locating PFEs during fueling operations include placing them out and upwind of the fuel-dispensing site and potential spill area, as well as within the access travel distance specified in NFPA 10 for extra-hazard locations. When two PFEs are required, they should be located close enough to each other so NFPA 10 access travel distances are not exceeded and a spill incident does not prevent access to or use of both appliances.

FAA regulations and NFPA 407 require refueling personnel to receive PFE and fire safety training. Annex A of NFPA 407 recommends that such training include live-fire exercises. Training should be adequately detailed so that supervisors are capable of properly indoctrinating their subordinates in fire safety essentials. Topics covered in the training program should include electrical bonding and grounding; maintenance of aircraft egress; emergency shutdown of fuel-servicing equipment; notification of emergency forces; and supporting emergency operations.

The low flow rate in Item 1 requires that at least two 20-B:C hand-held PFEs are provided. It also assumes that the trained personnel available will be able to handle the relatively small anticipated spill. Such PFEs typically discharge for up to ± 25 seconds for distances up to ± 20 feet (± 6096 mm).

Item 2 states that a ruptured hose discharging up to 350 gallons per minute (gpm) (1325 L/m) creates a potentially larger spill area and a more challenging fire for first-aid appliances. The higher “B” rating requires a quantity of extinguishing agent, usually dry chemical, that likely exceeds 50 pounds (28 kg), depending on the agent. Accordingly, a wheeled PFE will enable a single operator more mobility in moving the PFE for fire attack. The size of the wheeled unit, in addition to its longer discharge hose, allows the operator a greater agent discharge time, a higher agent flow rate, a greater agent discharge distance and more mobility in the hazardous area. The potential for such large fuel discharges increases the extinguishing requirements. For the same reasons discussed under Item 2, a minimum of two wheeled units are required to allow a more aggressive fire attack.

**2005.7 Fire extinguisher access.** Portable fire extinguishers required by this chapter shall be accessible at all times. Where necessary, provisions shall be made to clear accumulations of snow, ice and other forms of weather-induced obstructions.

- ❖ Unobstructed access to PFEs is essential. In colder climates, snow and ice may block access and must be removed because fire can occur at any time.

**2005.7.1 Cabinets.** Cabinets and enclosed compartments used to house portable fire extinguishers shall be clearly marked with the words FIRE EXTINGUISHER in letters not less than 2 inches (51 mm) high. Cabinets and compartments shall be readily accessible at all times.

- ❖ In an emergency, people can panic and become confused. Labeling cabinets where PFEs are housed with letters 2 inches high (51 mm) (often in red) makes the PFEs easier to locate.

**2005.8 Reporting use.** Use of a fire extinguisher under any circumstances shall be reported to the manager of the airport and the *fire code official* immediately after use.

- ❖ The fire code official is responsible for the investigation of fires within the jurisdiction and for maintaining records thereof. Likewise, the airport manager is responsible for all activities and events within the airport. Both persons must be notified of extinguisher use so the circumstances of the event can be investigated and appropriate follow-up procedures initiated to mitigate the hazard that resulted in the incident. Discharged PFEs must be promptly replaced with serviceable units.

## SECTION 2006 AIRCRAFT FUELING

**2006.1 Aircraft motor vehicle fuel-dispensing facilities.** Aircraft motor vehicle fuel-dispensing facilities shall be in accordance with Chapter 23.

- ❖ Requirements for fuel-dispensing stations for aircraft motor vehicles are found in Chapter 23. This provision addresses the dispensing of fuel into small general aviation-type aircraft at stationary fuel-dispensing facilities that use equipment similar to that used at automotive service stations rather than fuel hydrants or fuel tanker trucks that are used on larger aircraft. See the commentary to Section 202 for the definition of “Aircraft motor vehicle fuel-dispensing facility.”

**2006.2 Airport fuel systems.** Airport fuel systems shall be designed and constructed in accordance with NFPA 407.

- ❖ Aviation fuels present a wide range of hazards. The fuel, ambient temperature, control of ignition sources, drainage, availability of fire protection equipment and the experience and training of fuel-service personnel have the greatest influence over the outcome of fueling accidents. Consequently, this section references

NFPA 407, specifying requirements for the design and operation of fueling installations, vehicles and procedures.

At normal ambient temperatures, the kerosene-grade fuels are not readily ignitable, which may explain their popularity. When spilled on a warm aircraft apron, however, kerosene-grade fuels can be readily heated above their flash points. Once ignited, most aviation fuels exhibit relatively similar burning characteristics (see Commentary Figure 2006.2 for information on common aviation fuels).

Fuel spills are relatively uncommon occurrences compared to the daily number of refuelings that occur. Most fuel spills occur as the result of a slow or faulty internal shutoff valve that causes overfilling of the tank, resulting in fuel escaping through the tank vent point. To prevent or minimize such accidents, fuel shutoffs and fail-safe, self-closing valves should be exercised and inspected regularly. In addition, faulty valves and equipment should be removed from service and repaired or replaced immediately. All spills must be promptly reported to airport fire-fighting personnel and investigated to determine their cause. The most common ignition source in liquid fuel spills is static electricity. The kerosene and kerosene-gasoline blends are more electrostatically active than AVGAS, and transfer operations may generate con-

siderable amounts of static electricity; therefore, prior to most fueling operations both the aircraft and refueler shall be independently grounded and then bonded to one another either by the filling hose or a separate bonding line (see commentary, Section 2006.5.2 and its subsections for further information).

**2006.3 Construction of aircraft-fueling vehicles and accessories.** Aircraft-fueling vehicles shall comply with this section and shall be designed and constructed in accordance with NFPA 407.

❖ The following sections apply to vehicles operated for refueling aircraft. The sections address transfer apparatus, pumps, dispensing, electrical equipment, venting and smoking. The design and construction of the vehicle tanks, trailers, piping, exhaust system, lighting, venting and safe operating procedures parallel those in NFPA 407, Chapter 2 (see Commentary Figure 2006.3).

**2006.3.1 Transfer apparatus.** Aircraft-fueling vehicles shall be equipped and maintained with an *approved* transfer apparatus.

❖ The transfer apparatus installed on the fuel-servicing vehicle must be approved and tested for transferring fuel into an aircraft. All sections involved in a flammable liquid feed system should be constructed and located to minimize a fire hazard.

	Gasoline	Kerosene Grades	Blends of Kerosene and Gasoline
Commercial Designation	AVGAS	JET A, JET A-1	JET B
Military Designation		JP-5, JP-6, JP-8	JP-4
<b>Characteristics</b>			
Freezing Point	-76°F	-49 to -58°F	-60°F
Vapor Pressure	5.5 to 7.0 psi	0.1 psi	2.0 to 3.0 psi
Flash Point (Closed-cup Method @ MSL)	-50°F	95 to 145°F	-10 to +30°F
Flash Point (Air-saturation Method)	-75 to -85°F	None	-60°F
Flammable Range			
Lower	1.5%	0.74%	1.16%
Upper	7.6%	5.32%	7.63%
Temperature Range	-50 to +30°F	95 to 165°F	-10 to +100°F
Auto-ignition Temperature	825 to 960°F	440 to 475°F	470 to 480°F
Boiling Points			
Initial	110°F	325°F	135°F
End	325°F	450°F	485°F
Pool Rate of Flame Spread	700 to 800 feet per minute	≤ 100 feet per minute	700 to 800 feet per minute

Source: Brennenman, J.J. *Industrial Fire Hazards Handbook*.  
For SI; 1 foot per minute = 0.00508 m/s, °C = [(°F) - 32]/1.8.

**Figure 2006.2**  
**PHYSICAL AND FLAMMABILITY CHARACTERISTICS OF AVIATION FUELS**



**Figure 2006.3  
AIRCRAFT-FUELING VEHICLE**

**2006.3.1.1 Internal combustion type.** Where such transfer apparatus is operated by an individual unit of the internal-combustion-motor type, such power unit shall be located as remotely as practicable from pumps, piping, meters, air eliminators, water separators, hose reels and similar equipment, and shall be housed in a separate compartment from any of the aforementioned items. The fuel tank in connection therewith shall be suitably designed and installed, and the maximum fuel capacity shall not exceed 5 gallons (19 L) where the tank is installed on the engine. The exhaust pipe, muffler and tail pipe shall be shielded.

- ❖ Isolation of an internal combustion engine from the fuel transfer system helps to control possible ignition sources. The ignition sources need to be shielded and equipment should be housed in separate compartments.

**2006.3.1.2 Gear operated.** Where operated by gears or chains, the gears, chains, shafts, bearings, housing and all parts thereof shall be of an *approved* design and shall be installed and maintained in an *approved* manner.

- ❖ The gears and other associated parts should be covered and protected from damage, whether the damage comes from environmental or mechanical sources. The design must be approved for the function. Maintenance should be scheduled to provide consistent and proper operation.

**2006.3.1.3 Vibration isolation.** Flexible connections for the purpose of eliminating vibration are allowed if the material used therein is designed, installed and maintained in an *approved* manner, provided such connections do not exceed 24 inches (610 mm) in length.

- ❖ Because hoses are the weak point in any system and they are necessary for flexible connections, they should be kept as short as possible. Hose length must not exceed 24 inches (610 mm).

**2006.3.2 Pumps.** Pumps of a positive-displacement type shall be provided with a bypass relief valve set at a pressure

of not more than 35 percent in excess of the normal working pressure of such unit. Such units shall be equipped and maintained with a pressure gauge on the discharge side of the pump.

- ❖ A relief valve is needed on positive-displacement pumps to prevent high-pressure damage or an explosion within the fuel feed system. At 35 percent over the normal operating pressure the relief valve will allow the excess pressure to escape, thus preventing a dangerous situation. A pressure gauge also allows monitoring of pump operation to detect overpressure conditions.

**2006.3.3 Dispensing hoses and nozzles.** Hoses shall be designed for the transferring of hydrocarbon liquids and shall not be any longer than necessary to provide efficient fuel transfer operations. Hoses shall be equipped with an *approved* shutoff nozzle. Fuel-transfer nozzles shall be self-closing and designed to be actuated by hand pressure only. Notches and other devices shall not be used for holding a nozzle valve handle in the open position. Nozzles shall be equipped with a bonding cable complete with proper attachment for aircraft to be serviced.

- ❖ Nozzles having notches for holding a nozzle valve handle in the open position create the risk of an overflow/spill situation if the handle sticks in the open position. The shutoff nozzle also aids in the prevention of an overflow/spill situation. Bonding the nozzle to the aircraft helps to dissipate static electricity that is generated in the fueling operation.

**2006.3.4 Protection of electrical equipment.** Electric wiring, switches, lights and other sources of ignition, where located in a compartment housing piping, pumps, air eliminators, water separators, hose reels or similar equipment, shall be enclosed in a vapor-tight housing. Electrical motors located in such a compartment shall be of a type *approved* for use as specified in NFPA 70.

- ❖ Because electrical equipment can be a serious sparking source, precautions must be taken to eliminate this potential ignition source and fire hazard.

**2006.3.5 Venting of equipment compartments.** Compartments housing piping, pumps, air eliminators, water separators, hose reels and similar equipment shall be adequately ventilated at floor level or within the floor itself.

- ❖ Venting compartments housing this equipment provide both dilution air to keep possible air-vapor mixtures below the flammable range and airflow for dissipation of any vapors present.

**2006.3.6 Accessory equipment.** Ladders, hose reels and similar accessory equipment shall be of an *approved* type and constructed substantially as follows:

1. Ladders constructed of noncombustible material are allowed to be used with or attached to aircraft-fueling vehicles, provided the manner of attachment or use of such ladders is *approved* and does not constitute an additional fire or accident hazard in the operation of such fueling vehicles.

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2. Hose reels used in connection with fueling vehicles shall be constructed of noncombustible materials and shall be provided with a packing gland or other device that will preclude fuel leakage between reels and fuel manifolds.

❖ Ladders made of noncombustible materials and that are securely attached help eliminate a potential spark ignition source, and limit the possibility of falling equipment breaking a component of the fuel system.

Hose reels constructed of noncombustible material help eliminate the possibility of an ignition source causing a fire hazard. The installation of a packing gland or other device helps eliminate the possibility of a fuel leak causing a fire hazard.

**2006.3.7 Electrical bonding provisions.** Transfer apparatus shall be metallicly interconnected with tanks, chassis, axles and springs of aircraft-fueling vehicles.

❖ Fuel transfer vehicles must be bonded together as a unit. This helps to eliminate the electrostatic charge created by flowing fuel through pipes and hoses.

**2006.3.7.1 Bonding cables.** Aircraft-fueling vehicles shall be provided and maintained with a substantial heavy-duty electrical cable of sufficient length to be bonded to the aircraft to be serviced. Such cable shall be metallicly connected to the transfer apparatus or chassis of the aircraft-fueling vehicle on one end and shall be provided with a suitable metal clamp on the other end, to be fixed to the aircraft.

❖ The fueling vehicle and the aircraft must be bonded together with a cable before making any fueling connection to the aircraft. This provides a conductive path to equalize the electrostatic charge between the fueling vehicle and the aircraft.

**2006.3.7.2 Bonding cable protection.** The bonding cable shall be bare or have a transparent protective sleeve and be stored on a reel or in a compartment provided for no other purpose. It shall be carried in such a manner that it will not be subjected to sharp kinks or accidental breakage under conditions of general use.

❖ Bonding cable that is worn, frayed or kinked cannot make good contact or provide a continuous path to eliminate the electrostatic charge. Bonding cables require special care in storage and handling.

**2006.3.8 Smoking.** Smoking in aircraft-fueling vehicles is prohibited. Signs to this effect shall be conspicuously posted in the driver's compartment of all fueling vehicles.

❖ Because flammable vapors being discharged during refueling can accumulate in closed areas, such as the driver's compartment of the fueling vehicle, smoking in that compartment is strictly prohibited. Signs must

be posted conspicuously in the driver's compartment as a warning.

**2006.3.9 Smoking equipment.** Smoking equipment such as cigarette lighters and ash trays shall not be provided in aircraft-fueling vehicles.

❖ Because smoking is prohibited in fueling vehicles, the elimination of cigarette lighters and ashtrays reinforces this regulation.

**2006.4 Operation, maintenance and use of aircraft-fueling vehicles.** The operation, maintenance and use of aircraft-fueling vehicles shall be in accordance with Sections 2006.4.1 through 2006.4.4 and other applicable provisions of this chapter.

❖ Fuel-servicing equipment must comply with the requirements of the following sections and must be maintained in safe operating condition. Leaking or malfunctioning equipment must be removed from service.

**2006.4.1 Proper maintenance.** Aircraft-fueling vehicles and all related equipment shall be properly maintained and kept in good repair. Accumulations of oil, grease, fuel and other flammable or combustible materials is prohibited. Maintenance and servicing of such equipment shall be accomplished in *approved* areas.

❖ Fueling vehicles should be inspected every day. The accumulation of oil, grease or any other material creates a fire hazard if it is ignited by an ignition source. A clean, well-maintained fueling vehicle is a high priority in the line of fire-hazard prevention. The cleaning should take place in an area constructed and approved for such a task.

**2006.4.2 Vehicle integrity.** Tanks, pipes, hoses, valves and other fuel delivery equipment shall be maintained leak free at all times.

❖ All fuel delivery equipment should be checked every day for leaks. If a leak occurs, the probability of a fire occurring increases.

**2006.4.3 Removal from service.** Aircraft-fueling vehicles and related equipment that are in violation of Section 2006.4.1 or 2006.4.2 shall be immediately defueled and removed from service and shall not be returned to service until proper repairs have been made.

❖ Whenever a problem is discovered with the vehicle, tank, pipes, hoses, valves or any equipment related to aircraft fueling, the vehicle must be taken out of service immediately and repaired. Having a vehicle in service that is not working properly increases the potential for a fire.

**2006.4.4 Operators.** Aircraft-fueling vehicles that are operated by a person, firm or corporation other than the permittee or the permittee's authorized employee shall be provided with a legible sign visible from outside the vehicle showing the name of the person, firm or corporation operating such unit.

- ❖ A change in the operator, firm or corporation from the permit holder of a fueling vehicle requires notification. In addition to verbal or written communication, a sign that can be read from outside the vehicle must be posted on or in the vehicle notifying observers that a different person or organization is performing the procedure.

**2006.5 Fueling and defueling.** Aircraft-fueling and defueling operations shall be in accordance with Sections 2006.5.1 through 2006.5.5.

- ❖ This section covers the requirements for positioning and bonding the fueling vehicle. It also covers the requirements for training fuel transfer personnel and their responsibilities.

**2006.5.1 Positioning of aircraft-fueling vehicles.** Aircraft-fueling vehicles shall not be located, parked or permitted to stand in a position where such unit would obstruct egress from an aircraft should a fire occur during fuel-transfer operations. Aircraft-fueling vehicles shall not be located, parked or permitted to stand under any portion of an aircraft.

**Exception:** Aircraft-fueling vehicles shall be allowed to be located under aircraft wings during underwing fueling of turbine-engine powered aircraft.

- ❖ Safety of crew and passengers is always the highest priority. Fuel-service vehicles must not be positioned under any part of an aircraft and must always be in a location that leaves aircraft egress paths free of obstruction (see commentary, Section 2006.9, Item 4). The exception, applicable only to jet aircraft, recognizes that a number of factors, including the size of the aircraft, the location of fuel inlets and the length of hose on the tank truck, will dictate where aircraft fueling vehicles are necessarily located.

**2006.5.1.1 Fueling vehicle egress.** A clear path shall be maintained for aircraft-fueling vehicles to provide for prompt and timely egress from the fueling area.

- ❖ The requirement for a clear and unobstructed path in and out of the fueling area calls for cooperation between refueling crews and other ground support personnel to make sure the path exists. This allows for a safe, timely and efficient fueling operation.

**2006.5.1.2 Aircraft vent openings.** A clear space of not less than 10 feet (3048 mm) shall be maintained between aircraft fuel-system vent openings and any part or portion of an aircraft-fueling vehicle.

- ❖ Fuel vapors are released from fuel-system vent openings. The 10-foot (3048 mm) radius gives a distance sufficient for vapor dissipation.

**2006.5.1.3 Parking.** Prior to leaving the cab, the aircraft-fueling vehicle operator shall ensure that the parking brake has been set. Not less than two chock blocks not less than 5 inches by 5 inches by 12 inches (127 mm by 127 mm by 305 mm) in size and dished to fit the contour of the tires shall be utilized and positioned in such a manner as to preclude movement of the vehicle in any direction.

- ❖ This requirement for securing the fueling vehicle is an important safety consideration. Even a slight grade or dishing of the pavement could cause an unsecured vehicle to roll far enough to strain the fueling link into leaking, disconnecting or breaking, which would create the possibility of a spill and a hazardous situation.

**2006.5.2 Electrical bonding.** Aircraft-fueling vehicles shall be electrically bonded to the aircraft being fueled or defueled. Bonding connections shall be made prior to making fueling connections and shall not be disconnected until the fuel-transfer operations are completed and the fueling connections have been removed.

Where a hydrant service vehicle or cart is used for fueling, the hydrant coupler shall be connected to the hydrant system prior to bonding the fueling equipment to the aircraft.

- ❖ Bonding increases the likelihood that the receiving tank (aircraft or vehicle) and the fueling/defueling equipment have the same electrical potential and provides a path for the charges in all parts of the fueling system to neutralize. The bonding of the fuel vehicle and aircraft must be completed before any fuel is moved and must remain in place until after the fueling operation is complete.

**2006.5.2.1 Conductive hose.** In addition to the bonding cable required by Section 2006.5.2, conductive hose shall be used for all fueling operations.

- ❖ The use of conductive hose helps to prevent electrostatic discharge. It is not a substitute for required bonding.

**2006.5.2.2 Bonding conductors on transfer nozzles.** Transfer nozzles shall be equipped with *approved* bonding conductors that shall be clipped or otherwise positively engaged with the bonding attachment provided on the aircraft adjacent to the fuel tank cap prior to removal of the cap.

**Exception:** In the case of overwing fueling where no appropriate bonding attachment adjacent to the fuel fill port has been provided on the aircraft, the fueling operator shall touch the fuel tank cap with the nozzle spout prior to removal of the cap. The nozzle shall be kept in contact with the fill port until fueling is completed.

- ❖ This procedure provides a conductive path for equalizing the potential electrostatic charge between the aircraft and the transfer nozzle. Even if a clip or engaging mechanism is not provided, contact with the fill port must be maintained until the fueling process is complete.

**2006.5.2.3 Funnels.** Where required, metal funnels are allowed to be used during fueling operations. Direct contact

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between the fueling receptacle, the funnel and the fueling nozzle shall be maintained during the fueling operation.

- ❖ Prevention of potential sparks that produce ignition sources for fires is the objective for keeping metal funnels in direct contact with fueling nozzles and receptacles at all times.

**2006.5.3 Training.** Aircraft-fueling vehicles shall be attended and operated only by persons instructed in methods of proper use and operation and who are qualified to use such fueling vehicles in accordance with minimum safety requirements.

- ❖ Only personnel trained in the proper and safe operation of the equipment, emergency controls and emergency procedures are allowed to fuel or defuel aircraft.

**2006.5.3.1 Fueling hazards.** Fuel-servicing personnel shall know and understand the hazards associated with each type of fuel dispensed by the airport fueling-system operator.

- ❖ Personnel performing fueling or defueling procedures must be familiar with every hazard that is involved with each and every fuel that is dispensed.

**2006.5.3.2 Fire safety training.** Employees of fuel agents who fuel aircraft, accept fuel shipments or otherwise handle fuel shall receive *approved* fire safety training.

- ❖ Employees must be trained in and be aware of fire safety rules and precautions involving fuel-servicing processes. Training must be in areas involving vehicle integrity and placement; bonding of vehicles; aircraft; hose connections; valves; and fuel-process equipment. The training must be an approved in-depth program that is recognized by airport authorities.

**2006.5.3.2.1 Fire extinguisher training.** Fuel-servicing personnel shall receive *approved* training in the operation of fire-extinguishing equipment.

- ❖ Employees involved in fuel servicing must have adequate training with extinguishers to use them effectively in the event of an emergency (see commentary, Section 2005.6 for further information).

**2006.5.3.2.2 Records.** The airport fueling-system operator shall maintain records of all training administered to its employees.

- ❖ Training must be documented and records kept on premises for verification, if requested, that the personnel have received the proper training.

**2006.5.4 Transfer personnel.** During fuel-transfer operations, a qualified person shall be in control of each transfer nozzle and another qualified person shall be in immediate control of the fuel-pumping equipment to shut off or otherwise control the flow of fuel from the time fueling operations are begun until they are completed.

### Exceptions:

1. For underwing refueling, the person stationed at the point of fuel intake is not required.

2. For overwing refueling, the person stationed at the fuel pumping equipment shall not be required where the person at the fuel dispensing device is within 75 feet (22 800 mm) of the emergency shutoff device; is not on the wing of the aircraft and has a clear and unencumbered path to the fuel pumping equipment; and the fuel dispensing line does not exceed 50 feet (15 240 mm) in length.

The fueling operator shall monitor the panel of the fueling equipment and the aircraft control panel during pressure fueling or shall monitor the fill port during overwing fueling.

- ❖ Two qualified trained individuals must perform fuel transfer procedures. One individual controls the nozzles. The other individual must be in the control area for flow monitoring and control; and immediate shutdown of fuel flow in case of an emergency (overflow, spill, fire, etc.). The exception for underwing fueling is appropriate because underwing operations require a liquid-tight connection that does not require constant monitoring to ensure freedom from spills and overflows. The four items that must be met in the overwing refueling process are meant for quick response in case a problem occurs. The individual must be completely alert to the fueling process and free from distractions if alone.

**2006.5.5 Fuel flow control.** Fuel flow-control valves shall be operable only by the direct hand pressure of the operator. Removal of the operator's hand pressure shall cause an immediate cessation of the flow of fuel.

- ❖ Deadman controls should be designed so that the operator, while wearing gloves, can hold them for the time required to complete the operation.

**2006.6 Emergency fuel shutoff.** Emergency fuel shutoff controls and procedures shall comply with Sections 2006.6.1 through 2006.6.4.

- ❖ The following sections address emergency fuel shutoff accessibility, fire department notification, determining cause if shutoff activates and testing procedures.

**2006.6.1 Accessibility.** Emergency fuel shutoff controls shall be readily accessible at all times when the fueling system is being operated.

- ❖ Emergency controls must be unobstructed whenever the fueling system is operating. Time should not be wasted having to move objects or material blocking access to the controls before fueling operations can be shut down in an emergency.

**2006.6.2 Notification of the fire department.** The fueling-system operator shall establish a procedure by which the fire department will be notified in the event of an activation of an emergency fuel shutoff control.

- ❖ A plan must be developed for notifying the fire department. The plan should be in a written format and reviewed with trained and certified employees in advance of fueling operations. Notification of the fire

department will have emergency responders on their way immediately in case fire or rescue operations are required.

**2006.6.3 Determining cause.** Prior to reestablishment of normal fuel flow, the cause of fuel shutoff conditions shall be determined and corrected.

❖ If for any reason the flow of fuel is discontinued by the emergency shutoff systems during fueling operations, the cause of the activation must be determined and the problem fixed before fuel flow is started again. Fuel flow may not be restarted if the cause of the shutdown is not determined. If fuel flow were restarted, the problem may occur again and more serious problems could develop.

**2006.6.4 Testing.** Emergency fuel shutoff devices shall be operationally tested at intervals not exceeding three months. The fueling-system operator shall maintain testing records.

❖ Testing of the emergency fuel shutoff devices increases the likelihood that the devices will function properly. Although three-month intervals are the maximum allowed, the test may be performed more frequently if desired. Records are required for documentation that the tests were performed. If an accident occurs, these records will be a great asset for verification that the devices were tested and operational.

**2006.7 Protection of hoses.** Before an aircraft-fueling vehicle is moved, fuel transfer hoses shall be properly placed on the *approved* reel or in the compartment provided, or stored on the top decking of the fueling vehicle if proper height rail is provided for security and protection of such equipment. Fuel-transfer hose shall not be looped or draped over any part of the fueling vehicle, except as herein provided. Fuel-transfer hose shall not be dragged when such fueling vehicle is moved from one fueling position to another.

❖ Accidents or fires may occur if hoses are not properly stored and handled. Sparks caused by metal nozzles or hose ends/couplings striking pavement when hoses are dragged from one area to another are a serious potential ignition source. Also, the hoses are least likely to be damaged if stored in proper locations.

**2006.8 Loading and unloading.** Aircraft-fueling vehicles shall be loaded only at an *approved* loading rack. Such loading racks shall be in accordance with Section 5706.5.1.12.

**Exceptions:**

1. Aircraft-refueling units are allowed to be loaded from the fuel tanks of an aircraft during defueling operations.
2. Fuel transfer between tank vehicles is allowed to be performed in accordance with Section 5706.6 when the operation is not less than 200 feet (60 960 mm) from an aircraft.

The fuel cargo of such units shall be unloaded only by *approved* transfer apparatus into the fuel tanks of aircraft, underground storage tanks or *approved* gravity storage tanks.

❖ Section 5706.5.1.12 addresses requirements for loading racks. Loading racks, platforms and stairs must be constructed of noncombustible materials. Buildings for pumps and buildings that shelter personnel can be part of the loading rack. The area within 25 feet (7620 mm) of a loading platform shall be electrically classified in accordance with Table 5703.1.1.

Transfer of fuel from one tank vehicle to another and from aircraft to vehicle is allowable using approved methods and procedures. At times, loading and unloading fuel from aircraft and refueling units is necessary when taking units out of service and when defueling an aircraft while preparing for maintenance or repair.

An aircraft refueling unit is normally loaded either for refueling an aircraft or for storage. Fuel must not be unloaded into any other type tank, structure or vehicle.

**2006.9 Passengers.** Passenger traffic is allowed during the time fuel transfer operations are in progress, provided the following provisions are strictly enforced by the *owner* of the aircraft or the *owner's* authorized employee:

1. Smoking and producing an open flame in the cabin of the aircraft or the outside thereof within 50 feet (15 240 mm) of such aircraft shall be prohibited.

A qualified employee of the aircraft *owner* shall be responsible for seeing that the passengers are not allowed to smoke when remaining aboard the aircraft or while going across the ramp from the gate to such aircraft, or vice versa.

2. Passengers shall not be permitted to linger about the plane, but shall proceed directly between the loading gate and the aircraft.
3. Passenger loading stands or walkways shall be left in loading position until all fuel transfer operations are completed.
4. Fuel transfer operations shall not be performed on the main *exit* side of any aircraft containing passengers except when the *owner* of such aircraft or a capable and qualified employee of such *owner* remains inside the aircraft to direct and assist the escape of such passengers through regular and emergency *exits* in the event fire should occur during fuel transfer operations.

❖ Special precautions must be taken to protect passengers during fueling operations. If passengers are permitted on or around the aircraft during refueling operations, an employee of the airline or a representative of the airport authority must remain on board and the specified precautions must be taken.

Aircraft fueling, servicing, baggage and cargo loading, movement and passenger boarding are generally conducted in and around the passenger terminal building on the aircraft apron. Aircraft refueling is often accomplished by special refueling vehicles acting like mobile gas stations, transferring fuel directly from their tanks to aircraft fuel tanks. Aircraft fuel tanks are usually topped off after each flight, unless they are making scheduled stops on a multistop flight.

Terminal building discharge to the aircraft apron is not permitted by FAA regulations; however, egress from the aircraft to the apron in the event of a fire or other emergency is permitted. Passengers and unauthorized personnel must be immediately accounted for and escorted from the aircraft operation area.

The terminal building is not required to be separated from the aircraft apron by fire-resistance-rated construction; however, it is considered good practice to take reasonable steps to prevent fire from fueling accidents or other mishaps. Portable fire extinguishers are required on the aircraft apron in accordance with Section 2005.

In Item 1, smoking and open flames are prohibited within and around the aircraft during refueling operations because of the potential for fuel vapors being present. The “No Smoking” signs located in the aircraft cabin must remain illuminated while the aircraft is parked at the gate during refueling operations.

Item 2 requires that deplaning passengers must proceed directly to the terminal and may not remain on the aircraft apron during refueling operations, cargo loading or other similar service functions in order to avoid potential injury.

In Item 3, egress stairways and passageways must remain connected or intact during refueling operations. These stairways and ramps are the primary exit if an emergency occurs during aircraft refueling operations.

Item 4 recognizes that maintenance and fueling operations represent the most serious fire safety concerns at airports and heliports. Fueling represents perhaps the greatest risk because it is commonly conducted near passenger and cargo handling areas and buildings, while maintenance operations are confined to hangars or designated outside maintenance areas. Fueling operations are to be conducted in a manner that avoids locating the refueler on the primary exit side of the aircraft. Airline employees or airport authorities are responsible for directing and assisting egress in the event of an emergency and must direct passengers to exits away from the fueling operation (see commentary, Section 2006.5.1).

**2006.10 Sources of ignition.** Smoking and producing open flames within 50 feet (15 240 mm) of a point where fuel is being transferred shall be prohibited. Electrical and motor-driven devices shall not be connected to or disconnected from an aircraft at any time fueling operations are in progress on such aircraft.

- ❖ The 50-foot (15 240 mm) distance is considered a safe distance from the fuel transfer operation for dis-

sipation of any escaping vapors. Prohibiting open flames and smoking eliminates a prime ignition source (examples of open flame devices are lighted cigarettes, cigars, pipes, cigarette lighters, etc.). Because disconnection or connection of any electrical or motor-driven device could create a spark, these activities are not allowed during refueling.

**2006.11 Fuel spill prevention and procedures.** Fuel spill prevention and the procedures for handling spills shall comply with Sections 2006.11.1 through 2006.11.7.

- ❖ The following sections address equipment maintenance, fuel nozzles, fueling drums, fuel spill procedures, fire department notification and prohibited procedures for multiple fuel deliveries.

**2006.11.1 Fuel-service equipment maintenance.** Aircraft fuel-servicing equipment shall be maintained and kept free from leaks. Fuel-servicing equipment that malfunctions or leaks shall not be continued in service.

- ❖ Fuel-service equipment must not be used unless it is in proper repair and free of possible cracks, frays or breaks that could cause leaks. Defective equipment must be taken out of service and repaired.

**2006.11.2 Transporting fuel nozzles.** Fuel nozzles shall be carried utilizing appropriate handles. Dragging fuel nozzles along the ground shall be prohibited.

- ❖ An ignition source may be produced by dragging the nozzle. Using the appropriate handling devices eliminates both sparking and nozzle damage.

**2006.11.3 Drum fueling.** Fueling from drums or other containers having a capacity greater than 5 gallons (19 L) shall be accomplished with the use of an *approved* pump.

- ❖ The use of an approved pump for transferring fuel from drums with capacity in excess of 5 gallons (19 L) greatly reduces the possibility of spills.

**2006.11.4 Fuel spill procedures.** The fueling-system operator shall establish procedures to follow in the event of a fuel spill. These procedures shall be comprehensive and shall provide for all of the following:

1. Upon observation of a fuel spill, the aircraft-fueling operator shall immediately stop the delivery of fuel by releasing hand pressure from the fuel flow-control valve.
  2. Failure of the fuel control valve to stop the continued spillage of fuel shall be cause for the activation of the appropriate emergency fuel shutoff device.
  3. A supervisor for the fueling-system operator shall respond to the fuel spill area immediately.
- ❖ Safety and emergency procedures must be in place, and personnel must be trained on these procedures. Should a spill occur, the person operating the fuel delivery hose must immediately release hand pressure to stop fuel flow. If this action does not shut off fuel flow, the emergency shutoff device must be activated.

Fuel system supervisors and operators must be trained in the procedures they must follow in case of

a fuel spill. Supervisors must respond if a spill occurs and assist in containment and cleanup if necessary.

**2006.11.5 Notification of the fire department.** The fire department shall be notified of any fuel spill that is considered a hazard to people or property or which meets one or more of the following criteria:

1. Any dimension of the spill is greater than 10 feet (3048 mm).
2. The spill area is greater than 50 square feet (4.65 m<sup>2</sup>).
3. The fuel flow is continuous in nature.

❖ Three criteria are given for determining when the fire department must be notified. Any amount of spill exceeding those criteria causes great concern and must be considered a fire hazard. The fire department must be notified because people and property are at risk if a spill ignites and causes explosion and fire.

**2006.11.6 Investigation required.** An investigation shall be conducted by the fueling-system operator of all spills requiring notification of the fire department. The investigation shall provide conclusive proof of the cause and verification of the appropriate use of emergency procedures. Where it is determined that corrective measures are necessary to prevent future incidents of the same nature, they shall be implemented immediately.

❖ Any spill must be investigated to determine the cause and whether the emergency action plan was properly carried out. If corrective measures are needed, they must be implemented immediately. This investigation should be looked upon as positive, potentially leading to a more efficient emergency action plan that could avoid future property damage and loss of life.

**2006.11.7 Multiple fuel delivery vehicles.** Simultaneous delivery of fuel from more than one aircraft-fueling vehicle to a single aircraft-fueling manifold is prohibited unless proper backflow prevention devices are installed to prevent fuel flow into the tank vehicles.

❖ Only one tank vehicle may be connected to any one aircraft-fueling manifold unless a means is provided that prevents fuel from flowing back into the tank vehicle because of a difference in the pumping pressure. Backflow from one tanker to another could result in fuel overflow from the receiving vehicle that would cause a major fuel spill.

**2006.12 Aircraft engines and heaters.** Operation of aircraft onboard engines and combustion heaters shall be terminated prior to commencing fuel service operations and shall remain off until the fuel-servicing operation is completed.

**Exception:** In an emergency, a single jet engine is allowed to be operated during fuel servicing where all of the following conditions are met:

1. The emergency shall have resulted from an onboard failure of the aircraft's auxiliary power unit.

2. Restoration of auxiliary power to the aircraft by ground support services is not available.
3. The engine to be operated is either at the rear of the aircraft or on the opposite side of the aircraft from the fuel service operation.
4. The emergency operation is in accordance with a written procedure *approved* by the *fire code official*.

❖ Operation of any aircraft engines or combustion heaters allows the possibility of an ignition source being produced. Even in the exceptions allowed in an emergency, care must be taken in preventing a possible fire hazard.

**2006.13 Vehicle and equipment restrictions.** During aircraft-fueling operations, only the equipment actively involved in the fueling operation is allowed within 50 feet (15 240 mm) of the aircraft being fueled. Other equipment shall be prohibited in this area until the fueling operation is complete.

**Exception:** Aircraft-fueling operations utilizing single-point refueling with a sealed, mechanically locked fuel line connection and the fuel is not a Class I flammable liquid.

A clear space of not less than 10 feet (3048 mm) shall be maintained between aircraft fuel-system vent openings and any part or portion of aircraft-servicing vehicles or equipment.

❖ To control the number and type of ignition sources to which the fueling operation might be exposed, no equipment, other than the equipment performing aircraft-servicing functions, is permitted within a 50-foot (15 240 mm) radius of the aircraft during the fueling of the aircraft. The space between service vehicles and equipment and the aircraft fuel vent must be no less than 10 feet (3048 mm) when using a single-point sealed mechanically locked fuel line connector.

**2006.13.1 Overwing fueling.** Vehicles or equipment shall not be allowed beneath the trailing edge of the wing when aircraft fueling takes place over the wing and the aircraft fuel-system vents are located on the upper surface of the wing.

❖ Equipment under the trailing edge of the wing could cause a fire hazard if a leak or spill were to occur. The fuel would run off the edge of the wing and the equipment could have an ignition source and cause a fire.

**2006.14 Electrical equipment.** Electrical equipment, including but not limited to, battery chargers, ground or auxiliary power units, fans, compressors or tools, shall not be operated, nor shall they be connected or disconnected from their power source, during fuel service operations.

❖ Even hand lamps used in the fuel-servicing operation must be approved for the proper hazardous location classification. The equipment could produce sparks that could be an ignition source.

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**2006.14.1 Other equipment.** Electrical or other spark-producing equipment shall not be used within 10 feet (3048 mm) of fueling equipment, aircraft fill or vent points, or spill areas unless that equipment is intrinsically safe and *approved* for use in an explosive atmosphere.

- ❖ No equipment that produces a spark during its operation can be used within a 10-foot (3048 mm) radius of the fueling-operational equipment.

**2006.15 Open flames.** Open flames and open-flame devices are prohibited within 50 feet (15 240 mm) of any aircraft fuel-servicing operation or fueling equipment.

- ❖ Blow torches, welding and cutting equipment, and flare pots are a few examples of equipment that are not allowed within 50 feet (15 240 mm) of the fueling equipment or the fueling operation.

**2006.15.1 Other areas.** The *fire code official* is authorized to establish other locations where open flames and open-flame devices are prohibited.

- ❖ Depending on the situation, the fire code official may find other locations in which open flames and open-flame devices must be prohibited. Examples could be exposed flame heaters, portable gasoline or kerosene heaters.

**2006.15.2 Matches and lighters.** Personnel assigned to and engaged in fuel-servicing operations shall not carry matches or lighters on or about their person. Matches or lighters shall be prohibited in, on or about aircraft-fueling equipment.

- ❖ Because matches, lighters and smoking materials are an ignition hazard, these items are prohibited everywhere in the vicinity of aircraft fueling operations.

**2006.16 Lightning procedures.** The *fire code official* is authorized to require the airport authority and the fueling-system operator to establish written procedures to follow when lightning flashes are detected on or near the airport. These procedures shall establish criteria for the suspension and resumption of aircraft-fueling operations.

- ❖ Fuel-servicing procedures must cease when lightning flashes occur at or in the vicinity of the airport. The fueling supervisor and airport authority must establish a written procedure that sets the criteria for stopping and restarting fueling operations.

**2006.17 Fuel-transfer locations.** Aircraft fuel-transfer operations shall be prohibited indoors.

**Exception:** In aircraft hangars built in accordance with the provisions of the *International Building Code* for Group F-1 occupancies, aircraft fuel-transfer operations are allowed where either of the following conditions exist:

1. Necessary to accomplish aircraft fuel-system maintenance operations. Such operations shall be performed in accordance with nationally recognized standards.
  2. The fuel being used has a *flash point* greater than 100°F (37.8°C).
- ❖ Aircraft fueling operations must be performed outdoors to minimize the accumulation of flammable

vapors. The exception allows indoor fueling only under very specific and limited conditions.

**2006.17.1 Position of aircraft.** Aircraft being fueled shall be positioned such that any fuel system vents and other fuel tank openings are not less than:

1. Twenty-five feet (7620 mm) from buildings or structures other than jet bridges; and
2. Fifty feet (15 240 mm) from air intake vents for boiler, heater or incinerator rooms.

- ❖ Maintaining minimum distances between fueling operations and other aircraft or buildings allows any flammable vapors released during fueling to dissipate before encountering any possible ignition sources. These distances also provide protection against ignitable vapor concentrations getting to an ignition source in the event of a fuel spill.

**2006.17.2 Fire equipment access.** Access for fire service equipment to aircraft shall be maintained during fuel-servicing operations.

- ❖ A clear and unobstructed path is required for quick response for fire personnel. A quick response is essential in an emergency; however, an obstacle may create a delay in emergency operations.

**2006.18 Defueling operations.** The requirements for fueling operations contained in this section shall also apply to aircraft defueling operations. Additional procedures shall be established by the fueling-system operator to prevent overfilling of the tank vehicle used in the defueling operation.

- ❖ Transferring of fuel from an aircraft through a hose to a tank vehicle is generally the same process as fueling. The same requirements apply to defueling as to fuel servicing an aircraft. Operators must establish procedures and safeguards for prevention of overfilling the tank vehicle, which is a hazard when defueling.

**2006.19 Maintenance of aircraft-fueling hose.** Aircraft-fueling hoses shall be maintained in accordance with Sections 2006.19.1 through 2006.19.4.

- ❖ The following sections address the maintenance of aircraft fueling hose in terms of the frequency of inspections, recognizing damaged hose and repairing the hose before placing it back in service.

**2006.19.1 Inspections.** Hoses used to fuel or defuel aircraft shall be inspected periodically to ensure their serviceability and suitability for continued service. The fuel-service operator shall maintain records of all tests and inspections performed on fueling hoses. Hoses found to be defective or otherwise damaged shall be immediately removed from service.

- ❖ Regular inspections of fueling equipment are essential to maintaining serviceable systems. Records of these inspections are required to document inspection results. Damaged or defective items must be removed from service immediately for repair or replacement.

**2006.19.1.1 Daily inspection.** Each hose shall be inspected daily. This inspection shall include a complete visual scan of the exterior for evidence of damage, blistering or leakage. Each coupling shall be inspected for evidence of leaks, slip-page or misalignment.

- ❖ Daily hose inspections are essential for prevention of leaks. Even minor damage to a hose, coupling, nozzle or other system part can lead to safety hazards.

**2006.19.1.2 Monthly inspection.** A more thorough inspection, including pressure testing, shall be accomplished for each hose on a monthly basis. This inspection shall include examination of the fuel delivery inlet screen for rubber particles, which indicates problems with the hose lining.

- ❖ During the monthly inspection, the hose again must be extended to its full length of operation. The area within 12 inches (305 mm) of the coupling must be examined for structural weakness by pressing and observing soft spots. Hoses must be pressure tested at operating pressure and observed for ballooning or twisting that would indicate a weakening of the hose carcass. Examination of the fuel inlet screen for rubber particles is a means of checking the condition of hose linings.

**2006.19.2 Damaged hose.** Hose that has been subjected to severe abuse shall be immediately removed from service. Such hoses shall be hydrostatically tested prior to being returned to service.

- ❖ If hose has been subjected to unusual abuse, it must be removed from service immediately as a safety precaution. Such hoses must be hydrostatically tested and inspected. If any soft spots or weakening of the hose is observed, the hose may not be returned to service.

**2006.19.3 Repairing hose.** Hoses are allowed to be repaired by removing the damaged portion and recoupling the undamaged end. When recoupling hoses, only couplings designed and *approved* for the size and type of hose in question shall be used. Hoses repaired in this manner shall be visually inspected and hydrostatically tested prior to being placed back in service.

- ❖ Damaged hoses can be repaired. The damaged portion must be cut off and the undamaged part recoupled. Two lengths from separate hoses may not be joined. To increase the likelihood that the repaired hose is leak tight, only couplings specifically designed for that type and size of hose can be used. Hydrostatic testing of the repaired hose increases efficiency and safety for fueling operations.

**2006.19.4 New hose.** New hose shall be visually inspected prior to being placed into service.

- ❖ Before any new hose assembly can be placed into service, it must be inspected visually for evidence of damage or wear and tear of any kind.

**2006.20 Aircraft fuel-servicing vehicles parking.** Unattended aircraft fuel-servicing vehicles shall be parked in areas that provide for both the unencumbered dispersal of vehicles in the event of an emergency and the control of leakage such

that adjacent buildings and storm drains are not contaminated by leaking fuel.

- ❖ The fuel-servicing vehicles must be positioned so that they can be moved quickly if an emergency occurs. This may not only save the vehicle but also assist in a rapid response to an emergency situation and saving lives. Fuel leaking into storm drains causes not only environmental problems, but also a serious explosion hazard if vapor accumulates in the confines of a drain line.

**2006.20.1 Parking area design.** Parking areas for tank vehicles shall be designed and utilized such that a clearance of 10 feet (3048 mm) is maintained between each parked vehicle for fire department access. In addition, a minimum clearance of 50 feet (15 240 mm) shall be maintained between tank vehicles and parked aircraft and structures other than those used for the maintenance and/or garaging of aircraft fuel-servicing vehicles.

- ❖ This section regulates the design and use of outdoor parking areas for aircraft fueling vehicles. The requirement for a 10-foot (3048 mm) clearance between parked fueling vehicles permits ready access by fire department personnel and equipment in case of an emergency. The fire department may need the area to deploy hose in case of a fire or to walk through the area en route to an investigation of an emergency call. The 50-foot (15 240 mm) clearance requirement is to allow dispersion of flammable vapors in case of a leak before the vapors can enter nearby buildings or parked aircraft, and possibly reach an ignition source inside. Such clearance would not be required for buildings that have been approved by the fire code official in accordance with Section 5706.6.3 for the purpose of garaging or repairing aircraft fuel-servicing vehicles, based on the assumption that such buildings would have ignition sources safeguarded. This clearance also provides a measure of exposure protection for the parked vehicles in the event of a fire in the building or a parked aircraft.

**2006.21 Radar equipment.** Aircraft fuel-servicing operations shall be prohibited while the weather-mapping radar of that aircraft is operating.

Aircraft fuel-servicing or other operations in which flammable liquids, vapors or mists could be present shall not be conducted within 300 feet (91 440 mm) of an operating aircraft surveillance radar.

Aircraft fuel-servicing operations shall not be conducted within 300 feet (91 440 mm) of airport flight traffic surveillance radar equipment.

Aircraft fuel-servicing or other operations in which flammable liquids, vapors or mists could be present shall not be conducted within 100 feet (30 480 mm) of airport ground traffic surveillance radar equipment.

- ❖ The beam of radar equipment has been known to cause flammable vapor-air mixtures to ignite from electrical arcs or sparks from chance resonant (con-

tinuing) conditions. This ability of an arc to ignite flammable vapor-air mixtures depends on the total energy of the arc and the time lapse involved. The key factor in establishing safe distances between fueling operations, storage areas and radar antennas is the peak power output of the radar unit.

**2006.21.1 Direction of radar beams.** The beam from ground radar equipment shall not be directed toward fuel storage or loading racks.

**Exceptions:**

1. Fuel storage and loading racks in excess of 300 feet (91 440 mm) from airport flight traffic surveillance equipment.
  2. Fuel storage and loading racks in excess of 100 feet (30 480 mm) from airport ground traffic surveillance equipment.
- ❖ Ground radar for approach control or traffic pattern surveillance is considered the most hazardous type of radar normally operated at an airport. The beam must not be directed toward fuel storage or loading racks because of the possible ignition sources (sparks, arcs) igniting flammable vapor-air mixtures. The exceptions are based on the arc energy emissions of the radars listed.

**SECTION 2007  
HELISTOPS AND HELIPORTS**

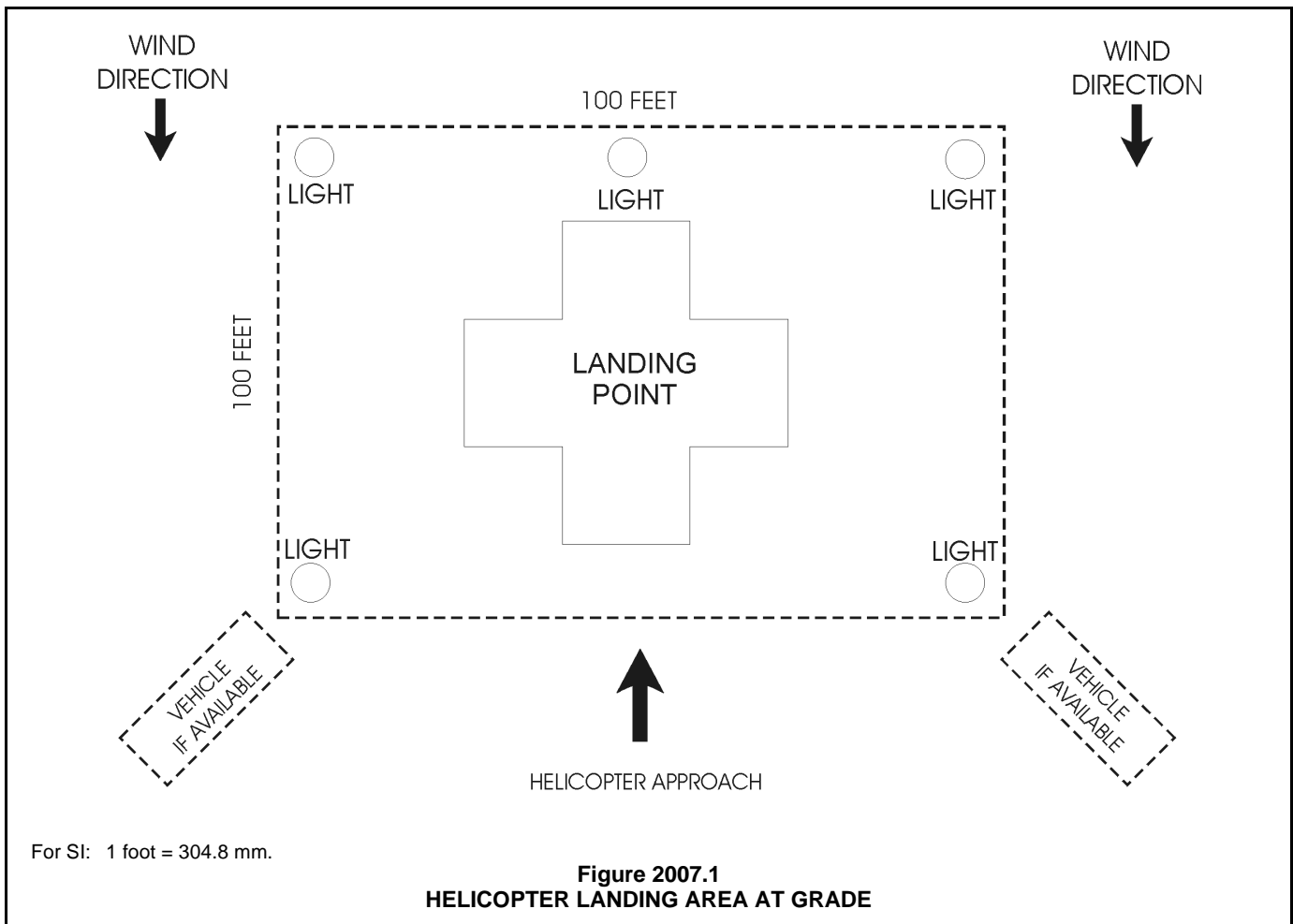
**2007.1 General.** Helistops and heliports shall be maintained in accordance with Sections 2007.2 through 2007.8. Helistops and heliports on buildings shall be constructed in accordance with the *International Building Code*.

❖ The following sections address clearances of the touch-down areas, spillage of liquid fuels, exits, fire protection systems and approval of the FAA. Information for construction and design of heliports can be found in FAA A/C 150/5390-2A, as well as in the IBC (see Commentary Figure 2007.1).

**2007.2 Clearances.** The touchdown area shall be surrounded on all sides by a clear area having minimum average width at roof level of 15 feet (4572 mm) but no width less than 5 feet (1524 mm). The clear area shall be maintained.

❖ Most accidents involving helicopters occur during takeoff and landing procedures, with a significant number occurring at night or in bad weather. The clearance requirements are intended to limit the likelihood of the aircraft colliding with permanent features at the landing site.

**2007.3 Flammable and Class II combustibile liquid spillage.** Landing areas on structures shall be maintained so as to



confine flammable or Class II *combustible liquid* spillage to the landing area itself, and provisions shall be made to drain such spillage away from *exits* or *stairways* serving the helicopter landing area or from a structure housing such *exit* or *stairway*.

❖ Rooftop landing areas must be designed to prevent fuel spills from escaping the landing area and flowing into adjacent or lower building spaces that could contain ignition sources for the fuel vapors. The stairways and exits serving the landing area must also be protected from the effects of fuel spills to afford personnel a safe means of escape from any dangers developing on the landing area. To accomplish this task, some rooftop heliport structure designs drain the pad to the center of the landing area. Although it is not required by the code, such designs often provide some means of separating fuel runoff from storm water. Additionally, drip pans should be provided below the helicopter engine when the aircraft is parked with the engine off.

**2007.4 Exits.** *Exits* and *stairways* shall be maintained in accordance with Section 412.7 of the *International Building Code*.

❖ IBC Section 412.5 refers to Chapter 10 for exit requirements. The section also addresses landing platforms and roof area size and the number of exits required. At least two means of egress must be provided off the landing pad.

**2007.5 Standpipe systems.** A building with a rooftop heli-stop or heliport shall be provided with a Class I or III standpipe system extended to the roof level on which the heli-stop or heliport is located. All portions of the heli-stop and heliport area shall be within 150 feet (45 720 mm) of a 2<sup>1</sup>/<sub>2</sub>-inch (63.5 mm) outlet on the standpipe system.

❖ A heliport is a distinct hazard that will involve flammable fuels. In the event of an emergency, rapid deployment of hand-held hose lines will be necessary to attack a resulting fire, effectuate rescue and protect exposures, as well as the remainder of the building.

Section 905.3.6 and this section require that when a heli-stop or heliport is provided on a rooftop location, a standpipe system is required throughout the building, with a 2<sup>1</sup>/<sub>2</sub>-inch hose connection within 150 feet of all parts of the heli-stop or heliport at the roof level. This is critical in fire-fighting operations because many times the connection below the rooftop level may be needed just to gain access to the roof. If the only hose connection were on the roof, it would be of no use if the fire fighters could not get to it. Since a heliport includes liquid fueling operations, it is entirely possible for a spill to affect not only the rooftop area, but also the floors below as the liquid fuel spreads downward into the building. The standpipe system will again be utilized in these situations.

Class I standpipes serve 2<sup>1</sup>/<sub>2</sub>-inch (63.5 mm) fire hose valves for fire department use. Class III standpipes have both 2<sup>1</sup>/<sub>2</sub>-inch (63.5 mm) valves for fire

department use and 1<sup>1</sup>/<sub>2</sub>-inch (38 mm) fire hose cabinets for use by building occupants.

**2007.6 Foam protection.** Foam fire-protection capabilities shall be provided for rooftop heliports. Such systems shall be designed, installed and maintained in accordance with the applicable provisions of Sections 903, 904 and 905.

❖ A foam fire-extinguishing system must be designed and installed for protection of the rooftop landing pad. Factors considered in the design of the system are aircraft size, effectiveness of agent selected, time required to achieve control and time required to maintain control. Foam discharge rates must also be considered according to the type of foam selected.

**2007.7 Fire extinguishers.** Not less than one portable fire extinguisher having a minimum 80-B:C rating shall be provided for each permanent takeoff and landing area and for the aircraft parking areas. Installation, inspection and maintenance of these extinguishers shall be in accordance with Section 906.

❖ The portable fire extinguisher for the takeoff/landing area must be effective for the extinguishment of a flammable liquid fire and for energized electrical components.

**2007.8 Federal approval.** Before operating helicopters from heli-stops and heliports, approval shall be obtained from the Federal Aviation Administration.

❖ The FAA approves all installations of heliports and heli-stops. Design criteria can be found in FAA A/C 150/5390-2A.

## Bibliography

The following resource material was used in the preparation of the commentary for this chapter of the code:

*Code Changes Resource Collection—2015 International Fire Code*. Washington, DC: International Code Council, 2014.



# Chapter 21: Dry Cleaning

## General Comments

Dry cleaning operations remove dirt, grease and other foreign substances from clothing, rugs, textiles and fabrics with solvents that are not water based, thus it is called “dry.” These methods may involve several techniques, including immersion and agitation, brushing or scouring, or dual-phase processing, which replicate a laundering (soap and water) process using the same equipment. The solvents employed may be flammable or nonflammable and may present certain health hazards. Both the fire code official and fire service personnel should be aware of the health and flammability hazards.

Concerns over flammability hazards and hazardous waste disposal have radically altered the nature of the dry cleaning business in the United States. Most plants currently use nonflammable solvents, such as perchloroethylene (“perc”) or tetrachloroethylene, rather than Stoddard solvent, naphtha, kerosene, gasoline or specially compounded oils, which were favored in previous years. “Perc” had become the solvent of choice for the dry cleaning industry over the years because it is not

only safer and faster, but does a much better job of cleaning, requires small equipment and is safe enough to be used in retail- or public-operated equipment. However, it has fallen into disfavor because of its carcinogenicity (see commentary, Section 2108.2).

Storage of flammable and combustible liquids must comply with the requirements of Chapter 57. Flammable solvent containers and processing equipment must be bonded and grounded during storage, handling and use to prevent buildup of static charges. Solvents must be used only in equipment approved for use with that specific class of solvent.

## Purpose

The provisions of Chapter 21 are intended to reduce hazards associated with use of flammable and combustible dry cleaning solvents. These materials, like all volatile organic chemicals, generate significant quantities of static electricity and are thus readily ignitable. Many flammable and nonflammable dry cleaning solvents also possess health hazards when involved in a fire.

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## SECTION 2101 GENERAL

**2101.1 Scope.** Dry cleaning plants and their operations shall comply with the requirements of this chapter.

❖ Hazards associated with dry cleaning operations are addressed by the provisions of this chapter. Solvent storage hazards are addressed by Chapter 57.

**2101.2 Permit required.** Permits shall be required as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit and Section 105.6.13 for discussion of specific operational permits for dry cleaning plants and their operation.

## SECTION 2102 DEFINITIONS

**2102.1 Definitions.** The following terms are defined in Chapter 2:

**DRY CLEANING.**

**DRY CLEANING PLANT.**

**DRY CLEANING ROOM.**

**DRY CLEANING SYSTEM.**

**SOLVENT OR LIQUID CLASSIFICATIONS.**

**Class I solvents.**

**Class II solvents.**

**Class IIIA solvents.**

**Class IIIB solvents.**

**Class IV solvents.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper

application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3 or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

### SECTION 2103 CLASSIFICATIONS

**2103.1 Solvent classification.** Dry cleaning solvents shall be classified according to their *flash points* as follows:

1. Class I solvents are liquids having a *flash point* below 100°F (38°C).
  2. Class II solvents are liquids having a *flash point* at or above 100°F (38°C) and below 140°F (60°C).
  3. Class IIIA solvents are liquids having a *flash point* at or above 140°F (60°C) and below 200°F (93°C).
  4. Class IIIB solvents are liquids having a *flash point* at or above 200°F (93°C).
  5. Class IV solvents are liquids classified as nonflammable.
- ❖ In order to establish regulations for mitigating the hazards of dry cleaning, the hazards of dry cleaning solvent must be identified and established. Because the liquid solvents used in dry cleaning operations, other than Class IV solvents, are either flammable or combustible, they are classified using the same criteria as those used to classify flammable and combustible liquids in Chapter 57.

Class I solvents are, by the definition in Chapter 57, flammable liquids because they have a closed-cup flash point of less than 100°F (38°C). The 100°F (38°C) flash point for flammable solvents assumes possible indoor ambient temperature conditions of 100°F (38°C), which means that the solvent could be used at or below its flash point under normal operating conditions in the dry cleaning plant. This solvent classification, however, includes no further subclassifications based on flash point and boiling point as does Chapter 57 for Class I flammable liquids.

Combustible solvents (Classes II and III) differ from flammable solvents in that the closed-cup flash point of all combustible liquids is at or above 100°F (38°C) (see commentary, definition of “Flash point” in Chapter 57). The range of flash point dictates the class of liquid solvent. The flash point range of 100°F (38°C) to 140°F (60°C) for Class II solvents is based on a possible indoor ambient temperature exceeding 100°F (38°C). Only a moderate degree of heating is required to bring the solvent to its flash point in this situation. Class III solvents, which have flash points higher than 140°F (38°C), require a significant heat source in addition to ambient temperature conditions to reach their flash point (see commentary, definition of “Flammable liquid” in Chapter 57).

### 2103.2 Classification of dry cleaning plants and systems.

Dry cleaning plants and systems shall be classified based on the solvents used as follows:

1. Type I—systems using Class I solvents.
2. Type II—systems using Class II solvents.
3. Type III-A—systems using Class IIIA solvents.
4. Type III-B—systems using Class IIIB solvents.
5. Type IV—systems using Class IV solvents in which dry cleaning is not conducted by the public.
6. Type V—systems using Class IV solvents in which dry cleaning is conducted by the public.

Spotting and pretreating operations conducted in accordance with Section 2106 shall not change the type of the dry cleaning plant.

❖ Dry cleaning plants are classified based on the solvents they use and the hazards presented by them.

Type I dry cleaning systems are those systems using a Class I flammable liquid [flash point less than 100°F (38°C)] as a cleaning solvent, such as low flash-point [less than 50°F (10°C)] naphtha. Such plants are prohibited by Section 2104.1.

Type II dry cleaning systems are those systems using a Class II combustible liquid [flash points 100°F (38°C) to 140°F (60°C)] as a cleaning solvent, such as Stoddard solvent. NFPA 32 classifies the entire dry cleaning room of a Type II plant as a Class I, Division 2 hazardous (classified) location.

Type III-A dry cleaning systems are those systems using a Class IIIA combustible liquid as a cleaning solvent [flash point 140°F (60°C) to 200°F (93°C)].

Type III-B dry cleaning systems are those systems using a Class IIIB combustible liquid as a cleaning solvent [flash point greater than 200°F (93°C)], usually specially compounded oils.

Type IV dry cleaning systems are those systems using nonflammable solvents, and dry cleaning is done only by trained operators.

Type V dry cleaning systems are those systems using nonflammable solvent, typically perchloroethylene, and dry cleaning is done by the general public (e.g., at coin-operated laundries).

This section recognizes the practical need to have limited amounts of higher hazard solvents on hand in the plant for spotting and pretreating by not classifying the plant based on the highest hazard solvent that might be present in any quantity. See the commentary to Section 2106 for further information on spotting and pretreating operations.

**2103.2.1 Multiple solvents.** Dry cleaning plants using more than one class of solvent for dry cleaning shall be classified based on the numerically lowest solvent class.

❖ Ventilation, and electrical requirements in particular, vary considerably among various types of dry cleaning plants. Additionally, each type of dry cleaning equipment is designed for the hazards specific to the

solvent used. The greatest hazard determines the appropriate level of protection where a danger of accidental misuse exists.

The more volatile compounds, such as naphtha, Stoddard solvent and oils, may still be found in some specialized industrial dry cleaning plants to remove specific materials from work clothes. Although perchloroethylene and similar safety solvents are not flammable, they do present certain health hazards, especially under fire conditions. Commentary Figure 2103.2.1 lists some of the more common dry cleaning solvents with their physical, flammability and toxicity characteristics.

Perchloroethylene concentrations as low as 300 to 1,100 parts per million (ppm) under normal conditions may cause loss of coordination and impairment, while dizziness, drowsiness or loss of consciousness may result at higher concentrations. Perchloroethylene may also emit highly toxic and irritating fumes in a fire.

**2103.3 Design.** The occupancy classification, design and construction of dry cleaning plants shall comply with the applicable requirements of the *International Building Code*.

❖ This section makes it clear that dry cleaning plants are required to comply with the applicable provisions of the *International Building Code*® (IBC®) for their classification of occupancy, as well as their design and construction.

Dry cleaning operations are classified in Group B based on IBC Section 304.1 where only drop-off/pickup facilities are provided or where self-service dry cleaning is done by the public using Class V systems with Class IV solvents (see Sections 2103.1 and 2103.2 of the code). Nonself-service dry cleaning operations using other than flammable liquids in cleaning or dyeing operations are classified in moderate hazard industrial Group F-1 (see IBC Section 306.2) based on the classification and quantity of dry cleaning solvent used. The Group F-1 occupancy classification for dry cleaning plants is based on IBC Section 307.1, which provides two exceptions to classification in Group H for dry cleaning plants.

The first exception, Exception 4, states that plants utilizing Class IIIA solvents [flash point at or above 140°F (60°C)] in closed, testing laboratory-listed machines are exempt from being classified in Group H, provided that the plant is physically separated from all other portions of the building in which it is located

by 1-hour fire barriers or horizontal assemblies, or both.

The second exception, Exception 5, states that plants utilizing Class IIIB solvents [flash point at or above 200°F (93°C)] that are difficult to ignite are exempt from being classified in Group H without further conditions. Such liquids can be used in open systems, but with due care.

Systems that do not meet the descriptions and exceptions above must be evaluated for possible classification in Group H based upon the type and quantity of solvent in storage use. If a Group H classification is warranted, IBC Section 415.9.3 requires compliance with the applicable provisions of the *International Plumbing Code*® (IPC®), the *International Mechanical Code*® (IMC®) and NFPA 32 for plant construction and system installation. Both NFPA 32 and the IMC specify mechanical exhaust ventilation rates for dry cleaning rooms.

The IPC specifies requirements for sanitary sewers and drains in laundries and where hazardous materials are used or stored.

**SECTION 2104  
GENERAL REQUIREMENTS**

**2104.1 Prohibited use.** Type I dry cleaning plants shall be prohibited. Limited quantities of Class I solvents stored and used in accordance with this section shall not be prohibited in dry cleaning plants.

❖ This section flatly prohibits Class I dry cleaning plants (i.e., those that use Class I flammable liquids) because of the extreme flammability of such liquids. This section also recognizes the practical need to have limited amounts of Class I solvent on hand in the plant for spotting and pretreating, provided that it is stored and used in accordance with Chapter 57. See the commentary to Section 2106 for further information on spotting and pretreating operations.

**2104.2 Building services.** Building services and systems shall be designed, installed and maintained in accordance with this section and Chapter 6.

❖ Electrical and mechanical systems serving the dry cleaning plant must comply with the provisions of Sections 2104.2.1 through 2104.2.4 and the applicable provisions of Chapter 6.

CHEMICAL NAME	FLASH POINT	IGNITION TEMPERATURE	HEALTH <sup>a</sup>	FLAMMABILITY <sup>a</sup>	REACTIVITY <sup>a</sup>
Naptha	28° to 50°F	450°F	1	3	0
Perchloroethylene	None	None	2	0	0
Stoddard solvent	Above 100°F	444°F	0	2	0

For SI: °C = [(°F) - 32]/1.8.

a. Based on NFPA 704.

**Figure 2103.2.1  
CHARACTERISTICS OF DRY CLEANING SOLVENTS**

## DRY CLEANING

**2104.2.1 Ventilation.** Ventilation shall be provided in accordance with Section 502 of the *International Mechanical Code* and DOL 29 CFR Part 1910.1000, where applicable.

❖ This section is intended to provide ventilation in dry cleaning plants that is adequate to protect plant employees and the public from the hazards associated with dry cleaning operations using any of the various classes of dry cleaning solvents, both in approved dry cleaning machines and in spotting and pretreating operations in the open. To achieve this objective, this section requires that mechanical ventilation systems comply with the provisions of IMC Section 502.6. Compliance with the applicable provisions of the Occupational Safety and Health Administration (OSHA) workplace regulations pertaining to air contaminants contained in DOL 29 CFR 1910.1000 is also required.

**2104.2.2 Heating.** In Type II dry cleaning plants, heating shall be by indirect means using steam, hot water or hot oil only.

❖ Open-flame heating appliances, such as unit heaters, must not be located in Type II dry cleaning plants because they could create conditions conducive to the ignition of any fugitive vapors from the Class II dry cleaning solvent used in these plants. Indirect steam, hot water or hot oil heat supplied from appliances located in rooms separated from the Type II dry cleaning plant or in separate buildings are examples of indirect heat methods.

**2104.2.3 Electrical wiring and equipment.** Electrical wiring and equipment in dry cleaning rooms or other locations subject to flammable vapors shall be installed in accordance with NFPA 70.

❖ To reduce the likelihood of a vapor ignition, electrical wiring and equipment located where flammable vapors might be released by malfunctioning equipment, rupture or breakage is typically classified as Class I, Division 1 equipment under the provisions of NFPA 70. This would include rooms or spaces containing closed-system dry cleaning equipment that, under normal conditions, keeps the solvent vapors confined within the equipment. For the same reason, in areas where flammable vapors are present under normal operating conditions, such as in spotting or pretreating areas, using Class I solvents in the open, in tubs or on soaking tables, electrical wiring and equipment must be classified as Class I, Division 1, equipment to meet the requirements of NFPA 70.

**2104.2.4 Bonding and grounding.** Storage tanks, treatment tanks, filters, pumps, piping, ducts, dry cleaning units, stills, tumblers, drying cabinets and other such equipment, where not inherently electrically conductive, shall be bonded together and grounded. Isolated equipment shall be grounded.

❖ Solvent containers and processing equipment during storage, handling and use must be bonded and grounded to prevent buildup of static charges, thus eliminating a common source of ignition for vapors

emitted by flammable and combustible liquid solvents.

## SECTION 2105 OPERATING REQUIREMENTS

**2105.1 General.** The operation of dry cleaning systems shall comply with the requirements of Sections 2105.1.1 through 2105.3.

❖ Section 2105 establishes requirements for the safe operation and maintenance of dry cleaning plants. The fire hazard associated with these plants has diminished significantly in recent years as fire protection, environmental and hazardous waste disposal concerns have caused the industry to move away from the use of flammable and combustible solvents. Poor housekeeping is the primary fire prevention concern these days.

**2105.1.1 Written instructions.** Written instructions covering the proper installation and safe operation and use of equipment and solvent shall be given to the buyer.

❖ This section applies to persons or firms that engage in wholesale or retail sales of dry cleaning equipment. Each piece of equipment sold must be accompanied by written instructions for the installation and operation of the equipment and for the safe storage, handling and use of the dry cleaning solvent for which it is designed.

**2105.1.1.1 Type II, III-A, III-B and IV systems.** In Type II, III-A, III-B and IV dry cleaning systems, machines shall be operated in accordance with the operating instructions furnished by the machinery manufacturer. Employees shall be instructed as to the hazards involved in their departments and in the work they perform.

❖ Safety in dry cleaning operations depends on employees being familiar with not only the dry cleaning machines and their operation as described in the written instructions required by Section 2105.1.1, but also understanding the hazards associated with and the proper methods of storing, handling, dispensing and using dry cleaning solvents within their respective work spaces. This section requires that employees be trained in all aspects of dry cleaning operations.

**2105.1.1.2 Type V systems.** Operating instructions for customer use of Type V dry cleaning systems shall be conspicuously posted in a location near the dry cleaning unit. A telephone number shall be provided for emergency assistance.

❖ Type V dry cleaning systems are operated by the general public rather than by trained employees as are Type II, III-A and III-B systems. Under ideal conditions, such operations should have an attendant to supervise cleaning activities and be available to answer questions on the proper operation of the machines. Most Type V systems, however, are not attended. For this reason, machine operating instruc-

tions must be posted prominently in the machine area where they can be seen readily by patrons. In addition, an emergency phone number must be posted prominently for patron use. Note that this section does not require a public telephone on the premises. With the proliferation of cellular technology, much of the public carries a cell phone that can be used in case of an emergency.

**2105.1.2 Equipment identification.** The manufacturer shall provide nameplates on dry cleaning machines indicating the class of solvent for which each machine is designed.

- ❖ Because dry cleaning machines are designed to be used only with a specific class of solvent, this information must be clearly displayed on a permanent nameplate affixed to the machine so that there can be no question of what solvent may be used in a given machine (also see commentary, Section 2105.1.4).

**2105.1.3 Open systems prohibited.** Dry cleaning by immersion and agitation in open vessels shall be prohibited.

- ❖ Dry cleaning is intended to be a closed-system process, with the cleaning solvent contained within the machinery. Pouring large quantities of combustible solvent into an open container to soak or agitate items being cleaned allows and increases the escape of combustible vapors or, in the case of Type IV systems, noncombustible but toxic vapors, and is, therefore, prohibited. Also see the commentary to Section 2106 for a discussion of spotting and pretreating in the open and special handling provisions that allow limited hand agitation in the open.

**2105.1.4 Prohibited use of solvent.** The use of solvents with a *flash point* below that for which a machine is designed or *listed* shall be prohibited.

- ❖ Dry cleaning equipment is designed and tested for use with specific classifications of solvents. This section mandates that equipment be used only with the class of solvent for which it has been designed. Equipment approved for higher flash-point or nonflammable solvents may not be equipped with many of the inherent safety features required for lower flash-point solvents.

**2105.1.5 Equipment maintenance and housekeeping.** Proper maintenance and operating practices shall be observed in order to prevent the leakage of solvent or the accumulation of lint. The handling of waste material generated by dry cleaning operations and the maintenance of facilities shall comply with the provisions of this section.

- ❖ Safe dry cleaning depends on safe, well-maintained equipment and good housekeeping practices. Because dry cleaning is intended to be a closed-system use, machines must be checked regularly for loose fittings and connections that could allow the leakage of a solvent and its vapors. Also, the lint that accumulates in the cleaning of textile materials must be regularly removed from lint traps and disposed of properly. This section requires that dry cleaning

plants comply with the provisions of Sections 2105.1.5.1 through 2105.1.5.4.

**2105.1.5.1 Floors.** Class I and II liquids shall not be used for cleaning floors.

- ❖ This section prohibits the use of flammable and Class II combustible liquids for cleaning floors in dry cleaning plants for basically the same reasons that open soaking and agitation with solvents are prohibited by Section 2105.1.3: open use will allow flammable vapors to escape and accumulate. This effect is aggravated by the fact that in many instances, dry cleaning plants operate at high ambient temperatures that may be at or above the flash point of Class I or II liquids, thus forming an immediately ignitable mixture in air.

**2105.1.5.2 Filters.** Filter residue and other residues containing solvent shall be handled and disposed of in covered metal containers.

- ❖ The Environmental Protection Agency (EPA) has raised health and safety concerns about dry cleaning workers and people living near dry cleaners. Improper handling and disposal of dry cleaning solvents can pollute outdoor air, soil and water. Dry cleaning and laundry plants that might generate hazardous waste and be subject to Resource Conservation and Recovery Act (RCRA) requirements covering the generation, transportation and management of hazardous waste include: retail dry cleaning stores; industrial and linen supply plants with dry cleaning operations; self-service laundromats with dry cleaning equipment; or other facilities with dry cleaning operations. The volume of hazardous waste produced in these facilities often places them in the EPA category of "small quantity generator." Proper storage and disposal of spent filters and other solvent-containing wastes (empty solvent containers, still residues from solvent distillation and water contaminated with cleaning solvent) as required by this section reduces the potential for the production of solvent vapors and environmental pollution.

**2105.1.5.3 Lint.** Lint and refuse shall be removed from traps daily, deposited in *approved* waste cans, removed from the premises, and disposed of safely. At all other times, traps shall be held securely in place.

- ❖ Lint is finely divided textile fiber sloughed off of articles being cleaned and is generated in large quantities in the dry cleaning process. As with any combustible material, the more finely it is divided, the more surface area of the material is available for ignition and the more readily it will ignite. For this reason, this hazard must be reduced by collection and removal of lint, as well as other combustible waste materials, at least daily, followed by proper disposal.

**2105.1.5.4 Customer areas.** In Type V dry cleaning systems, customer areas shall be kept clean.

- ❖ Coin-operated laundries and dry cleaning establishments are often unattended, which can lead to poor

housekeeping and hazardous conditions that could contribute to the start or spread of a fire. This section requires that reasonable housekeeping procedures be established and executed regularly to reduce this hazard.

**2105.2 Type II systems.** Special operating requirements for Type II dry cleaning systems shall comply with the provisions of Sections 2105.2.1 through 2105.2.3.

- ❖ Sections 2105.2.1 through 2105.2.3 contain operating procedures uniquely applicable to Type II dry cleaning systems because of their use of Class II solvents and the higher relative hazards associated with that use.

**2105.2.1 Inspection of materials.** Materials to be dry cleaned shall be searched thoroughly and foreign materials, including matches and metallic substances, shall be removed.

- ❖ To prevent damage to dry cleaning equipment and eliminate potential sources of ignition, such as matches being ignited or metallic objects striking a spark with dry cleaning machine parts, articles to be dry cleaned must be carefully screened for foreign objects that could create a hazardous condition.

**2105.2.2 Material transfer.** In removing materials from the washer, provisions shall be made for minimizing the dripping of solvent on the floor. Where materials are transferred from a washer to a drain tub, a nonferrous metal drip apron shall be placed so that the apron rests on the drain tub and the cylinder of the washer.

- ❖ To reduce the amount of Class II solvent lost during removal of cleaned articles from the dry cleaning machine, means must be provided to minimize the amount of solvent that drips on the plant floor and evaporates into hazardous vapors in the work space. This section describes one method of preventing solvent drips by placing a drain board between the dry cleaning machine and drain tubs. The drain board must be nonferrous to prevent potential metal-to-metal sparks during the transfer process.

**2105.2.3 Ventilation.** A mechanical ventilation system which is designed to exhaust 1 cubic foot of air per minute for each square foot of floor area [ $0.0058 \text{ m}^3/(\text{s} \cdot \text{m}^2)$ ] shall be installed in dry cleaning rooms and in drying rooms. The ventilation system shall operate automatically when the dry cleaning equipment is in operation and shall have manual controls at an *approved* location.

- ❖ This section intended to prevent solvent vapors from Type II dry cleaning systems from accumulating to an ignitable concentration in the room in which those appliances are located by providing adequate mechanical ventilation. The prescribed rate of mechanical ventilation will also help prevent the ambient temperature in the room from exceeding the flash point of the solvent being used in the cleaning process. It is not the intent that this system be classified as a “hazardous exhaust system” as addressed

in IMC Section 510; however, consistent with IMC Section 502, this system must be independent of all other exhaust and ventilation systems.

The required ventilation rate of 1 cubic foot per minute (cfm) per square foot [ $0.0058 \text{ m}^3/(\text{s} \cdot \text{m}^2)$ ] of floor area is typical of that required in hazardous material-related areas where fugitive flammable vapors need dilution or removal. Although its exact technical origins remain obscure, it is thought to have been derived from a rule of thumb (possibly from the insurance industry) that established a ventilation requirement in flammable and combustible liquid use areas of six air changes per hour, which has proven to be effective over the years. Although this method provides effective ventilation and hazard reduction, moving that volume of air in industrial or storage buildings with larger-than-average floor-to-floor and floor-to-roof dimensions requires large, costly mechanical equipment installations and creates concerns over energy conservation. To deal with those concerns, a design ceiling height of 10 feet (3048 mm) was assumed in recognition of the fact that solvent vapors will gather at the lowest point in the room. Each square foot of building area, then, would represent 10 cubic feet ( $0.3 \text{ m}^3$ ) and, at the rate of six air changes per hour, 60 cubic feet ( $1.7 \text{ m}^3$ ) of air per hour would be moved, which yields 1 cfm per square foot [ $0.0058 \text{ m}^3/(\text{s} \cdot \text{m}^2)$ ] of room area.

To be effective, the exhaust equipment is required by this section to be interlocked with the dry cleaning equipment so that it operates whenever the dry cleaning equipment operates. Manual controls are also required for additional flexibility and reliability in the event that the mechanical system runs on after the dry cleaning system is shut down. The location of the controls is to be approved by the fire code official.

**2105.3 Type IV and V systems.** Type IV and V dry cleaning systems shall be provided with an automatically activated exhaust ventilation system to maintain a minimum of 100 feet per minute ( $0.51 \text{ m/s}$ ) air velocity through the loading door when the door is opened. Such systems for dry cleaning equipment shall comply with the *International Mechanical Code*.

**Exception:** Dry cleaning units are not required to be provided with exhaust ventilation where an exhaust hood is installed immediately outside of and above the loading door which operates at an airflow rate as follows:

$$Q = 100 \times A_{LD} \quad \text{(Equation 21-1)}$$

where:

$Q$  = flow rate exhausted through the hood, cubic feet per minute ( $\text{m}^3/\text{s}$ ).

$A_{LD}$  = area of the loading door, square feet ( $\text{m}^2$ ).

- ❖ This section is intended to prevent solvent vapors from Type IV and V dry cleaning systems from escaping into the room where the appliances are located by

drawing the required exhaust airflow into the unit through the open door at the minimum velocity of 100 feet per minute (51 m/s). In this way, exposure of employees (in Type IV systems) or the public (in Type V systems) to potentially harmful solvent vapors is minimized. The exhaust capability contemplated by this section is integral with the dry cleaning unit, and its operation must be interlocked with the unit door to automatically start the required exhaust airflow as soon as the unit door is opened. It is not the intent that this system be classified as a “hazardous exhaust system” as addressed in IMC Section 510; however, consistent with IMC Section 502, this system must be independent of all other exhaust and ventilation systems.

The exception is a design alternative to achieve the goal of solvent vapor capture at the door opening through installation of what is often referred to as an “eyebrow hood” located immediately above the dry cleaning unit door opening. This enables the exhaust airflow to sweep across the loading door opening of the machine and capture any escaping solvent vapors. This kind of hood may be integral with the unit or may be an after-market-installed accessory to the unit. In either case, it must be either interlocked with the unit door to automatically start the required exhaust airflow as soon as the unit door is opened or operate continuously whenever the dry cleaning machine is in operation.

Since exhaust hoods are not designed for a constant air velocity in all parts of the hood, such as can be achieved by drawing air into a machine through a loading door opening, exhaust capability for this alternative design calculated in accordance with Equation 21-1 will be expressed as a flow rate rather than a fixed velocity. The fan will be drawing in a large volume of environmental air to achieve the prescribed exhaust airflow across the entire loading door opening. For example, applying the formula to a dry cleaning unit that has a 2-foot-diameter (610 mm) circular loading/unloading door, the exhaust flow rate ( $Q$ ) would be calculated as follows:

$$Q = 100 \times A_{LD}$$

$$A_{LD} = \pi r^2; \text{ where } \pi = 3.14 \text{ and } r = 1, \text{ therefore}$$

$$Q = 100 \times (3.14 \times 1^2)$$

$$Q = 100 \times 3.14$$

$$Q = 314 \text{ cubic feet per minute}$$

It is not the intent that this system be classified as a “hazardous exhaust system” as addressed in IMC Section 510; however, consistent with IMC Section 502.1.3, this system must be independent of all other exhaust and ventilation systems.

## SECTION 2106 SPOTTING AND PRETREATING

**2106.1 General.** Spotting and pretreating operations and equipment shall comply with the provisions of Sections 2106.2 through 2106.5.

- ❖ Spotting and pretreating operations consist of soaking or direct local application of cleaning solvents to articles about to be dry cleaned. These operations focus the solvent’s cleaning power on the removal of more stubborn stains, such as those from grease, oils, makeup, paint, dirt or petroleum products (tar, asphalt sealer, etc). The operations typically take place on spotting tables or in scrubbing tubs in the open in the dry cleaning plant. Compliance with the requirements of Section 2106 will result in an acceptable level of safety for spotting and pretreating operations.

**2106.2 Class I solvents.** The maximum quantity of Class I solvents permitted at any work station shall be 1 gallon (4 L). Spotting or prespotting shall be permitted to be conducted with Class I solvents where they are stored in and dispensed from *approved* safety cans or in sealed DOT-approved metal shipping containers of not more than 1-gallon (4 L) capacity.

- ❖ This section allows up to 1 gallon (4 L) of Class I (flammable) solvent to be stored in its original shipping container or, where used for spotting or prespotting, stored in and dispensed from a safety can complying with UL 30 (see commentary, Sections 5005.1.10 and 5705.2.4).

**2106.2.1 Spotting and prespotting.** Spotting and pre-spotting shall be permitted to be conducted with Class I solvents where dispensed from plastic containers of not more than 1 pint (0.5 L) capacity.

- ❖ This section recognizes the use of U.S. Department of Transportation-approved plastic containers to ship and store chemicals used in dry cleaning plants, including spotting chemicals. Use of such containers is permitted by Section 5704.3.1 of the code and OSHA regulations for the storage of flammable and combustible liquids. Similar provisions also appear in Chapter 5 of NFPA 32. Note that the quantity limitation in this section is well below the use-open maximum allowable quantities (MAQ) for flammable liquids in Table 5003.1.1(1).

**2106.3 Class II and III solvents.** Scouring, brushing, and spotting and pretreating shall be permitted to be conducted with Class II or III solvents. The maximum quantity of Class II or III solvents permitted at any work station shall be 1 gallon (4 L). In other than Group H-2 occupancy, the aggregate quantities of solvents shall not exceed the maximum allowable quantity per control area for use-open system.

- ❖ This section allows Class II or III solvents to be used for spotting or pretreating and limits the quantity of

## DRY CLEANING

solvent that can be in use at a spotting or pretreating work station to 1 gallon (4 L) to reduce the likelihood of an unmanageable solvent spill. Aggregate quantities of spotting or pretreating solvent must not exceed the MAQ for open system use established by Table 5003.1.1(1), including the increases allowed for the sprinkler system required by Section 2108.2.

**2106.3.1 Spotting tables.** Scouring, brushing or spotting tables on which articles are soaked in solvent shall have a liquid-tight top with a curb on all sides not less than 1 inch (25 mm) high. The top of the table shall be pitched to ensure thorough draining to a 1½-inch (38 mm) drain connected to an *approved* container.

❖ To reduce spills of spotting solvents during their open use, surfaces upon which the spotting is done must be designed to catch and route solvent to an approved container (preferably a closed one) for disposal or recycling.

**2106.3.2 Special handling.** Where *approved*, articles that cannot be washed in the usual washing machines are allowed to be cleaned in scrubbing tubs. Scrubbing tubs shall comply with the following:

1. Only Class II or III liquids shall be used.
2. The total amount of solvent used in such open containers shall not exceed 3 gallons (11 L).
3. Scrubbing tubs shall be secured to the floor.
4. Scrubbing tubs shall be provided with permanent 1½-inch (38 mm) drains. Such drain shall be provided with a trap and shall be connected to an *approved* container.

❖ Although dry cleaning by immersion and agitation in open vessels is prohibited by Section 2105.1.3, there are isolated circumstances in which an article that needs dry cleaning cannot be cleaned in the conventional manner in an approved dry cleaning machine. This section establishes minimum safeguards intended to reduce the hazards associated with open cleaning in a scrubbing tub.

The first step in cleaning an article in the open is to secure the approval of the fire code official for the operation. This enables him or her to inspect the area where the open cleaning is to be done to verify that the housekeeping complies with this chapter, that all the safeguards required by this section are in place, that the ventilation requirements of Section 2106.3.3 are met, and that the bonding and grounding required by Section 2106.3.4 are in place.

Although limited use of Class I spotting solvents is allowed by Section 2106.3, this section makes it clear that dry cleaning in the open is limited to only Class II or III solvents because of their higher flash points. To avoid an unmanageable spill while still allowing a workable quantity of solvent in the scrubbing tub, Class II or III solvents are limited to only 3 gallons (11 L) in process, and then only in a tub that is firmly fixed in place by securing it to the floor in an approved manner. Solvents used in open dry cleaning pro-

cesses must be captured in an approved (preferably closed) container for recycling or proper disposal.

**2106.3.3 Ventilation.** Scrubbing tubs, scouring, brushing or spotting operations shall be located such that solvent vapors are captured and exhausted by the ventilating system.

❖ When locating the spotting or pretreating operation within the plant, care must be taken to choose a location that will allow adequate airflow on all sides of the spotting or pretreating equipment to maximize the effectiveness of the exhaust ventilation system required by Section 2105.2.3 in preventing the accumulation of hazardous vapor concentrations.

**2106.3.4 Bonding and grounding.** Metal scouring, brushing and spotting tables and scrubbing tubs shall be permanently and effectively bonded and grounded.

❖ Solvent containers and processing equipment during storage, handling and use must be grounded to prevent buildup of static charges, thus eliminating a common source of ignition for vapors from flammable and combustible liquid solvents.

**2106.4 Type IV systems.** Flammable and combustible liquids used for spotting operations shall be stored in *approved* safety cans or in sealed DOTn-approved shipping containers of not more than 1 gallon (4 L) in capacity. Aggregate amounts shall not exceed 10 gallons (38 L).

❖ Type IV dry cleaning systems are those systems using nonflammable solvents where dry cleaning is done only by trained operators who must be familiar with solvent hazards. Up to an aggregate quantity of 10 gallons (38 L) of Class I, II or III spotting or pretreating solvents is allowed if the solvents comply with the minimum storage safeguard of being stored in their original shipping container or safety cans complying with UL 30 (see commentary, Sections 5005.1.10 and 5705.2.4).

**2106.5 Type V systems.** Spotting operations using flammable or *combustible liquids* are prohibited in Type V dry cleaning systems.

❖ Type V dry cleaning systems are those systems using nonflammable solvents where dry cleaning is done by the general public, such as in coin-operated laundries that may or may not be attended by qualified staff. To prevent exposing the general public to the hazards of spotting or pretreating operations using solvents more hazardous than the nonflammable solvents used in the Type V system itself, and to preclude any action that might violate Section 2105.1.4, this section prohibits spotting and pretreating operations altogether.

## SECTION 2107 DRY CLEANING SYSTEMS

**2107.1 General equipment requirements.** Dry cleaning systems, including dry cleaning units, washing machines, stills, drying cabinets, tumblers and their appurtenances,

including pumps, piping, valves, filters and solvent coolers, shall be installed and maintained in accordance with NFPA 32. The construction of buildings in which such systems are located shall comply with the requirements of this section and the *International Building Code*.

❖ NFPA 32 contains provisions for the prevention and control of fire and explosion hazards incidental to dry cleaning operations for the protection of employees and the public. Likewise, the IBC regulates the construction of dry cleaning plant buildings based on the relative hazards of the occupancies. IBC Chapter 3 classifies dry cleaning pickup/drop-off stations and Type V dry cleaning systems in Occupancy Group B (business) because of their low-hazard nature. Type II, III and IV dry cleaning plants are classified in Occupancy Group F-1 (moderate-hazard factory-industrial) because they include or could include the processing of combustible textiles using combustible solvents and, on a limited basis, flammable liquids for spotting. Certain dry cleaning operations could be classified by the IBC in Group H, depending on the quantity of solvent present and the type of machines used. See the commentary to IBC Section 307.1 for further discussion of exceptions to Group H classifications.

**2107.2 Type II systems.** Type II dry cleaning and solvent tank storage rooms shall not be located below grade or above the lowest floor level of the building and shall comply with Sections 2107.2.1 through 2107.2.3.

**Exception:** Solvent storage tanks installed underground, in vaults or in special enclosures in accordance with Chapter 57.

❖ Type II dry cleaning systems are those systems using a Class II combustible liquid [flash point from 100°F (38°C) to 140°F (60°C)] as a cleaning solvent, sometimes at or above its lowest flash point under normal plant operating conditions. For this reason, this section prohibits the location of these systems and solvent storage at other than the level of fire department access or exit discharge (i.e., other than at grade). Because of the higher relative hazards of these systems and their solvents, locating them above or below the lowest grade floor level could affect rapid egress by employees, as well as rapid access to the system by fire fighters in case of an emergency.

**2107.2.1 Fire-fighting access.** Type II dry cleaning plants shall be located so that access is provided and maintained from one side for fire-fighting and fire control purposes in accordance with Section 503.

❖ The general design of fire apparatus access to buildings is regulated by Section 503. To give fire fighters timely access to the building, this section requires that the building containing the Type II system be accessible on at least one side. This is consistent with the provisions of Section 503.1.1, which allows access on only one side when a building is equipped throughout with an automatic sprinkler system as is required by Section 2108.2 for dry cleaning plants. Fire apparatus access must be kept unobstructed at

all times and comply with the provisions of Section 503.

**2107.2.2 Number of means of egress.** Type II dry cleaning rooms shall have not less than two *means of egress* doors located at opposite ends of the room, not less than one of which shall lead directly to the outside.

❖ The number of exit access doorways required from a room or space is regulated by Section 1015.1. That general section would not require two doors out of a Type II dry cleaning room classified in Occupancy Group F-1 unless it had an occupant load of more than 50 persons; that is, greater than 5,000 square feet (465 m<sup>2</sup>) in area based on 100 square feet (9 m<sup>2</sup>) per person in accordance with Table 1004.1.2. However, this section is specific to Type II dry cleaning rooms and supersedes general Group F egress requirements by requiring two doors out of the room, regardless of occupant load. Note that at least one of the doors must be an exit door that opens directly to the exit discharge or public way outside of the building. All doors must also comply with Section 1022.2.

This section also supersedes the general exit or exit access remoteness requirements of Section 1015.2 by mandating that the two means of egress doors from a Type II dry cleaning room be located at opposite ends of the room, rather than a distance apart equal to one-half the overall diagonal dimension of the room.

**2107.2.3 Spill control and secondary containment.** Curbs, drains or other provisions for spill control and secondary containment shall be provided in accordance with Section 5004.2 to collect solvent leakage and fire protection water and direct it to a safe location.

❖ To prevent the flow of Class II solvents to rooms or spaces adjoining the dry cleaning room, spill control complying with Section 5004.2 is required by this section. Care must be taken in the design of drainage and secondary containment systems to accurately calculate automatic sprinkler design discharge flow rates and fire suppression hand line [typically 1½- or 1¾-inch (38 mm or 44 mm) hose] flows. Note that secondary containment provisions do not include control of the flammable, irritating or toxic vapors given off by the solvent. Care must be taken to minimize exposure to hazardous vapors. Runoff from spills or manual fire suppression activities may result in environmental contamination if not properly controlled (also see commentary, Section 5004.2).

**2107.3 Solvent storage tanks.** Solvent storage tanks for Class II, IIIA and IIIB liquids shall conform to the requirements of Chapter 57 and be located underground or outside, above ground.

**Exception:** As provided in NFPA 32 for inside storage or treatment tanks.

❖ Safe and proper storage of solvents is a paramount concern in the safe operation of a dry cleaning plant or facility. This section requires that combustible sol-

vents be stored in approved tanks located either underground or above ground outside the building, and references Chapter 57 for detailed requirements.

The exception recognizes the provisions contained in NFPA 32 governing the inside storage of solvents. While NFPA 32 allows the unenclosed indoor installation of up to three 1,500-gallon (5678 L) storage or treatment tanks of Class II solvent, it should be noted that, in accordance with the IBC, indoor storage of Class II solvents in excess of the MAQ indicated in IBC Table 307.1(1) would cause the dry cleaning facility to be classified in Group H-3.

### SECTION 2108 FIRE PROTECTION

**2108.1 General.** Where required by this section, *fire protection systems*, devices and equipment shall be installed, inspected, tested and maintained in accordance with Chapter 9.

❖ To control the relative hazards posed by dry cleaning operations, this section requires the installation of a fire protection system and references Chapter 9 for installation and maintenance.

**2108.2 Automatic sprinkler system.** An *automatic sprinkler system* shall be installed in accordance with Section 903.3.1.1 throughout dry cleaning plants containing Type II, Type III-A or Type III-B dry cleaning systems.

**Exceptions:**

1. An *automatic sprinkler system* shall not be required in Type III-A dry cleaning plants where the aggregate quantity of Class III-A solvent in dry cleaning machines and storage does not exceed 330 gallons (1250 L) and dry cleaning machines are equipped with a feature that will accomplish any one of the following:
  - 1.1. Prevent oxygen concentrations from reaching 8 percent or more by volume.
  - 1.2. Keep the temperature of the solvent not less than 30°F (16.7°C) below the flash point.
  - 1.3. Maintain the solvent vapor concentration at a level lower than 25 percent of the lower explosive limit (LEL).
  - 1.4. Utilize equipment *approved* for use in Class I, Division 2 hazardous locations in accordance with NFPA 70.
  - 1.5. Utilize an integrated dry-chemical, clean agent or water-mist automatic fire-extinguishing system designed in accordance with Chapter 9.
2. An *automatic sprinkler system* shall not be required in Type III-B dry cleaning plants where the aggregate quantity of Class III-B solvent in dry cleaning

machines and storage does not exceed 3,300 gallons (12 490 L).

❖ Section 903.2 contains the general “where required” criteria for the installation of automatic sprinklers in buildings. Section 2108.7 is more specific and would require an automatic sprinkler system throughout dry cleaning plants regardless of the size of the fire area. This is related to the hazard of relatively high fire loads coupled with the presence of combustible and possibly flammable liquids. These liquids may be in both open and closed system operations

Several exceptions to the requirement for sprinklers are included in this section of the code in part because several states have banned the use of the nonflammable dry cleaning fluid perchlorethylene or “perc” due to its carcinogenicity which already requires that plant operators purchase new equipment using alternative dry cleaning technology. The ICC voting membership approved the addition of the exceptions because its members felt that having a sprinkler requirement on top of that capital expense would be a business hardship and also because the nationally recognized standard, NFPA 32, already included such exceptions. Exception 1 recognizes that modern Type IIIA dry cleaning machines have intrinsic safety features that can prevent fires from starting within the dry cleaning machine and parallels Section 8.1.2.6 of NFPA 32. It recognizes the lesser relative hazard of plants using higher flash point [140°F to 299°F (60°C to 148.23)] Class IIIA dry cleaning solvents while maintaining a reasonable limit on aggregate solvent quantity and providing needed safety features. Exception 2 parallels Section 8.2.3.4 of NFPA 32 and recognizes the even lesser hazard of Class IIIB solvents having a very high flash point [at or above 200°F (93.33°C)] further decreasing the likelihood of accidental ignition. These exceptions were added to the code rather than relying on a reference to NFPA 32 so the inspector would not have to carry the referenced standard into the field. See also the commentary to Section 2103.3 and IBC Section 307.1, Exceptions 4 and 5 for further information.

**2108.3 Automatic fire-extinguishing systems.** Type II dry cleaning units, washer-extractors, and drying tumblers in Type II dry cleaning plants shall be provided with an *approved* automatic fire-extinguishing system installed and maintained in accordance with Chapter 9.

**Exception:** Where *approved*, a manual steam jet not less than 3/4 inch (19 mm) with a continuously available steam supply at a pressure not less than 15 pounds per square inch gauge (psig) (103 kPa) is allowed to be substituted for the automatic fire-extinguishing system.

❖ Section 2108.2 focuses on the protection of the dry cleaning plant occupants and building. This section requires additional fire protection for dry cleaning

equipment using Class II solvent because of its lower flash point. Automatic fire-extinguishing systems for local, direct application of suppression media in the dry cleaning machinery must be installed in accordance with Section 904. The type of automatic fire-extinguishing system typically used (and required by NFPA 32) in this application is carbon dioxide, installed in accordance with Section 904.8, although approved dry chemical or gaseous-agent systems could also be used.

The exception recognizes the fire-smothering capabilities of steam. Although there is no recognized standard for the design of steam-smothering systems, the fact that steam is usually available in large quantities in dry cleaning plants makes it an inexpensive alternative to the more state-of-the-art fire-extinguishing systems. The design and installation of the steam jet(s) that must be available for personnel to manually use must be reviewed and approved by the fire code official. Because steam poses a serious burn hazard, the system design should minimize personnel exposure to this hazard.

**2108.4 Portable fire extinguishers.** Portable fire extinguishers shall be selected, installed and maintained in accordance with this section and Section 906. A minimum of two, 2-A:10-B:C portable fire extinguishers shall be provided near the doors inside dry cleaning rooms containing Type II, Type III-A and Type III-B dry cleaning systems.

❖ Portable fire extinguishers are intended only for fighting incipient fires. Employees should be trained in the proper selection and use of portable fire extinguishers. Both the extinguisher rating and the travel distance must be consistent with Section 906 and NFPA 10 for the moderate hazards expected in dry cleaning plants. Placing the extinguishers at the doors leading out of rooms containing Type II, III-A and III-B dry cleaning systems will enhance personnel safety by requiring them to travel toward the means of egress door to gain access to an extinguisher in case of a fire. The required size of the extinguisher(s) should give the operator sufficient agent capacity and discharge time to handle the magnitude of incipient fires expected.



# Chapter 22:

## Combustible Dust-Producing Operations

### General Comments

Problems associated with the production and handling of dusts were not widely recognized and understood until the twentieth century. Likewise, the need for adequate protection from dust explosions did not become widely accepted until the latter half of the twentieth century. A relatively incomplete understanding of the theoretical underpinnings of the explosion hazards of dusts is largely responsible for this lag.

The following factors affect the explosion hazards of dusts:

- Chemical composition of the dust.
- Geometry and size of the dust particles.
- Concentration of dust present in suspension (distance between dust particles or the mass of dust particles in a given volume).
- Nature and concentration of the oxidant, usually air.
- Moisture content of both the atmosphere and the dust.
- Minimum required ignition temperature or ignition energy of the dust and amount of time the two are in contact with each other.

Curiously, not all combustible dusts are explosible. The reasons for this are not very well understood. Explosion hazards of dusts are often defined by the lower and upper explosive limits, explosion pressures and explosion rates of various dusts. These values cannot be derived from the thermal properties of the dusts but rather must be determined by measurement. Combustible dusts may produce explosion pressures as great as 150 pounds per square inch gauge (psig) (103 kPa) and explosion pressure rise rates as high as 15,000 pounds per square inch (psi) per second (103 425 kPa).

Dust explosions usually produce flame fronts traveling at rates less than the speed of sound, and are, therefore, classified as deflagrations. High oxidizer concentrations or the presence of flammable gases may, however, produce detonations with shockwaves traveling in excess of the speed of sound preceding the flame front.

Unlike flammable gases and vapors, concentrations of explosive dusts exceeding stoichiometric quantities (the amount of fuel necessary to consume all the available oxidizer) produce more violent explosions up to the point at which dust concentrations approach several times the stoichiometric concentration.

In 1973, K.N. Palmer listed the following explosion protection measures. Formation of explosive dust suspensions is inevitable, and complete elimination of igni-

tion sources cannot be relied on; therefore, implementing a combination of explosion protection strategies is strongly recommended. Such explosion protection measures include ignition prevention, suppression or containment of the primary explosion flame and allowing the explosion to take its full course in a safe manner.

Fire fighters are especially aware of the hazards of dust explosions in grain elevators in rural areas, but may not recognize the potential for dust explosions in a wide variety of other manufacturing operations. Dusts are produced and used in industrial applications ranging from water treatment to semiconductor manufacturing. The explosive force generated by a dust explosion is comparable to flammable vapor and gas explosions.

The following industries are involved in the production or handling of explosible dusts:

- Agricultural, including coffee, cornstarch, cottonseed, sugar and various grains.
- Chemical, including dye.
- Coal mining and use.
- Food (human and animal).
- Metals, including aluminum, magnesium, iron, manganese and various alloys.
- Pharmaceuticals.
- Plastics, including polyethylene resins, styrene polymer resins, epoxy resins and polycarbonate resins.
- Woodworking.

Conditions under which a combustible dust will produce an explosion are quite specific, though they are difficult to quantify. As a result, precautions to prevent dust explosions are often determined by assigning a particular dust to a hazard class. A sample of material is ignited under controlled conditions in a special test apparatus to determine the hazard class of a dust. The results of such tests were reported for common dusts by P. Field in his book *Dust Explosions*, which describes, in tabular form, the explosion data for selected combustible dusts. In each column, values of the table are derived experimentally using a special explosion apparatus. For each property, values are presented to fully describe the explosion characteristics of the given material. Dust hazard classes are expressed as ST-1 through ST-3, with ST-1 being the highest hazard, as portrayed in *The SFPE Handbook of Fire Protection Engineering*.

During the drafting of the code, combustible dust was not included in Table 5003.1.1(1) because of the inherent difficulty in establishing a maximum allowable quan-

tity (MAQ), and for determining if and when the MAQ had been exceeded. An occupancy with combustible dust is classified in Group H-2 in accordance with Section 307.4 of the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>), with the exception of certain woodworking uses classified as Group F-1. Many spaces with combustible dust should be classified in Group H-2. However, others may fall into Group F or S, depending on the specifics of the process. Accordingly, in the 2012 edition of the code, a new row in Table 5003.1.1(1) added combustible dust to the MAQ table, so the code user would not miss this important hazard category. Note q directs the code user to pertinent sections in the code and the IBC to determine if a dust hazard exists by an engineering evaluation. The content of Note q is also included in IBC Section 307.4.

**Purpose**

Awareness and knowledge of the hazards of dusts and powders are less common than of flammable liquids and gases; however, explosions and fires involving dusts and powders are just as hazardous in many industrial settings. The requirements of this chapter seek to reduce the likelihood of dust explosions by managing the hazards of suspensions of ignitable dusts. Ignition source control and good housekeeping practices in occupancies containing dust-producing operations are emphasized.

**SECTION 2201  
GENERAL**

**2201.1 Scope.** The equipment, processes and operations involving dust explosion hazards shall comply with the provisions of this chapter.

- ❖ This chapter details general requirements for the protection of properties and processes from explosions and deflagrations involving combustible dust residues and suspensions.

**2201.2 Permits.** Permits shall be required for *combustible dust*-producing operations as set forth in Section 105.6.

- ❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6.6 for discussion of specific combustible dust-producing operations requiring an operational permit.

**SECTION 2202  
DEFINITION**

**2202.1 Definition.** The following term is defined in Chapter 2: **COMBUSTIBLE DUST.**

- ❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated term used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

**SECTION 2203  
PRECAUTIONS**

**2203.1 Sources of ignition.** Smoking or the use of heating or other devices employing an open flame, or the use of spark-producing equipment is prohibited in areas where *combustible dust* is generated, stored, manufactured, processed or handled.

- ❖ Smoking is prohibited in areas where dust explosion hazards exist. Welding and cutting must be confined to approved areas and subject to a hot work permit system and prior approval for each operation (see commentary, Chapter 35). Open-flame heating and spark-producing equipment, as well as other heat-producing devices, are prohibited. Torches and other open-flame devices are never to be used to remove accumulations of dust or dust residue. Electrical wiring, lighting and equipment where dust explosion hazards exist should be approved for use in Class II hazardous (classified) locations as regulated in NFPA 70.

**2203.2 Housekeeping.** Accumulation of *combustible dust* shall be kept to a minimum in the interior of buildings. Accumulated *combustible dust* shall be collected by vacuum cleaning or other means that will not place *combustible dust* into suspension in air. Forced air or similar methods shall not be used to remove dust from surfaces.

- ❖ Good housekeeping practices are extremely important in occupancies where combustible dust-producing operations are located. Ideally, minimizing the amount of fugitive combustible dust that accumulates in buildings should be accomplished by fixed equipment, such as physical enclosures for dust-producing machinery, and by approved dust collection systems designed to capture the dust at the point of generation. In its simplest form, a dust collection system can

consist of a shop vacuum cleaner connected to a woodworking machine, such as a table saw. In larger industrial applications, a ducted dust collection system can serve multiple machines or entire production lines. Such systems are considered to be hazardous exhaust systems and should be designed and installed in accordance with the *International Mechanical Code*<sup>®</sup> (IMC<sup>®</sup>).

It is important when removing accumulated combustible dust not to place it into suspension in the air, thus creating the potential for a dust explosion. Accordingly, this section requires that dust be collected by vacuum cleaning equipment or other approved means that will not disturb the accumulated dust. Dust should never be brushed from dust-loaded surfaces or be blown off with compressed air.

**SECTION 2204  
EXPLOSION PROTECTION**

**2204.1 Standards.** The *fire code official* is authorized to enforce applicable provisions of the codes and standards listed in Table 2204.1 to prevent and control dust explosions.

- ❖ Because the pressure exerted by a combustible dust explosion typically ranges from 13 to 89 pounds per square inch (psi) (90 to 614 kPa), it is impractical to construct a building that will withstand such pressures. Therefore, a means of explosion relief or venting must be provided in accordance with Section 911 and the referenced standards. Additional guidance on the relative fire risk associated with various combustible dusts can be found in the referenced standards and the bibliographic material.

**TABLE 2204.1.** See below.

- ❖ Table 2204.1 references nine NFPA standards that detail specific precautions for a wide variety of dust explosion situations covering the broad spectrum of industries involved in dust-producing operations. These standards include the most common dust explosion hazards, and regulations for their prevention. Essentially, each of the referenced standards prescribes reasonable requirements for safety to life

and property from fire and explosion. The standards also minimize the resulting damage should a fire or explosion occur. More specifically, the standards contain requirements for construction, ventilation, explosion venting, equipment, heating devices, dust control, fire protection and supplemental requirements related to electrical wiring and equipment; provisions concerning protection from sparks; cutting and welding; and smoking and signage regulations.

Unusual situations, especially those involving plastics, resins, pharmaceuticals and semiconductor dusts, should be carefully evaluated.

**Bibliography**

The following resource materials were used in the preparation of the commentary for this chapter of the code:

Field, P. *Dust Explosions*. New York: Elsevier, 1982.

Palmer, K. N. *Dust Explosions and Fires*. London, England: Chapman and Hall, 1973.

*Report of Important Dust Explosions: A Record of Dust Explosions in the United States and Canada since 1860*. Fire Record Department, compiler. Boston, MA: National Fire Protection Association, 1957.

**TABLE 2204.1  
EXPLOSION PROTECTION STANDARDS**

STANDARD	SUBJECT
NFPA 61	Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities
NFPA 69	Standard on Explosion Prevention Systems
NFPA 70	National Electrical Code
NFPA 85	Boiler and Combustion System Hazards Code
NFPA 120	Standard for Fire Prevention and Control in Coal Mines
NFPA 484	Standard for Combustible Metals
NFPA 654	Standard for Prevention of Fire and Dust Explosions from the Manufacturing, Processing and Handling of Combustible Particulate Solids
NFPA 655	Standard for the Prevention of Sulfur Fires and Explosions
NFPA 664	Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities



# Chapter 23: Motor Fuel-Dispensing Facilities and Repair Garages

## General Comments

The requirements of this chapter apply to all occupancies that dispense any type of motor fuel and to automotive repair garages.

## Purpose

This chapter contains provisions that regulate the storage and dispensing of liquid or gaseous motor fuels at public and private automotive and marine motor fuel-dispensing facilities, fleet vehicle motor fuel-dispensing facilities, aircraft motor-vehicle fuel-dispensing facilities and repair garages.

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## SECTION 2301 GENERAL

**2301.1 Scope.** Automotive motor fuel-dispensing facilities, marine motor fuel-dispensing facilities, fleet vehicle motor fuel-dispensing facilities, aircraft motor-vehicle fuel-dispensing facilities and repair garages shall be in accordance with this chapter and the *International Building Code*, *International Fuel Gas Code* and *International Mechanical Code*. Such operations shall include both those that are accessible to the public and private operations.

❖ Generally speaking, if liquid or gaseous motor fuels are dispensed from a storage tank, either above or below ground, into the fuel tank of a motor vehicle, marine craft or general aviation aircraft from fixed, automotive-type equipment, then the operation is within the scope of this chapter. See also the commentary to Section 202 for the definition of “Aircraft motor-vehicle fuel-dispensing facility.”

**2301.2 Permits.** Permits shall be required as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit. The process also notifies the fire department of the need for prefire planning for the hazardous property.

**2301.3 Construction documents.** *Construction documents* shall be submitted for review and approval prior to the installation or construction of automotive, marine or fleet vehicle motor fuel-dispensing facilities and repair garages in accordance with Section 105.4.

❖ Construction documents, as defined in Section 202, must be drawn to scale with sufficient clarity to be

understood by the fire code official, contractors and owners and must address the requirements of the code. State or local laws may require preparation of the construction documents by a registered design professional. See the commentary to Section 106.1 of the *International Building Code*® (IBC®).

**2301.4 Indoor motor fuel-dispensing facilities.** Motor fuel-dispensing facilities located inside buildings shall comply with the *International Building Code* and NFPA 30A.

❖ Generally speaking, this type of motor fuel-dispensing facility is found at parking garages where space is very limited and is subject to the approval of the fire code official. Chapter 7 of NFPA 30A is, in part, dedicated to the provisions that govern motor fuel-dispensing facilities inside buildings.

**2301.4.1 Protection of floor openings in indoor motor fuel-dispensing facilities.** Where motor fuel-dispensing facilities are located inside buildings and the dispensers are located above spaces within the building, openings beneath dispensers shall be sealed to prevent the flow of leaked fuel to lower building spaces.

❖ Floor openings in the dispensing area must be sealed if located over other spaces and drains, and designed to protect areas below from flammable and combustible liquid spills as well as anticipated water from fire hose streams. Drains are to be equipped with separators in accordance with the *International Plumbing Code*® (IPC®).

**2301.5 Electrical.** Electrical wiring and equipment shall be suitable for the locations in which they are installed and shall comply with Section 605, NFPA 30A and NFPA 70.

❖ Chapter 8 of NFPA 30A addresses electrical equipment at motor fuel-dispensing facilities and is correlated with NFPA 70. Electrical equipment must be approved for the particular hazards anticipated at motor fuel-dispensing facilities and the hazardous

## MOTOR FUEL-DISPENSING FACILITIES AND REPAIR GARAGES

nature of flammable and combustible liquids and gases.

**2301.6 Heat-producing appliances.** Heat-producing appliances shall be suitable for the locations in which they are installed and shall comply with NFPA 30A and the *International Fuel Gas Code* or the *International Mechanical Code*.

❖ Heat-producing appliances are ignition sources. Precautions must be taken when using such appliances around flammable and combustible liquids. NFPA 30A, the *International Mechanical Code*® (IMC®) and the *International Fuel Gas Code*® (IFGC®) all provide requirements for the safe use of these appliances.

### SECTION 2302 DEFINITIONS

**2302.1 Definitions.** The following terms are defined in Chapter 2:

**AIRCRAFT MOTOR-VEHICLE FUEL-DISPENSING FACILITY.**

**ALCOHOL-BLENDED FUELS.**

**AUTOMOTIVE MOTOR FUEL-DISPENSING FACILITY.**

**DISPENSING DEVICE, OVERHEAD TYPE.**

**FLEET VEHICLE MOTOR FUEL-DISPENSING FACILITY.**

**LIQUEFIED NATURAL GAS (LNG).**

**MARINE MOTOR FUEL-DISPENSING FACILITY.**

**REPAIR GARAGE.**

**SELF-SERVICE MOTOR FUEL-DISPENSING FACILITY.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*® (I-Code®) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

### SECTION 2303 LOCATION OF DISPENSING DEVICES

**2303.1 Location of dispensing devices.** Dispensing devices shall be located as follows:

1. Ten feet (3048 mm) or more from *lot lines*.
2. Ten feet (3048 mm) or more from buildings having combustible exterior wall surfaces or buildings having noncombustible exterior wall surfaces that are not part

of a 1-hour fire-resistance-rated assembly or buildings having combustible overhangs.

**Exception:** Canopies constructed in accordance with the *International Building Code* providing weather protection for the fuel islands.

3. Such that all portions of the vehicle being fueled will be on the premises of the motor fuel-dispensing facility.
  4. Such that the nozzle, when the hose is fully extended, will not reach within 5 feet (1524 mm) of building openings.
  5. Twenty feet (6096 mm) or more from fixed sources of ignition.
- ❖ In order to reduce the likelihood of motor fuels coming into contact with ignition sources or posing a hazard to persons, adjoining property or on-site buildings, this section provides very specific dispenser location requirements in relation to buildings, lot lines and ignition sources.

#### Item 1

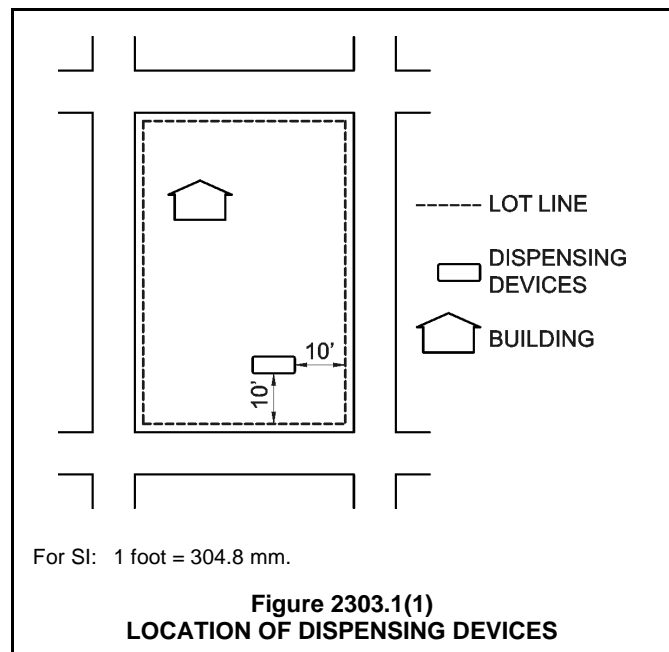
Commentary Figure 2303.1(1) shows the relationship of the dispenser to the lot line (see also commentary, Item 5).

#### Item 2

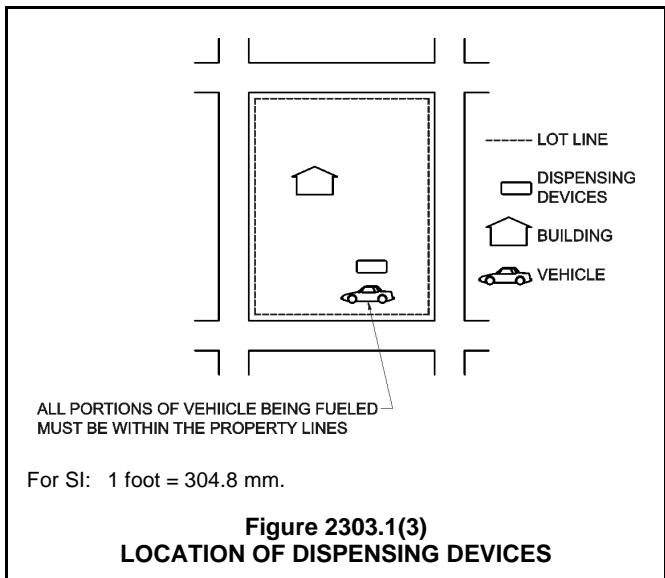
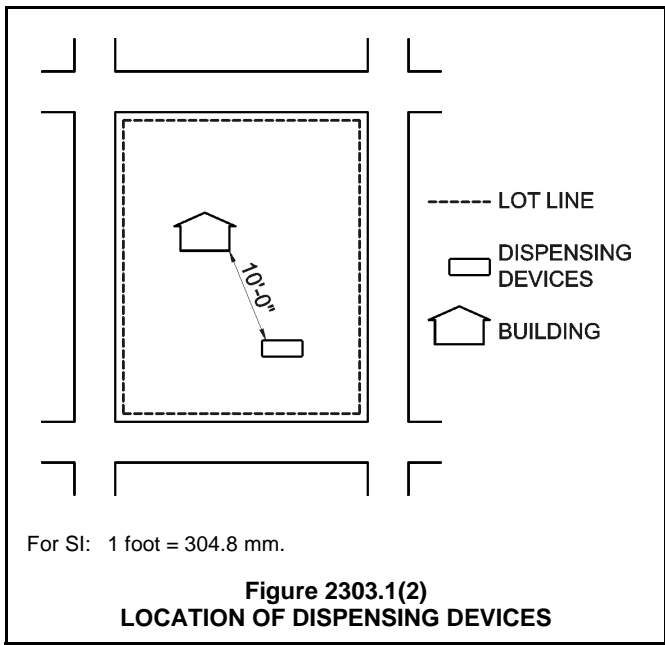
Commentary Figure 2303.1(2) shows the relationship of the dispenser to a building with a combustible exterior.

#### Item 3

Commentary Figure 2303.1(3) shows the location of the vehicle being fueled in relation to the motor fuel-



dispensing facility property lines. Note that this item is a dispenser location requirement or hose length limitation in that neither feature should be such that any portion of a vehicle could be off site while being fueled. In the past, it was not unusual to find dispensing devices installed on the sidewalk or near the curb in front of the motor fuel-dispensing facility so that vehicles could simply pull up to the curb and be fueled. This was especially true for motor fuel-dispensing facilities situated on very small sites. The intent of this requirement is similar to Item 4; that is, to keep the motor fuel from possible contact with off-site ignition sources. It also eliminates the hazard of an off-site vehicle being struck by another vehicle during fueling.

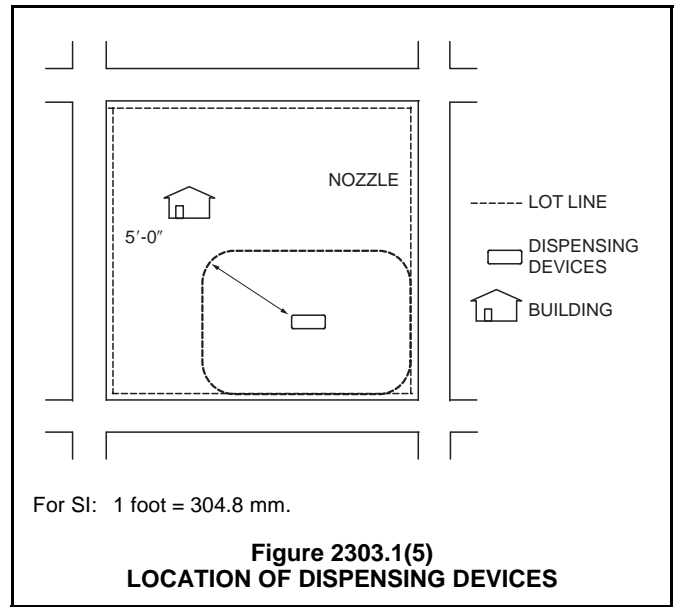
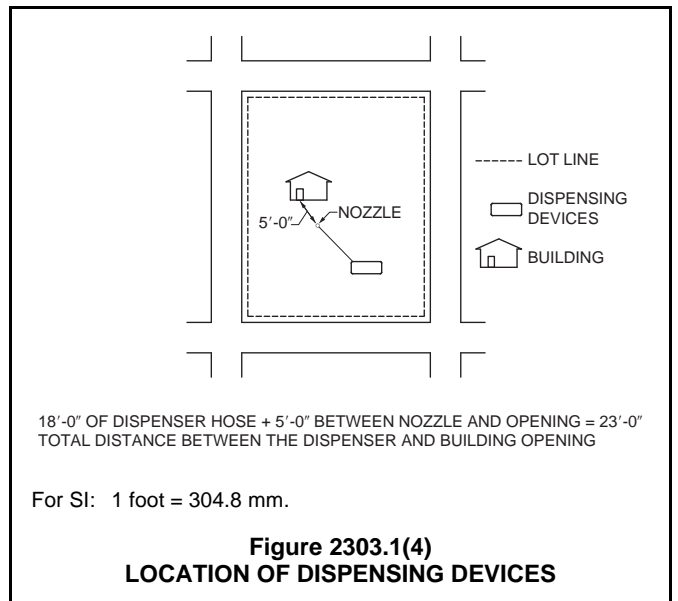


**Item 4**

Commentary Figure 2303.1(4) shows the relationship of the dispenser nozzle to a building opening. The intent of this requirement is similar to Item 3; that is, to keep the motor fuel from possible contact with ignition sources inside the building.

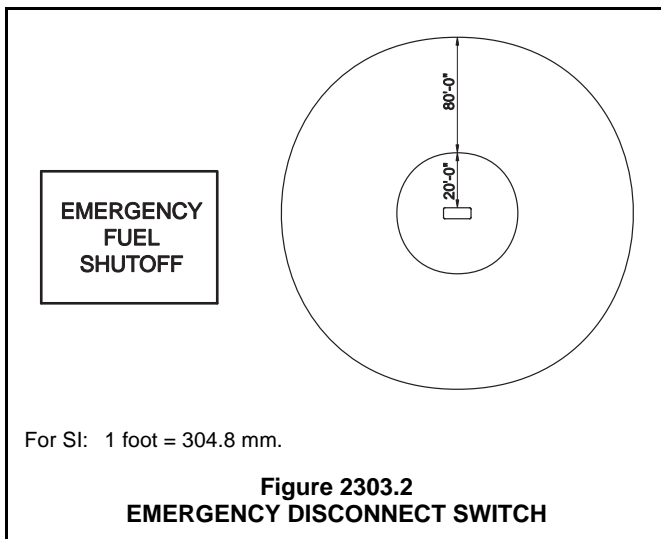
**Item 5**

Commentary Figure 2303.1(5) illustrates the area around a dispenser where fixed sources of ignition are prohibited. In planning and reviewing dispenser locations, the 20-foot (6096 mm) dimension should be correlated with Item 1 to prevent any fixed ignition sources beyond the property line from falling within the 20-foot (6096 mm) area required by this item.



**2303.2 Emergency disconnect switches.** An *approved*, clearly identified and readily accessible emergency disconnect switch shall be provided at an *approved* location to stop the transfer of fuel to the fuel dispensers in the event of a fuel spill or other emergency. The emergency disconnect switch for exterior fuel dispensers shall be located within 100 feet (30 480 mm) of, but not less than 20 feet (6096 mm) from, the fuel dispensers. For interior fuel-dispensing operations, the emergency disconnect switch shall be installed at an *approved* location. Such devices shall be distinctly *labeled* as: EMERGENCY FUEL SHUTOFF. Signs shall be provided in *approved* locations.

❖ This section establishes the requirement for emergency disconnect switches to shut off the flow of fuel in an emergency and specifies where they are to be located for both exterior and interior applications. The emergency disconnect switch must be clearly visible and placed far enough away from the fuel dispenser so that the switch will be easily accessible without entering the fuel spill area, but not so far that it would take too long to get to the switch. The switch location must be prominently indicated by an approved sign and access to the switch must be free of any obstructions, such as displayed merchandise. Commentary Figure 2303.2 illustrates the zone in which the disconnect switch must be located.



**SECTION 2304**  
**DISPENSING OPERATIONS**

**2304.1 Supervision of dispensing.** The dispensing of fuel at motor fuel-dispensing facilities shall be conducted by a qualified attendant or shall be under the supervision of a qualified attendant at all times or shall be in accordance with Section 2304.3.

❖ Motor fuel-dispensing facilities must have a trained, qualified attendant on duty when the facility is open for business, unless the fire code official specifically approves an unattended location.

**2304.2 Attended self-service motor fuel-dispensing facilities.** Attended self-service motor fuel-dispensing facilities shall comply with Sections 2304.2.1 through 2304.2.5. Attended self-service motor fuel-dispensing facilities shall have not less than one qualified attendant on duty while the facility is open for business. The attendant’s primary function shall be to supervise, observe and control the dispensing of fuel. The attendant shall prevent the dispensing of fuel into containers that do not comply with Section 2304.4.1, control sources of ignition, give immediate attention to accidental spills or releases, and be prepared to use fire extinguishers.

❖ An attendant trained in spill control, ignition source control, recognizing approved fuel containers and fire extinguishment is required to be in visual contact with the dispensing operation when the motor fuel-dispensing facility is open for business unless the fire code official has given approval for an unattended self-service facility. The attendant may perform other duties such as those of cashier as long as the attendant can supervise the dispensing operation and has immediate access to emergency shutoff controls. Note that the responsibility of supervision, observation and control of the dispensing operations includes enforcement of the procedures and rules in Sections 2305.6 and 2310.5.

**2304.2.1 Special-type dispensers.** *Approved* special-dispensing devices and systems such as, but not limited to, card- or coin-operated and remote-preset types, are allowed at motor fuel-dispensing facilities provided there is not less than one qualified attendant on duty while the facility is open to the public. Remote preset-type devices shall be set in the “off” position while not in use so that the dispenser cannot be activated without the knowledge of the attendant.

❖ Special dispensing devices that allow the customer to pay at the dispenser have become very popular. This provision requires that the dispenser be maintained in the off position so that the attendant is alerted before the fuel is dispensed and can, therefore, supervise the dispensing operation, making certain that the customer is placing fuel in an approved container and there are no sources of ignition in the area.

**2304.2.2 Emergency controls.** *Approved* emergency controls shall be provided in accordance with Section 2303.2.

❖ A clearly marked emergency fuel shutoff switch must be located no further than 100 feet (30 480 mm) from the dispenser and no closer than 20 feet (6096 mm) to the dispenser. The switch must be readily available to all persons and must cut off power to all dispensers and pumps.

**2304.2.3 Operating instructions.** Dispenser operating instructions shall be conspicuously posted in *approved* locations on every dispenser.

❖ Clearly understandable operating instructions for the use of the dispenser must be posted on the dispenser. The location must be approved by the fire code official. These operating instructions are in addition to the warnings required in Section 2305.6.

**2304.2.4 Obstructions to view.** Dispensing devices shall be in clear view of the attendant at all times. Obstructions shall not be placed between the dispensing area and the attendant.

❖ This provision does not specify a distance the attendant must be from the dispensing operation; however, the attendant must be able to clearly view the entire dispensing area from his or her workstation. In some cases, this is accomplished by closed-circuit television monitoring; however, the fire code official should carefully evaluate the clarity and resolution of the video image to verify that it meets the “clear view” requirement of this section. This section also prohibits the common practice of loading outside areas, including the dispenser islands, with displayed merchandise piled high enough so as to be a visual obstruction to the attendant.

**2304.2.5 Communications.** The attendant shall be able to communicate with persons in the dispensing area at all times. An *approved* method of communicating with the fire department shall be provided for the attendant.

❖ This is a two-part requirement. The first part requires that the attendant has the ability to communicate, for example, via intercom, with the person performing the dispensing. The second part requires the attendant to have some type of communication equipment that will allow him or her to immediately call the fire department in case of an emergency.

**2304.3 Unattended self-service motor fuel-dispensing facilities.** Unattended self-service motor fuel-dispensing facilities shall comply with Sections 2304.3.1 through 2304.3.7.

❖ An unattended self-service motor fuel-dispensing facility is allowed only with the specific approval of the fire code official. He or she should consider the location; exposures; the likelihood of vandalism; and how emergency equipment such as the emergency shut-off switch, portable fire extinguishers and the means of notifying the fire department in case of spill, fire or other emergency is going to be protected.

**2304.3.1 General.** Where *approved*, unattended self-service motor fuel-dispensing facilities are allowed. As a condition of approval, the *owner* or operator shall provide, and be accountable for, daily site visits, regular equipment inspection and maintenance.

❖ It is imperative that the owner/operator designates a responsible person to make daily site visits to the unattended self-service motor fuel-dispensing facility. All emergency equipment must be inspected for proper operation and availability to the customer. Vandalism is a major problem with unattended, self-service motor fuel-dispensing facilities. Vandals will trip the emergency fuel shutoff switch, and remove or discharge the fire-extinguishing equipment. This equipment must be maintained and made available to the person dispensing fuel. Also, a method of documenting the daily visits needs to be established and approved by the fire code official.

**2304.3.2 Dispensers.** Dispensing devices shall comply with Section 2306.7. Dispensing devices operated by the insertion of coins or currency shall not be used unless *approved*.

❖ The intent of this provision is to allow card or key-operated-type dispensers. Coin- or currency-type dispensers are allowed only with the approval of the fire code official.

**2304.3.3 Emergency controls.** *Approved* emergency controls shall be provided in accordance with Section 2303.2. Emergency controls shall be of a type that is only manually resettable.

❖ The emergency controls must be clearly identified and available to the person dispensing fuel. The controls or switch must be located no closer than 20 feet (6096 mm) to the dispenser and no farther than 100 feet (30 480 mm) from the dispenser. The switch must cut off power to all dispensers and pumps and must be manually resettable by the owner/operator. The intent is to prevent anyone from dispensing fuel until the problem has been corrected.

**2304.3.4 Operating instructions.** Dispenser operating instructions shall be conspicuously posted in *approved* locations on every dispenser and shall indicate the location of the emergency controls required by Section 2304.3.3.

❖ It is a special requirement for unattended self-service motor fuel-dispensing facilities that the location of the emergency control switch be included with the dispenser instructions and posted on the dispenser in an *approved* location.

**2304.3.5 Emergency procedures.** An *approved* emergency procedures sign, in addition to the signs required by Section 2305.6, shall be posted in a conspicuous location and shall read:

IN CASE OF FIRE, SPILL OR RELEASE

1. USE EMERGENCY PUMP SHUTOFF

2. REPORT THE ACCIDENT!

FIRE DEPARTMENT TELEPHONE NO. \_\_\_\_\_

FACILITY ADDRESS \_\_\_\_\_

❖ Signs must be clearly posted giving the location of the emergency fuel shutoff switch, the fire department’s telephone number and the motor fuel-dispensing facility address.

It is imperative that the person dispensing fuel at an unattended motor fuel-dispensing facility knows where the emergency control equipment is located. People not familiar with the area may not know the fire department’s telephone number or the address of the motor fuel-dispensing facility; therefore, this information must be included on the sign.

**2304.3.6 Communications.** A telephone not requiring a coin to operate or other *approved*, clearly identified means to notify the fire department shall be provided on the site in a location *approved* by the *fire code official*.

❖ The intent of this section is to provide a means to call the fire department in an emergency without the use

of a coin or phone card. Many jurisdictions with 911 telephone systems have pay phones that do not require the use of a coin or card to dial 911; this type of coin-operated telephone would be allowed.

**2304.3.7 Quantity limits.** Dispensing equipment used at unsupervised locations shall comply with one of the following:

1. Dispensing devices shall be programmed or set to limit uninterrupted fuel delivery to 25 gallons (95 L) and require a manual action to resume delivery.
  2. The amount of fuel being dispensed shall be limited in quantity by a preprogrammed card as *approved*.
- ❖ Limiting the amount of uninterrupted fuel delivered before another action is taken reduces the chances of a major fuel spill in the case of vandalism or equipment failure.

**2304.4 Dispensing into portable containers.** The dispensing of flammable or *combustible liquids* into portable *approved* containers shall comply with Sections 2304.4.1 through 2304.4.3.

❖ This section describes an approved container and states requirements for dispensing fuel into an approved container.

**2304.4.1 Approved containers required.** Class I, II and IIIA liquids shall not be dispensed into a portable container unless such container does not exceed a 6-gallon (22.7 L) capacity, is *listed* or of *approved* material and construction, and has a tight closure with a screwed or spring-loaded cover so designed that the contents can be dispensed without spilling. Liquids shall not be dispensed into portable or cargo tanks.

❖ Approved containers must be easily identified as fuel containers and constructed of materials that will maintain structural stability and resist spills. Flammable and combustible liquids should not be dispensed into portable or cargo tanks using conventional automotive dispensing equipment. If the tank is not properly grounded and the dispenser nozzle is not in contact with the tank, static electricity may build up and discharge between the nozzle and the tank. Note that this section is also intended to prohibit filling of a new class of portable gasoline containers that have entered the marketplace. These cans, some of which hold as much as 14 gallons (53 L) and weigh over 100 pounds (45 kg) when full, often include integrated hoses and dispensing nozzles, yet they do not comply with any Underwriters Laboratories (UL), American Society for Testing and Materials (ASTM) or similar recognized standard. Apparently, these cans are “certified” by the manufacturer as meeting United Nations/U.S. Department of Transportation (UN/DOT) standards for transportation, but it is questionable whether the safety standards required for transportation are adequate for storage and use of these products. For example, there are concerns about the ability of users to safely hoist these containers off of and onto vehicles to avoid static accumulation during filling, and the static charge will be greater than that

experienced with smaller cans because there is more fuel transferred during filling. Given that UL 30, UL 1313 and ASTM F852 or ASTM F976 (the recognized standards for construction of portable gas containers) all limit container capacities to approximately 6 gallons (22.7 L), it makes sense for the code to also reflect this limitation.

**2304.4.2 Nozzle operation.** A hose nozzle valve used for dispensing Class I liquids into a portable container shall be in compliance with Section 2306.7.6 and be manually held open during the dispensing operation.

❖ A listed automatic-closing-type nozzle must be used for dispensing fuel into portable containers. The hold-open device must not be used because the automatic-closing feature may not function properly since it is designed to operate in the neck of an automobile fuel receiver. The fuel tank vent in an automobile terminates in the receiver neck and the blow-back of fuel coming from the vent is what normally triggers the automatic shutoff feature.

**2304.4.3 Location of containers being filled.** Portable containers shall not be filled while located inside the trunk, passenger compartment or truck bed of a vehicle.

❖ Portable fuel containers riding on carpets, mats or pickup truck bed liners can build up a charge of static electricity that could discharge to the dispenser hose nozzle if not properly grounded. In order to dissipate the static charge, the container must be removed from the vehicle and placed on the ground before fueling begins. The nozzle must be in contact with the container before discharging the fuel. See the commentary to Section 2305.6, Warnings 3 and 4, for additional discussion of static electricity.

## SECTION 2305 OPERATIONAL REQUIREMENTS

**2305.1 Tank filling operations for Class I, II or III liquids.** Delivery operations to tanks for Class I, II or III liquids shall comply with Sections 2305.1.1 through 2305.1.3 and the applicable requirements of Chapter 57.

❖ History has shown that most accidents at motor fuel-dispensing facilities occur during the tank-filling operation. The provisions of this section address those operations.

**2305.1.1 Delivery vehicle location.** Where liquid delivery to above-ground storage tanks is accomplished by positive-pressure operation, tank vehicles shall be positioned not less than 25 feet (7620 mm) from tanks receiving Class I liquids and 15 feet (4572 mm) from tanks receiving Class II and IIIA liquids.

❖ Above-ground tanks are usually above the elevation of the fuel delivery truck, and the fuel must be pumped from the truck into the storage tank. The fuel is delivered in large volumes under pressure and most delivery trucks use a power take-off-driven pump that requires the truck engine to be running.

Because of this, the delivery truck and the storage tanks must be separated by the distances indicated so that venting vapors do not find their way to the running engine of the delivery vehicle and ignite.

**2305.1.2 Tank capacity calculation.** The driver, operator or attendant of a tank vehicle shall, before making delivery to a tank, determine the unfilled, available capacity of such tank by an *approved* gauging device.

❖ A gauge stick may be used to determine the quantity of fuel in a tank, but is impractical for use on an above-ground tank because the attendant would have to climb on top of the tank each time. In icy, wet or inclement weather this could be dangerous. It is more practical to install a fuel-level gauge accessible to the delivery operator on an above-ground tank.

After the driver places the delivery truck in position, he or she should record the ullage (i.e., the amount of liquid it would take to fill the tank) and set the delivery up for that amount of fuel. This is the first line of defense to prevent fuel spills (see also Section 5706.6.1.5 of the code).

**2305.1.3 Tank fill connections.** Delivery of flammable liquids to tanks more than 1,000 gallons (3785 L) in capacity shall be made by means of *approved* liquid- and vapor-tight connections between the delivery hose and tank fill pipe. Where tanks are equipped with any type of vapor recovery system, all connections required to be made for the safe and proper functioning of the particular vapor recovery process shall be made. Such connections shall be made liquid and vapor tight and remain connected throughout the unloading process. Vapors shall not be discharged at grade level during delivery.

❖ The delivery of Class I liquid motor fuel to either an above-ground or underground storage tank that exceeds 1,000 gallons (3785 L) in capacity must be through a liquid- and vapor-tight fitting to reduce the potential for the escape of flammable liquid or vapors at the point of connection. These fittings include liquid transfer lines and vapor recovery lines, which are designed to prevent the release of polluting, flammable fuel vapor during transfer. These requirements prohibit the extremely dangerous, but not uncommon, practice of delivery tanker operators not connecting vapor return hoses, thus allowing the vapors displaced during delivery to escape at grade level from the unmade connections. Incidents have been reported where the vapors have traveled to nearby buildings, found an ignition source and exploded (see also commentary, Section 5706.6.1.10).

**2305.2 Equipment maintenance and inspection.** Motor fuel-dispensing facility equipment shall be maintained in proper working order at all times in accordance with Sections 2305.2.1 through 2305.2.5.

❖ The provisions of this section address the requirements for maintaining safety equipment at dispensing operations.

**2305.2.1 Inspections.** Flammable and *combustible liquid* fuel-dispensing and containment equipment shall be periodically

inspected where required by the *fire code official* to verify that the equipment is in proper working order and not subject to leakage. Records of inspections shall be maintained.

❖ This section authorizes the fire code official to require the inspection of equipment on a periodic basis, and identifies that the inspection is to verify the equipment is in proper working order and is not leaking. The importance of the inspections is supported by the requirement for an operational permit in Section 105.6.16, Item 10, for the dispensing of flammable and combustible liquids into motor vehicles. The frequency and nature of the inspections are to be determined by the fire code official. This section also requires that written inspection records be kept. Such records should indicate the date, time and name of the person conducting the inspection or maintenance. These records must be maintained by the owner and should be made available to the fire code official for review when requested. This requirement relieves the fire code official of the administrative burden of maintaining test records.

**2305.2.2 Repairs and service.** The *fire code official* is authorized to require damaged or unsafe containment and dispensing equipment to be repaired or serviced in an *approved* manner.

❖ In conjunction with the inspection process in Section 2305.2.1, this section authorizes the fire code official to require that damaged, worn or leaking equipment be serviced or repaired in an approved manner. Though not specifically required by the section, removal from service of equipment needing repair or replacement would be advisable if its continued use presents an increased hazard to the public or emergency personnel. Examples of conditions that could prompt the need for repair or servicing include, but are not limited to, equipment that shows signs of physical damage, internal and external corrosion, leakage, brittleness, aging or undue wear and tear.

**2305.2.3 Dispensing devices.** Where maintenance to Class I liquid dispensing devices becomes necessary and such maintenance could allow the accidental release or ignition of liquid, the following precautions shall be taken before such maintenance is begun:

1. Only persons knowledgeable in performing the required maintenance shall perform the work.
2. Electrical power to the dispensing device and pump serving the dispenser shall be shut off at the main electrical disconnect panel.
3. The emergency shutoff valve at the dispenser, where installed, shall be closed.
4. Vehicle traffic and unauthorized persons shall be prevented from coming within 12 feet (3658 mm) of the dispensing device.

❖ Dispensers are complex pieces of machinery made up of many listed parts. Certain components of the dispenser are sealed to prevent ignition of fuel

vapors. Therefore, it is imperative that the repair technician be qualified to perform work on the dispenser.

The dispenser and the pump are usually two separate and distinct pieces of equipment. In most cases, the pump is located at the tank, remote from the dispensers, and fuel is supplied under pressure to the dispenser. Therefore, it is imperative that power be disconnected to both the dispenser and the pump before work is begun.

As a safety measure, in case the remote pump kicks on, the dispenser emergency valve must be manually closed. This valve is located below the dispenser in the liquid supply piping. This valve is required in remote pumping systems by Section 2306.7.4.

The separation distance of 12 feet (3658 mm) is intended to keep the public and ignition sources away from possible fuel spills that may occur during the maintenance of dispensing devices.

**2305.2.4 Emergency shutoff valves.** Automatic emergency shutoff valves required by Section 2306.7.4 shall be checked not less than once per year by manually tripping the hold-open linkage.

❖ The emergency shutoff valve, also known as an impact valve, is located in the pit in the island below the dispenser, and consists of a shear section and a fusible link with a spring-loaded valve that must be manually tripped at least annually to verify that it is operable. See the commentary to Section 2306.7.4 for additional discussion of these valves.

**2305.2.5 Leak detectors.** Leak detection devices required by Section 2306.7.7.1 shall be checked and tested not less than annually in accordance with the manufacturer's specifications to ensure proper installation and operation.

❖ In a remote pumping system (where fuel is supplied under pressure to the dispenser) a leak detection device is required on the discharge/pressure side of the pump. The most common area to leak fuel is the piping between the storage tanks and the dispensers. Therefore, it is imperative that the required leak detection equipment be tested annually and maintained in an operable condition.

**2305.3 Spill control.** Provisions shall be made to prevent liquids spilled during dispensing operations from flowing into buildings. Acceptable methods include, but shall not be limited to, grading driveways, raising doorsills or other *approved* means.

❖ This provision is intended to prevent flammable and combustible liquids from entering buildings if a spill occurs. The spill control method must be approved by the fire code official and may be as simple as scoring the concrete pavement adjacent to the dispenser island (similar to highway "rumble strips") to retard the surface flow of spilled fuel.

If the spilled liquid is to be routed to a drain, the drain must be equipped with a sump and an oil-water separator to prevent the fuel from entering the storm drainage system. The oil-water separator must be installed in accordance with the IPC.

**2305.4 Sources of ignition.** Smoking and open flames shall be prohibited in areas where fuel is dispensed. The engines of vehicles being fueled shall be shut off during fueling. Electrical equipment shall be in accordance with NFPA 70.

❖ This provision is intended to control all ignition sources near fuel-dispensing operations. This includes smoking, matches, lighters or any other ignition source. Internal combustion engines must also be shut off during the fueling operation in accordance with Section 2305.6, Item 2. Electrical equipment in close proximity to the fueling operation, including the dispensing equipment, must be in accordance with NFPA 70 and Table 5703.1.1 of the code.

**2305.5 Fire extinguishers.** *Approved* portable fire extinguishers complying with Section 906 with a minimum rating of 2-A:20-B:C shall be provided and located such that an extinguisher is not more than 75 feet (22 860 mm) from pumps, dispensers or storage tank fill-pipe openings.

❖ A person should not have to travel more than 75 feet (22 860 mm) from a fuel dispenser, pump or a fill opening to reach an extinguisher. If the dispenser, pump and fill opening are in close proximity to each other, one extinguisher may satisfy the requirements.

**2305.6 Warning signs.** Warning signs shall be conspicuously posted within sight of each dispenser in the fuel-dispensing area and shall state the following:

1. No smoking.
2. Shut off motor.
3. Discharge your static electricity before fueling by touching a metal surface away from the nozzle.
4. To prevent static charge, do not reenter your vehicle while gasoline is pumping.
5. If a fire starts, do not remove nozzle—back away immediately.
6. It is unlawful and dangerous to dispense gasoline into unapproved containers.
7. No filling of portable containers in or on a motor vehicle. Place container on ground before filling.

❖ The warning sign must be legible and conspicuously posted in the dispensing area. The intent is to notify the dispenser operator of the dangers of each of the enumerated items. Warnings 1 and 2 intend to control the obvious ignition hazards of smoking and operating internal combustion engines in the presence of gasoline vapors.

Warnings 3 and 4 focus on the hazard of static electricity. People generally build up a charge of

static electricity through the friction between their clothing and the car seat while entering, leaving and driving a vehicle, especially in cold, dry weather. If that charge is not dissipated in accordance with Warning 3 prior to fueling the vehicle, it is likely that the static charge will arc the gap between the person's hand and the vehicle fill pipe as they start to remove the fill cap and possibly ignite the vapors. Warning 4 recognizes that even if the Warning 3 precaution is taken, reentering the vehicle while fueling can regenerate a static charge that will, in all likelihood, arc the gap between the driver's hand and the hose nozzle valve or between the vehicle fill pipe and the hose nozzle as the nozzle is being withdrawn and ignite the vapors. Renkes reported in 2006 that, between 1992 and 2006, 166 incidents of static ignition at motor fuel-dispensing facilities were reported to the Petroleum Equipment Institute (PEI) and 34 to the National Highway Traffic Safety Administration (NHTSA). Those incidents resulted in varying levels of damage to vehicles and property and varying degrees of injury to consumers intimate with the ignition scenarios.

In case of fire, Warning 5 cautions the customer not to remove the hose nozzle from the fill pipe, possibly expanding the extent of the fire. Moving away from the fire while at the same time keeping an eye on it is the precaution of choice.

Warning 6 correlates with the provisions for dispensing into approved portable containers in Section 2304.4. Section 2304.4.1 outlines the characteristics of approved portable containers. The intent of this warning is to not allow dispensing into random containers that might be available, such as plastic milk jugs, glass or plastic bottles, open pans, etc.

Warning 7 correlates with Section 2304.4.3 as to removing containers from vehicles and placing them on the ground to dissipate any static electricity buildup prior to fueling (see commentary, Section 2304.4.3).

**2305.7 Control of brush and debris.** Fenced and diked areas surrounding above-ground tanks shall be kept free from vegetation, debris and other material that is not necessary to the proper operation of the tank and piping system.

Weeds, grass, brush, trash and other combustible materials shall be kept not less than 10 feet (3048 mm) from fuel-handling equipment.

- ❖ Above-ground tanks must to be secured and inaccessible to the public. The secured area around the tanks must be kept clean and free of combustibles. The area around dispensers, remote pumps and fill openings must also be kept clean and free of combustibles for a distance of at least 10 feet (3048 mm). The intent is to prevent the accumulation of readily

combustible materials near tanks and equipment that could contribute to a fire in the event of an ignition.

## SECTION 2306 FLAMMABLE AND COMBUSTIBLE LIQUID MOTOR FUEL-DISPENSING FACILITIES

**2306.1 General.** Storage of flammable and *combustible liquids* shall be in accordance with Chapter 57 and Sections 2306.2 through 2306.6.3.

- ❖ The general requirements for storing flammable and combustible liquids are found in Chapter 57. The provisions specific to motor fuel-dispensing facilities are found in this section. Due to the activities in locations such as convenience stores, vehicle traffic and location of most motor fuel-dispensing facilities, the provisions for tank capacities, locations and dispensing equipment are more stringent in this chapter of the code than the general provisions found in Chapter 57. Accordingly, these specific regulations take precedence over the general provisions of Chapter 57.

**2306.2 Method of storage.** *Approved* methods of storage for Class I, II and III liquid fuels at motor fuel-dispensing facilities shall be in accordance with Sections 2306.2.1 through 2306.2.6.

- ❖ These provisions are specifically for motor fuel-dispensing facilities.

**2306.2.1 Underground tanks.** Underground tanks for the storage of Class I, II and IIIA liquid fuels shall comply with Chapter 57.

- ❖ This section relies on Chapter 57, which contains the requirements for the location and installation of underground tanks.

**2306.2.1.1 Inventory control for underground tanks.** Accurate daily inventory records shall be maintained and reconciled on underground fuel storage tanks for indication of possible leakage from tanks and piping. The records shall include records for each product showing daily reconciliation between sales, use, receipts and inventory on hand. Where there is more than one system consisting of tanks serving separate pumps or dispensers for a product, the reconciliation shall be ascertained separately for each tank system. A consistent or accidental loss of product shall be immediately reported to the *fire code official*.

- ❖ In addition to the leak detection requirements of Section 2305.2.5, this section requires another level of scrutiny for underground motor fuel storage tanks in the form of daily, documented reconciliation of inventory versus product sold to help detect leaks in underground tanks and piping. Loss in inventory should be reported immediately to the fire code official (see also Section 5704.2.11.5.1).

**2306.2.2 Above-ground tanks located inside buildings.**

Above-ground tanks for the storage of Class I, II and IIIA liquid fuels are allowed to be located in buildings. Such tanks shall be located in special enclosures complying with Section 2306.2.6, in a liquid storage room or a liquid storage warehouse complying with Chapter 57, or shall be *listed* and *labeled* as protected above-ground tanks in accordance with UL 2085.

❖ This provision is intended to establish requirements for placing an above-ground tank inside a building. The options are:

- A tank in a special enclosure in accordance with Section 2306.2.6.
- A tank inside a liquid storage room in accordance with Section 5704.3.7.
- A tank inside a liquid storage warehouse in accordance with Section 5704.3.8.
- A protected above-ground tank in accordance with UL 2085.

**2306.2.3 Above-ground tanks located outside, above grade.**

Above-ground tanks shall not be used for the storage of Class I, II or III liquid motor fuels, except as provided by this section.

1. Above-ground tanks used for outside, above-grade storage of Class I liquids shall be *listed* and *labeled* as protected above-ground tanks in accordance with UL 2085 and shall be in accordance with Chapter 57. Such tanks shall be located in accordance with Table 2306.2.3.
2. Above-ground tanks used for outside, above-grade storage of Class II or IIIA liquids shall be *listed* and *labeled* as protected above-ground tanks in accordance with UL 2085 and shall be installed in accordance with Chapter 57. Tank locations shall be in accordance with Table 2306.2.3.

**Exception:** Other above-ground tanks that comply with Chapter 57 where *approved* by the *fire code official*.

3. Tanks containing fuels shall not exceed 12,000 gallons (45 420 L) in individual capacity or 48,000 gallons

(181 680 L) in aggregate capacity. Installations with the maximum allowable aggregate capacity shall be separated from other such installations by not less than 100 feet (30 480 mm).

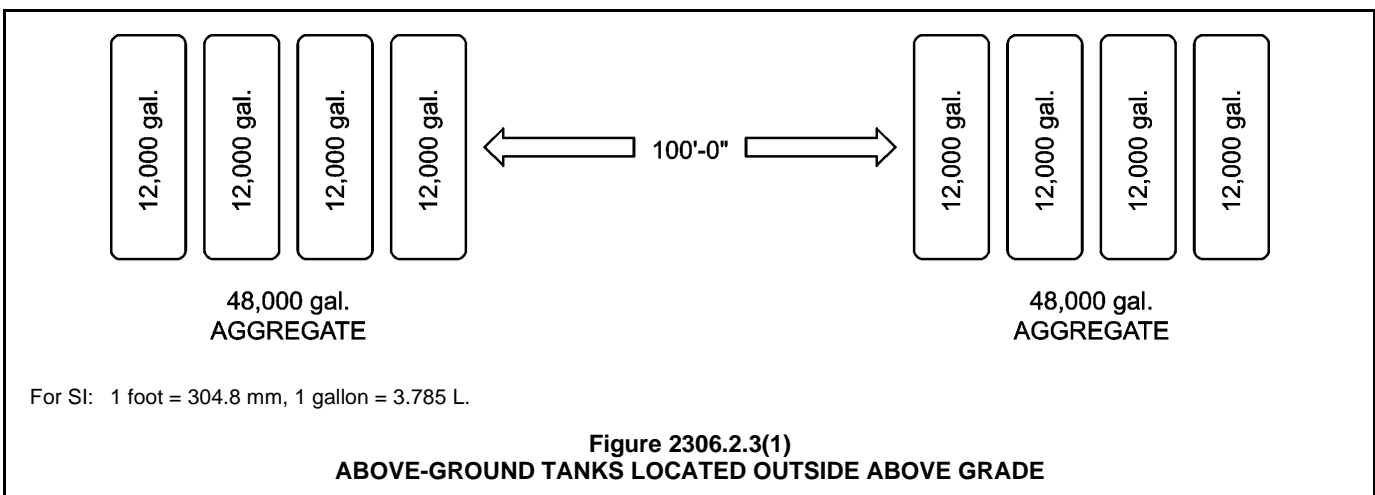
4. Tanks located at farms, construction projects, or rural areas shall comply with Section 5706.2.
5. Above-ground tanks used for outside above-grade storage of Class IIIB liquid motor fuel shall be *listed* and *labeled* in accordance with UL 142 or *listed* and *labeled* as protected above-ground tanks in accordance with UL 2085 and shall be installed in accordance with Chapter 57. Tank locations shall be in accordance with Table 2306.2.3.

❖ This section essentially prohibits the use of above-ground tanks for the storage of motor fuels unless they are in compliance with one of the five listed conditions. Where above-ground storage of flammable liquid motor fuel is desired, the intent of Item 1 is to allow the storage of flammable liquids in protected above-ground tanks only, listed and labeled in accordance with UL 2085 and in compliance with the applicable requirements of Section 5704.2.9.

Item 2 states that Class II or IIIA combustible liquids must be stored in either a UL 2085 protected above-ground tank or other above-ground tanks where approved by the fire code official.

In Item 3, the maximum aggregate capacity is the total capacity of all the individual tanks in one area. A separation distance of at least 100 feet (30 480 mm) must be placed between installations of the maximum aggregate capacities [see Commentary Figure 2306.2.3(1)]. The 100-foot (30 480 mm) separation distance is intended to protect multiple aggregate capacity installations from one another in the event of a fire or other emergency.

Item 4 provides an exception since the provisions of Section 5706.2 pertain to the permanent and temporary storage and dispensing of Class I (gasoline) and Class II (diesel and kerosene) for private use on farms and rural areas and at construction sites, earth-moving projects and gravel pits. See Section 5706.2 for maximum capacities and other provisions, and Sec-



tion 5706.2.4.4 for locations where above-ground tanks are prohibited.

An increasing number of facilities are establishing motor-vehicle fuel-dispensing stations for dispensing B100/B99 biodiesel, a Class IIIB liquid, into motor vehicles. In many cases these fueling stations are not set up as traditional motor fuel-dispensing stations but, rather, they consist of a small stand-alone fuel-dispensing operation using a 500- to 3,000-gallon (1893 to 11 356 L) fuel tank located near a drive-through espresso stand or mini market [see Commentary Figures 2306.2.3(2) and 2306.2.3(3)]. Chapter 23 previously had only minimal requirements for the installation of tanks and fueling operations for dispensing Class IIIB liquids into motor vehicles. This section now addresses the trend of dispensing of Class IIIB liquid motor fuels in a more comprehensive manner by providing, in Item 5, two options for tanks used for Class IIIB motor fuels, i.e., either an unprotected above-ground tank complying with UL 142 or a protected above-ground tank listed and labeled in accordance with UL 2085 and complying with the applicable requirements of Section 5704.2.9 of the code. This will eliminate the heretofore fairly common practice of dispensing Class IIIB motor fuels directly from plastic intermediate bulk container (often termed IBCs) totes (see Chapter 9 of NFPA 30 for information on such containers).

requirements for a protected, above-ground tank of 6,000 gallons (22 710 L) or less in accordance with UL 2085. Commentary Figure 2306.2.3(5) shows the spacing requirements for a protected above-ground tank greater than 6,000 gallons (22 710 L) in accordance with UL 2085. Commentary Figure 2306.2.3(6) shows the spacing requirements for a listed UL 142 above-ground tank regardless of whether it is a double-wall UL 142 tank or a single-wall UL 142 tank inside of a dike.



**TABLE 2306.2.3.** See below.

❖ This table provides the minimum physical separation requirements for above-ground motor fuel storage tanks of all types allowed by Sections 2306.2.3 and 2306.2.4, including those installed in vaults. Commentary Figure 2306.2.3(4) shows the spacing

**TABLE 2306.2.3  
MINIMUM SEPARATION REQUIREMENTS FOR ABOVE-GROUND TANKS**

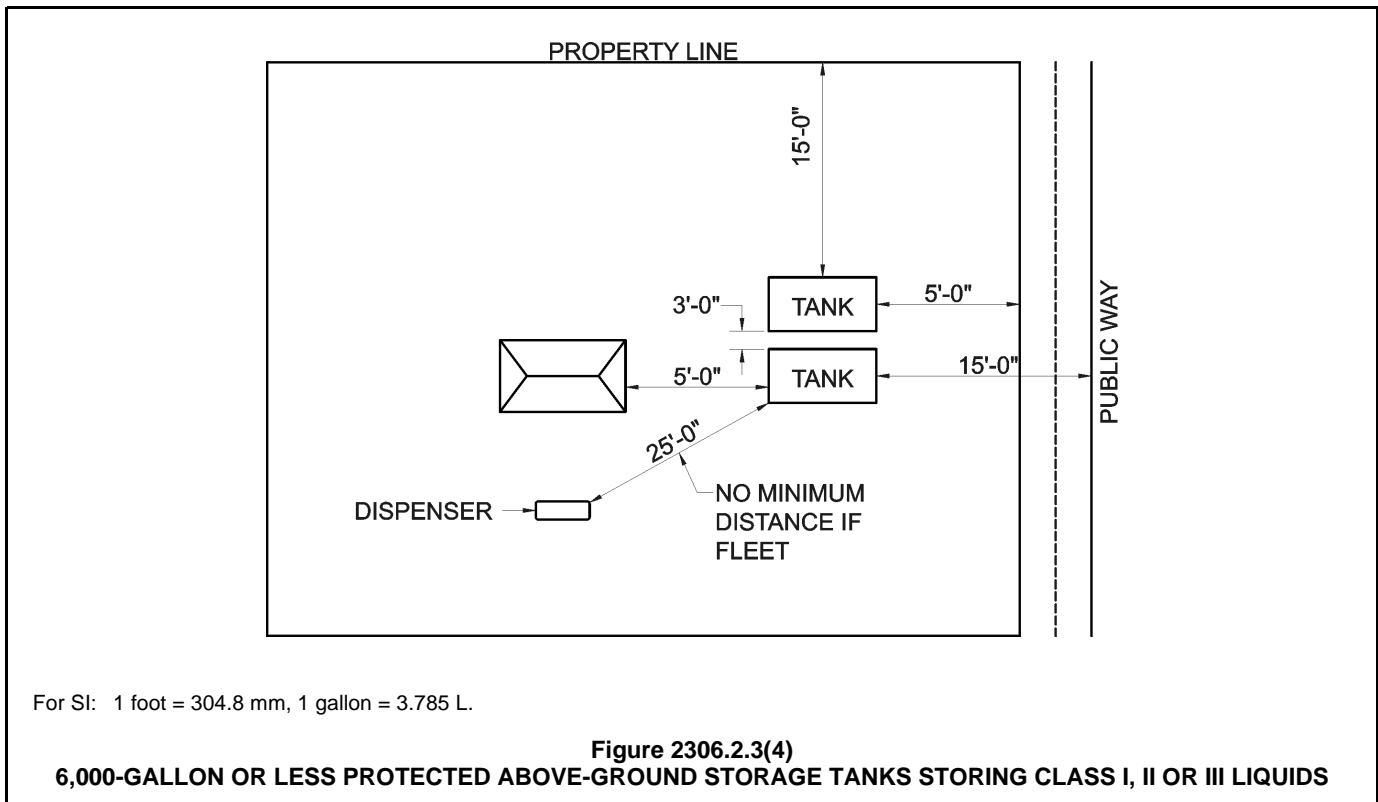
CLASS OF LIQUID AND TANK TYPE	INDIVIDUAL TANK CAPACITY (gallons)	MINIMUM DISTANCE FROM NEAREST IMPORTANT BUILDING ON SAME PROPERTY (feet)	MINIMUM DISTANCE FROM NEAREST FUEL DISPENSER (feet)	MINIMUM DISTANCE FROM LOT LINE THAT IS OR CAN BE BUILT UPON, INCLUDING THE OPPOSITE SIDE OF A PUBLIC WAY (feet)	MINIMUM DISTANCE FROM NEAREST SIDE OF ANY PUBLIC WAY (feet)	MINIMUM DISTANCE BETWEEN TANKS (feet)
Class I protected above-ground tanks	Less than or equal to 6,000	5	25 <sup>a</sup>	15	5	3
	Greater than 6,000	15	25 <sup>a</sup>	25	15	3
Class II and III protected above-ground tanks	Same as Class I	Same as Class I	Same as Class I <sup>c</sup>	Same as Class I	Same as Class I	Same as Class I
Tanks in vaults	0–20,000	0 <sup>b</sup>	0	0 <sup>b</sup>	0	Separate compartment required for each tank
Other tanks	All	50	50	100	50	3

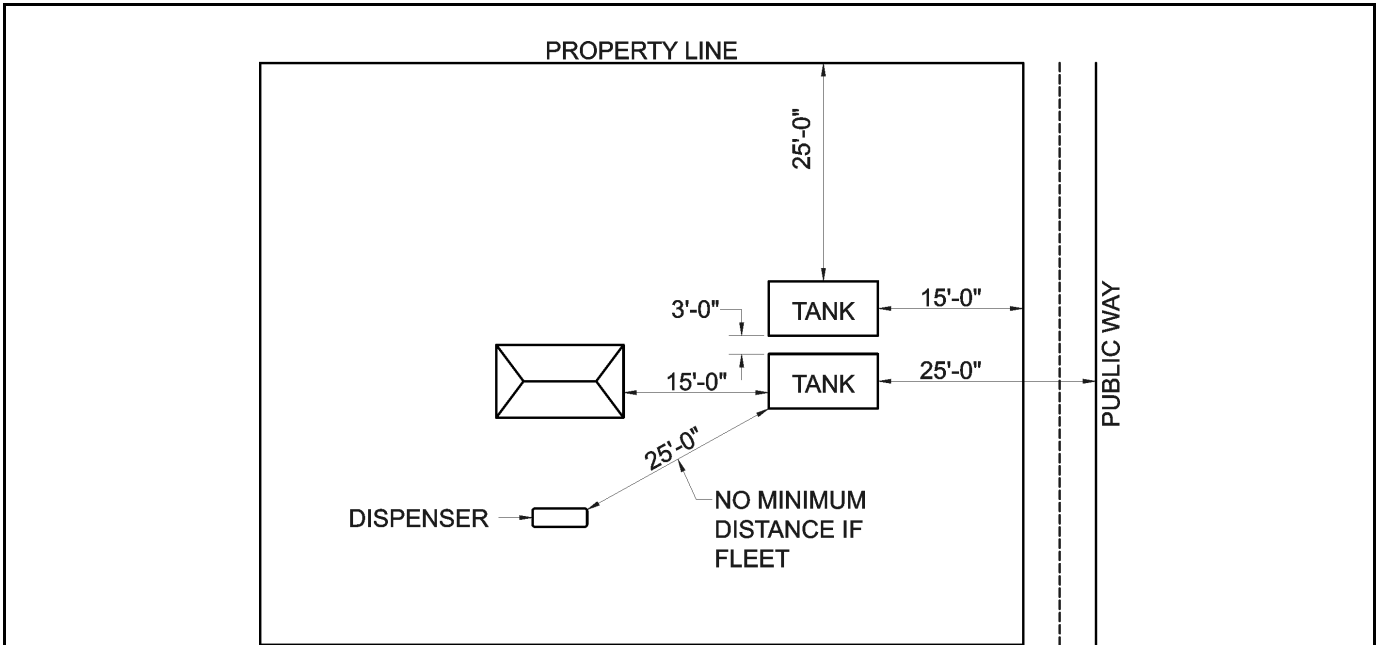
For SI: 1 foot = 304.8 mm, 1 gallon = 3.785 L.

- a. At fleet vehicle motor fuel-dispensing facilities, a minimum separation distance is not required.
- b. Underground vaults shall be located such that they will not be subject to loading from nearby structures, or they shall be designed to accommodate applied loads from existing or future structures that can be built nearby.
- c. For Class IIIB liquids in protected above-ground tanks, a minimum separation distance is not required.



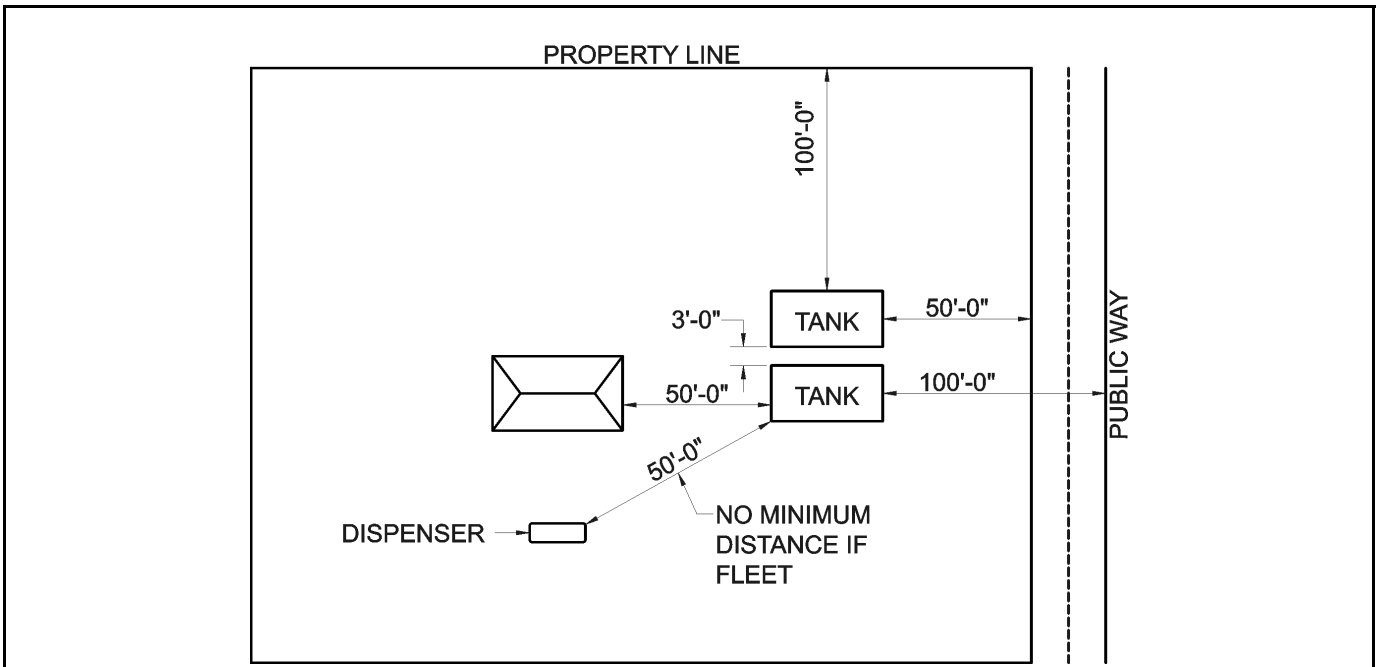
**Figure 2306.2.3(3)**  
**BIODIESEL FUELER**





For SI: 1 foot = 304.8 mm, 1 gallon = 3.785 L.

**Figure 2306.2.3(5)**  
**GREATER THAN 6,000-GALLON PROTECTED ABOVE-GROUND STORAGE TANKS STORING CLASS I, II OR III LIQUIDS**



For SI: 1 foot = 304.8 mm.

**Figure 2306.2.3(6)**  
**ALL OTHER ABOVE-GROUND STORAGE TANKS STORING CLASS II OR III LIQUIDS ONLY**

**2306.2.4 Above-ground tanks located in above-grade vaults or below-grade vaults.** Above-ground tanks used for storage of Class I, II or IIIA liquid motor fuels are allowed to be installed in vaults located above grade or below grade in accordance with Section 5704.2.8 and shall comply with Sections 2306.2.4.1 and 2306.2.4.2. Tanks in above-grade vaults shall also comply with Table 2306.2.3.

❖ The definition of an “Above-ground tank” is a tank without backfill. An underground tank receives strength from backfill. If the tank is not surrounded by backfill, the tank must be a listed and labeled above-ground tank. Therefore, a tank inside a vault, even if the vault is underground, must be a listed and labeled above-ground tank.

**2306.2.4.1 Tank capacity limits.** Tanks storing Class I and Class II liquids at an individual site shall be limited to a maximum individual capacity of 15,000 gallons (56 775 L) and an aggregate capacity of 48,000 gallons (181 680 L).

❖ This section places limitations on the capacities of tanks inside vaults. At motor fuel-dispensing facilities, the maximum capacity is 15,000 gallons (56 775 L) for a single tank and 48,000 gallons (181 680 L) aggregate capacity. The individual tank capacity allows the facility to receive the largest single product delivery that may be reasonably expected in a single tank. The aggregate capacity affords the facility the marketing flexibility it needs to carry for sale a wide range of motor fuels and specialty fuels, such as kerosene or diesel fuel.

**2306.2.4.2 Fleet vehicle motor fuel-dispensing facilities.** Tanks storing Class II and Class IIIA liquids at a fleet vehicle motor fuel-dispensing facility shall be limited to a maximum individual capacity of 20,000 gallons (75 700 L) and an aggregate capacity of 80,000 gallons (302 800 L).

❖ At fleet vehicle motor fuel-dispensing facilities (where the vehicles are used in connection with the fleet operator’s business) the maximum storage capacity is 20,000 gallons (75 700 L) for a single tank and 80,000 gallons (302 800 L) aggregate. These higher capacities recognize that the relative hazard of fleet facilities is less than at public motor fuel-dispensing facilities because the fleet fuel of choice is typically diesel fuel, a Class II liquid, rather than gasoline, a Class IB liquid. The higher capacities also reduce the hazard of liquid transfer by reducing the number of times the storage tanks must be refilled. Note that the additional capacity in this section applies only to Class II and IIIA liquid fuels. Class I fuels would remain subject to the provisions of Section 2306.2.4.1.

**2306.2.5 Portable tanks.** Where approved by the fire code official, portable tanks are allowed to be temporarily used in conjunction with the dispensing of Class I, II or III liquids into the fuel tanks of motor vehicles or motorized equipment

on premises not normally accessible to the public. The approval shall include a definite time limit.

❖ This section recognizes the need for allowing portable tanks to be used temporarily for fueling vehicles at locations that, because of topography or security, are not accessible to the general public, such as mining sites, logging camps, well-drilling sites, large rail yards, construction projects and the like. The key word here is “temporarily.” If such sites require a permanent fueling facility, then all applicable provisions of the code apply. The fire code official retains control over such temporary uses since approval is required and a definite time limit on such operations is imposed.

**2306.2.6 Special enclosures.** Where installation of tanks in accordance with Section 5704.2.11 is impractical, or because of property or building limitations, tanks for liquid motor fuels are allowed to be installed in buildings in special enclosures in accordance with all of the following:

1. The special enclosure shall be liquid tight and vapor tight.
2. The special enclosure shall not contain backfill.
3. Sides, top and bottom of the special enclosure shall be of reinforced concrete not less than 6 inches (152 mm) thick, with openings for inspection through the top only.
4. Tank connections shall be piped or closed such that neither vapors nor liquid can escape into the enclosed space between the special enclosure and any tanks inside the special enclosure.
5. Means shall be provided whereby portable equipment can be employed to discharge to the outside any vapors that might accumulate inside the special enclosure should leakage occur.
6. Tanks containing Class I, II or IIIA liquids inside a special enclosure shall not exceed 6,000 gallons (22 710 L) in individual capacity or 18,000 gallons (68 130 L) in aggregate capacity.
7. Each tank within special enclosures shall be surrounded by a clear space of not less than 3 feet (910 mm) to allow for maintenance and inspection.

❖ Special enclosures (essentially concrete vaults) can solve installation difficulties on problematic motor fuel-dispensing facility sites by allowing tanks to be installed inside of the facility building. The intent of this provision is to:

- Protect the building from the tank in case there is a fire involving the tank.
- Protect the tank from the building in case there is a fire involving the building.
- Prevent vapors from accumulating in the space between the tank and the enclosure.

- Limit the capacity of the tank inside the enclosure.
- Provide room for a maintenance technician to enter the space between the tank and the enclosure.

**2306.3 Security.** Above-ground tanks for the storage of liquid motor fuels shall be safeguarded from public access or unauthorized entry in an *approved* manner.

❖ This section is intended to protect the above-ground tank from vandalism and at the same time allow enough room for fire fighters to maneuver around the tank.

**2306.4 Physical protection.** Guard posts complying with Section 312 or other *approved* means shall be provided to protect above-ground tanks against impact by a motor vehicle unless the tank is *listed* as a protected above-ground tank with vehicle impact protection.

❖ This provision seeks to prevent leaks and spills caused by vehicle impact. The provision recognizes that vehicle damage can be reduced by placing 4-inch (102 mm) steel posts filled with concrete and spaced on 4-foot (1219 mm) centers around the above-ground tank, or by using a listed protected above-ground tank with vehicle impact protection.

**2306.5 Secondary containment.** Above-ground tanks shall be provided with drainage control or diking in accordance with Chapter 57. Drainage control and diking is not required for *listed* secondary containment tanks. Secondary containment systems shall be monitored either visually or automatically. Enclosed secondary containment systems shall be provided with emergency venting in accordance with Section 2306.6.2.5.

❖ A single-walled, above-ground, UL 142 tank inside a dike, or a double-wall, secondary containment, above-ground tank with emergency relief vents for the inner tank and the interstitial space will provide the level of protection required by this section. Both styles of tanks are listed for above-ground use and both tanks meet the requirements for drainage control and diking.

**2306.6 Piping, valves, fittings and ancillary equipment for use with flammable or combustible liquids.** The design, fabrication, assembly, testing and inspection of piping, valves, fittings and ancillary equipment for use with flammable or *combustible liquids* shall be in accordance with Chapter 57 and Sections 2306.6.1 through 2306.6.3.

❖ The majority of leaks come from piping, valves, fittings and ancillary equipment, not from the tank itself. Therefore, this section is intended to reduce fuel spills by addressing the requirements for this equipment.

**2306.6.1 Protection from damage.** Piping shall be located such that it is protected from physical damage.

❖ Piping is easily damaged by vehicles and other equipment. Piping must be installed and located in a way that will minimize damage either by burying the

pipe or protecting the pipe by some other physical means. More leaks come from piping than any other source.

**2306.6.2 Piping, valves, fittings and ancillary equipment for above-ground tanks for Class I, II and III liquids.** Piping, valves, fittings and ancillary equipment for above-ground tanks storing Class I, II and III liquids shall comply with Sections 2306.6.2.1 through 2306.6.2.6.

❖ Because above-ground tanks have a gravity head and some of the piping is always exposed above ground, special provisions apply to piping for above-ground tanks.

**2306.6.2.1 Tank openings.** Tank openings for above-ground tanks shall be through the top only.

❖ Tank openings must be through the top, above the liquid level, of an above-ground tank to reduce the risk of a liquid spill in the event of a piping failure.

**2306.6.2.2 Fill-pipe connections.** The fill pipe for above-ground tanks shall be provided with a means for making a direct connection to the tank vehicle's fuel-delivery hose so that the delivery of fuel is not exposed to the open air during the filling operation. Where any portion of the fill pipe exterior to the tank extends below the level of the top of the tank, a check valve shall be installed in the fill pipe not more than 12 inches (305 mm) from the fill-hose connection.

❖ The fill-pipe connection must be a liquid-tight connection, such as a cam-lock connection. The connection may be installed on top of the tank, which would require the fuel delivery person to climb on top of the tank, or the connection may be piped down to a lower level to prevent the delivery person from having to climb onto the tank. When the connection is piped down below the fuel level in the tank, a check valve must be installed in the location specified to prevent the discharge of fuel by siphon flow.

**2306.6.2.3 Overfill protection.** Overfill protection shall be provided for above-ground flammable and *combustible liquid* storage tanks in accordance with Sections 5704.2.7.5.8 and 5704.2.9.7.6.

❖ Overfill prevention is a major concern when dealing with above-ground tanks. The first step in preventing a spill is for the delivery truck operator to check the liquid level in the above-ground tank and set the truck up accordingly to fill the tank to the 90-percent level. The second prevention measure is the audible fill alarm that will sound an alarm when the tank reaches 90-percent capacity. The third level of prevention is for a device that will shut off the flow of liquid at 95-percent capacity.

An above-ground tank should be considered full at 90-percent capacity but under no circumstances should the tank be filled beyond 95-percent capacity.

The first thing the delivery driver should do after he or she properly positions the fuel delivery truck is to check and record the ullage (the amount of liquid required to fill the tank to 90-percent capacity).

The second line of defense to prevent an overfill is

an audible alarm set to go off when the tank reaches 90-percent capacity.

The third and final line of defense is the tank fill piping must be equipped with a device that will completely shut off the supply of liquid when the tank reaches 95 percent. This device is usually installed inside the tank fill opening and is part of the tank fill tube that extends down into the tank. The delivery operator should never rely on this device to determine when the tank is full; the delivery should have stopped at 90 percent. In the event that the delivery operator overfills the tank and the complete shutoff device closes, the tank delivery driver must have the means to drain the delivery hose without spilling the liquid on the ground.

As an alternative to the complete shutoff device, the code allows a device that will slow down the delivery rate when the tank reaches 90 percent. Once the tank reaches 90 percent, the rate of flow should slow down to a point where it will take 30 minutes to fill the tank to 95 percent.

**2306.6.2.4 Siphon prevention.** An *approved* antisiphon method shall be provided in the piping system to prevent flow of liquid by siphon action.

❖ Since piping connections to an above-ground tank must enter the tank through the top, this section requires that an approved anti-siphon device be installed in the liquid piping near the top of the tank to prevent liquid flow from the tank by siphon action if the supply pipe from the tank to the dispenser is damaged.

**2306.6.2.5 Emergency relief venting.** Above-ground storage tanks, tank compartments and enclosed secondary containment spaces shall be provided with emergency relief venting in accordance with Chapter 57.

❖ The emergency relief vent is the most important safety device installed on the tank. The emergency relief vent prevents the tank from overpressurizing in the event the tank is exposed to fire. In the case of a secondary containment above-ground tank there must be an emergency relief vent for each tank compartment and an emergency relief vent for the interstitial space.

**2306.6.2.6 Spill containers.** A spill container having a capacity of not less than 5 gallons (19 L) shall be provided for each fill connection. For tanks with a top fill connection, spill containers shall be noncombustible and shall be fixed to the tank and equipped with a manual drain valve that drains into the primary tank. For tanks with a remote fill connection, a portable spill container is allowed.

❖ The fill connection must be equipped with a spill-containment device that will hold at least 5 gallons (19 L). If the tank has a top-fill connection, the container must be noncombustible and attached directly to the tank and equipped with a drain valve that will allow any spilled liquid to be manually drained into the tank.

If the tank is equipped with a remote-fill connection, the container must be located at the connection when a delivery connection is made to the fill pipe.

**2306.6.3 Piping, valves, fittings and ancillary equipment for underground tanks.** Piping, valves, fittings and ancillary equipment for underground tanks shall comply with Chapter 57 and NFPA 30A.

❖ Section 5703.6 and NFPA 30A address the provisions for piping connected to underground tanks:

- Galvanic and corrosion protection.
- Leak detection.
- Special materials.
- Piping supports.
- Backflow protection.
- Flexible connections.
- Testing.

**2306.7 Fuel-dispensing systems for flammable or combustible liquids.** The design, fabrication and installation of fuel-dispensing systems for flammable or *combustible liquid* fuels shall be in accordance with Sections 2306.7.1 through 2306.7.9.2.4. Alcohol-blended fuel-dispensing systems shall also comply with Section 2306.8.

❖ The fuel-dispensing system consists of all the equipment required to get the fuel from the tank into the vehicle being fueled. It consists of the pumps, piping, dispensers, hoses, nozzles, break-away devices and any other equipment required for a particular application. Alternative alcohol-blended fuels, while they are considered in this category of fuels, possess characteristics that require the systems for dispensing them to comply with additional requirements contained in Section 2306.8. The additional provisions are needed because this section requires certain dispensing system components to be listed, and listings for equipment dispensing alcohol-blended fuels, including E85, are not yet available from nationally recognized testing laboratories. These organizations are currently working with stakeholders to address corrosion and material compatibility issues associated with E85 and other alcohol-blended fuels. See the commentary to Section 2306.8 for further information.

**2306.7.1 Listed equipment.** Electrical equipment, dispensers, hose, nozzles and submersible or subsurface pumps used in fuel-dispensing systems shall be *listed*.

❖ The use of listed equipment and devices provides evidence that they have been evaluated by a third-party agency for safe use in the applications for which they are designed. This is especially important where flammable liquids are being transferred or dispensed. See also the commentary for the definition of "Listed" in Chapter 2 for further discussion.

**2306.7.2 Fixed pumps required.** Class I and II liquids shall be transferred from tanks by means of fixed pumps designed

and equipped to allow control of the flow and prevent leakage or accidental discharge.

- ❖ There are two basic types of fixed pumps. One is remote from the dispenser and delivers the fuel under pressure to the dispenser. The most common place to find this type of pump is at the tank. Because the fuel is being delivered to the dispenser under pressure, leak detection devices must be used and a shear valve with a fusible link must be installed in the sump under the dispenser.

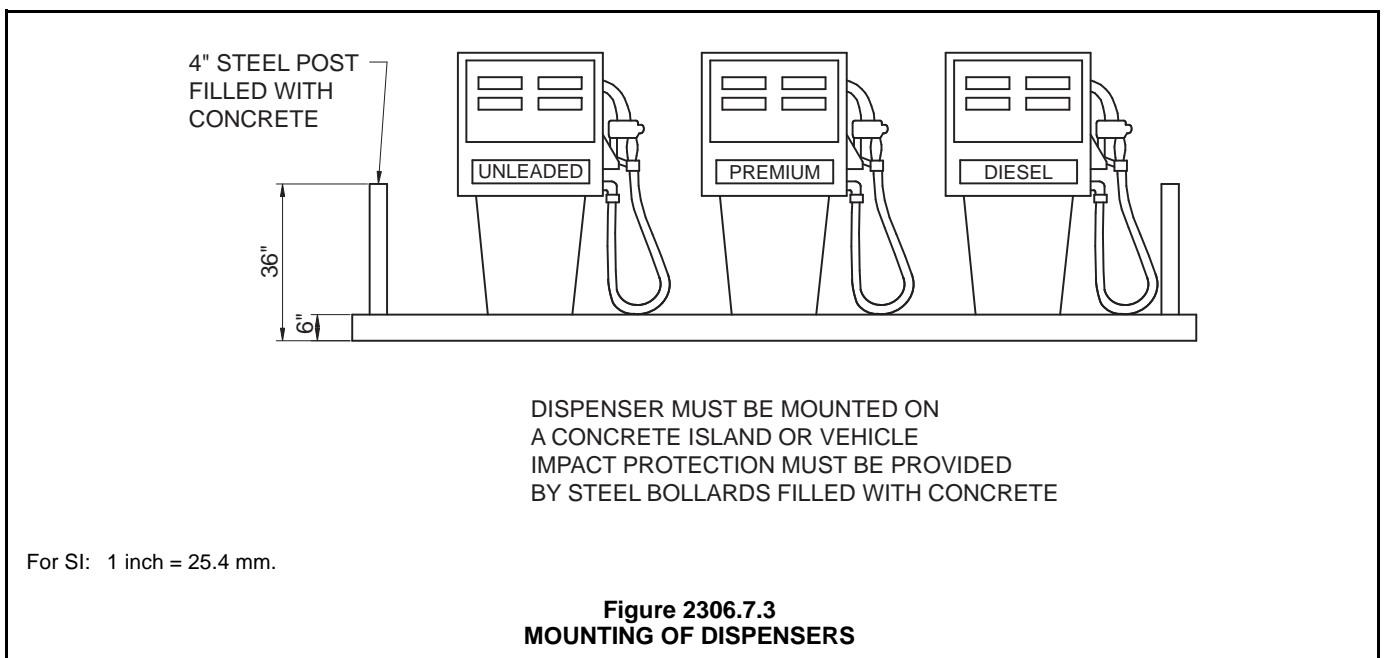
The second type of pump is a suction pump mounted in the base of the dispenser. A shear valve and leak detection are not required on this type of pump. Section 2306.7.4 requires an emergency shut-off valve on dispensers equipped with remote pumps.

**2306.7.3 Mounting of dispensers.** Dispensing devices, except those installed on top of a protected above-ground tank that qualifies as vehicle-impact resistant, shall be protected against physical damage by mounting on a concrete island 6 inches (152 mm) or more in height, or shall be protected in accordance with Section 312. Dispensing devices shall be installed and securely fastened to their mounting surface in accordance with the dispenser manufacturer’s instructions. Dispensing devices installed indoors shall be located in an *approved* position where they cannot be struck by an out-of-control vehicle descending a ramp or other slope.

- ❖ This provision addresses two alternatives to mounting dispensers so as to provide impact protection. One is to mount the dispenser on an elevated island and the other is to protect the dispenser in accordance with Section 312, which requires the dispenser to be protected by steel posts filled with concrete (see Commentary Figure 2306.7.3). Note that these provisions do not apply to dispensers mounted on top of a listed impact-resistant above-ground tank. Regardless of which of the above alternatives is chosen, the

stability of an installed dispenser depends on its installation in accordance with the manufacturer’s instructions, particularly with respect to ensuring that all bolts required to firmly mount the dispenser to the mounting surface are provided. It is not unusual to find dispensers with only half or fewer of their mounting bolts in place. Such a haphazard installation can make the dispenser piping and electrical conduits more susceptible to damage from a much less serious impact than might otherwise be tolerated if all bolts were in place or even from rocking action in high-wind conditions. This can lead to a liquid leak, an ignition from a damaged electrical circuit or both. NFPA 30A requires dispensers to be bolted to their mounting surface and UL 87 requires that two bolt holes be part of the dispenser base for dispensers not greater than 6 feet (1829 mm) tall, while four bolt holes are needed for dispensers over 6 feet (1829 mm) tall. These bolting requirements are for dispenser stability and piping protection and should not be considered part of the physical protection required by this section.

**2306.7.4 Dispenser emergency shutoff valve.** An *approved* automatic emergency shutoff valve designed to close in the event of a fire or impact shall be properly installed in the liquid supply line at the base of each dispenser supplied by a remote pump. The valve shall be installed so that the shear groove is flush with or within 1/2 inch (12.7 mm) of the top of the concrete dispenser island and there is clearance provided for maintenance purposes around the valve body and operating parts. The valve shall be installed at the liquid supply line inlet of each overhead-type dispenser. Where installed, a vapor return line located inside the dispenser housing shall have a shear section or *approved* flexible connector for the liquid supply line emergency shutoff valve to function. Emergency shutoff valves shall be installed and maintained in accordance with the manufacturer’s instructions, tested at the



time of initial installation and not less than yearly thereafter in accordance with Section 2305.2.4.

❖ The dispenser emergency valve (shear valve) is designed to close automatically when the dispenser is knocked over or if the dispenser is involved in a fire. This so-called “impact” valve is intended to prevent the free flow of fuel in the event a dispenser is struck by a vehicle. This spring-loaded, fusible-link-operated device may also be tripped by a fire. The relatively low clearance of the shear groove above the top surface of the dispenser island and the manufacturer’s requirement for a rigid mounting of the valve body are intended to enable the valve body to fracture at the shear groove upon impact, thus tripping the hold-open linkage and closing the valve.

These valves are only required on remote pumping systems (pump is on the tank). Suction system (pump is in dispenser) piping, if broken, will cause the system to lose prime, thus stopping liquid flow. Vapor recovery systems are usually interlocked with the liquid-dispensing system. Consequently, the vapor recovery breakaway design must be compatible with the liquid line shutoff so it functions as intended. Installation, maintenance, acceptance and periodic testing must conform to the manufacturer’s instructions. UL 842 describes the tests performed on these valves (see Commentary Figure 2306.7.4). The valve must be tested annually by manually tripping the hold-open linkage in accordance with Section 2305.2.4.

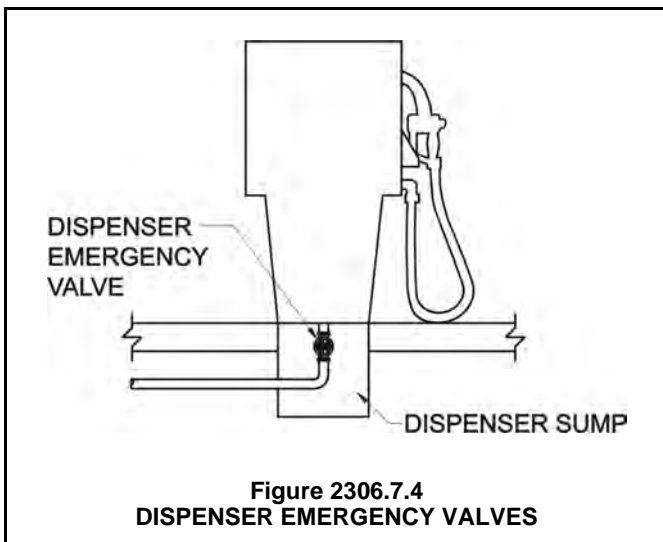


Figure 2306.7.4  
DISPENSER EMERGENCY VALVES

**2306.7.5 Dispenser hose.** Dispenser hoses shall be not more than 18 feet (5486 mm) in length unless otherwise *approved*. Dispenser hoses shall be *listed* and *approved*. When not in use, hoses shall be reeled, racked or otherwise protected from damage.

❖ The 18-foot-maximum (5486 mm) length for dispenser hose has become a standard, although the original reason for the 18-foot (5486 mm) length had nothing to do with fire safety. It was a weights-and-

measures requirement having to do with calibrating the dispenser to accurately give the volume of fuel delivered.

The fire code official should use caution when approving additional lengths of hose because the longer the hose, the harder it is to stow between uses, thus the more susceptible it is to damage by vehicles running over it if not properly stowed. Most dispenser hose-retrieving mechanisms are designed for 18-foot (5486 mm) hoses.

It is also important to remember that, when the hose is fully extended, the nozzle must not reach within 5 feet (1524 mm) of a building opening as regulated in Section 2303.1, Item 4.

**2306.7.5.1 Emergency breakaway devices.** Dispenser hoses for Class I and II liquids shall be equipped with a *listed* emergency breakaway device designed to retain liquid on both sides of a breakaway point. Such devices shall be installed and maintained in accordance with the manufacturer’s instructions. Where hoses are attached to hose-retrieving mechanisms, the emergency breakaway device shall be located between the hose nozzle and the point of attachment of the hose-retrieval mechanism to the hose.

❖ This provision requires a breakaway device on dispenser hoses delivering gasoline, diesel and kerosene (Class I and II liquids). These devices are installed to prevent a pull-down of the motor fuel dispenser in the event a car drives away with the hose nozzle valve still in the car’s fill pipe. The design of these valves is such that when they operate, the separated sections of the hose are sealed to prevent leakage of liquid from the hose. The placement of the breakaway device between the hose-retrieving mechanism clamp and the nozzle is important to the proper operation of the valve by preventing the pulling force of the driveoff from being transmitted via the retrieving cable directly to the dispenser. Commentary Figure 2306.7.5.1 shows a breakaway device installed between the nozzle and the hose-retrieving mechanism.

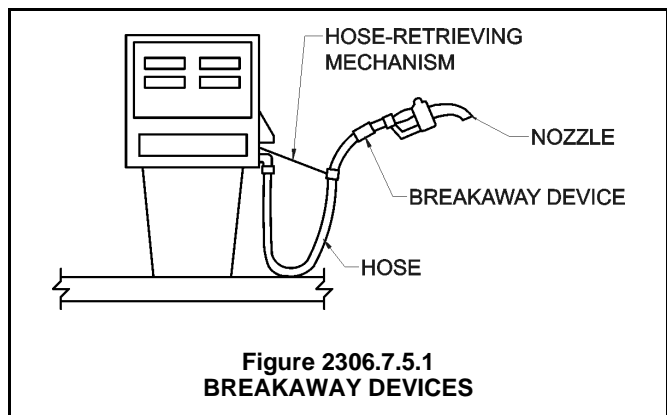


Figure 2306.7.5.1  
BREAKAWAY DEVICES

**2306.7.6 Fuel delivery nozzles.** A listed automatic-closing-type hose nozzle valve with or without a latch-open device shall be provided on island-type dispensers used for dispensing Class I, II or III liquids.

Overhead-type dispensing units shall be provided with a *listed* automatic-closing-type hose nozzle valve without a latch-open device.

**Exception:** A *listed* automatic-closing-type hose nozzle valve with latch-open device is allowed to be used on overhead-type dispensing units where the design of the system is such that the hose nozzle valve will close automatically in the event the valve is released from a fill opening or upon impact with a driveway.

- ❖ A *listed* automatic-closing-type hose nozzle with or without a latch-open device is designed to automatically close when the fuel spits back through the vent line or if the hose nozzle were to fall out of the car fill pipe and strike the ground. When the nozzle is equipped with certain types of vapor recovery equipment, it is designed to shut off when the nozzle is removed from the vehicle. The nozzle on island-type dispensers may or may not be equipped with a latch-open device. The fire code official may want to consider the fact that when a latch-open device is not installed, the dispenser operator may use some unapproved device to hold the nozzle open.

The distinction between an overhead-type dispenser and an island-type dispenser is included in this section even though the overhead dispenser is rarely used. However, the concern was that since the hose is on a retractable reel built into the canopy, the nozzle would not strike the ground if it were to fall out of the vehicle and a latch-open device would fail to work, allowing dangerous, uncontrolled fuel spills.

The exception is that if the overhead-type dispenser hose mechanism is designed to allow the nozzle to strike the ground and automatically shut off or if the nozzle was equipped with vapor return bellows that would automatically shut off the nozzle if it was removed from the vehicle, the latch-open device would be approved.

**2306.7.6.1 Special requirements for nozzles.** Where dispensing of Class I, II or III liquids is performed, a *listed* automatic-closing-type hose nozzle valve shall be used incorporating all of the following features:

1. The hose nozzle valve shall be equipped with an integral latch-open device.
2. Where the flow of product is normally controlled by devices or equipment other than the hose nozzle valve, the hose nozzle valve shall not be capable of being opened unless the delivery hose is pressurized. If pressure to the hose is lost, the nozzle shall close automatically.

**Exception:** Vapor recovery nozzles incorporating insertion interlock devices designed to achieve shut-off on disconnect from the vehicle fill pipe.

3. The hose nozzle shall be designed such that the nozzle is retained in the fill pipe during the filling operation.
4. The system shall include *listed* equipment with a feature that causes or requires the closing of the hose nozzle valve before the product flow can be resumed or before the hose nozzle valve can be replaced in its normal position in the dispenser.

zle valve before the product flow can be resumed or before the hose nozzle valve can be replaced in its normal position in the dispenser.

#### ❖ Item 1

This provision may seem to be in conflict with Section 2306.7.6, which requires a nozzle with or without a latch-open device. Hose nozzle valves are investigated and labeled by independent testing laboratories and are designed to shut off fuel flow automatically if dropped or jarred, or when fuel flows back into the nozzle spout (tank is full). Many jurisdictions have prohibited the use of latch-open-type hose nozzle valves at retail self-service stations, using the rationale that making customers hold the hose nozzle valve open during fueling would create a safer condition because they will be more alert during the fueling process. Not only does this section prohibit such a ban on a proven safety feature, but the fire record of self-service operations does not support this rationale. In fact, where factory-installed, latch-open devices (part of a tested, labeled hose nozzle valve assembly) are removed, it seems to challenge the creativity of customers in seeing how many different makeshift “hold-open” devices can be used to avoid having to hold manually the valve lever open. Such makeshift devices include gas caps, key rings, wallets, magazines, blocks of wood, rubber balls, etc. In one reported incident, a disposable cigarette lighter was used to prop open the hose nozzle valve lever only to strike a spark when the nozzle fell from the fill pipe. The resultant vapor ignition injured the customer and caused substantial damage to the service station and the customer’s car. UL 842 describes several types of hose nozzle valves and latch-open features and the tests to which they are subjected.

#### Item 2

The statement, “When the flow of product is normally controlled by devices or equipment other than the hose nozzle valve,” is referring to a prepay system; that is, a customer tells the person in the kiosk or convenience store how much fuel he or she wants and the dispenser shuts down and stops the flow, not the nozzle.

The exception addresses the fact that some vapor recovery nozzles are equipped with a bellows. When the nozzle is placed into the vehicle fill pipe, the bellows is compressed and the nozzle will operate. When the nozzle is removed, the bellows expands and the nozzle shuts off. The nozzle does not have to strike something to trigger the automatic shut-off; the nozzle shuts off as soon as the nozzle is removed.

#### Item 3

This device may be nothing more than a coil that looks like a spring around the dispenser nozzle spout. The spring tends to grip the lip of the vehicle’s receiver and helps to prevent the nozzle from falling out of the vehicle receiver.

**Item 4**

This safety feature is intended to prevent a situation in which a customer could finish fueling without releasing the latch-open device and replace the nozzle in the dispenser boot. The next customer could then remove the nozzle from the dispenser boot, authorize the sale and, before getting the nozzle into the vehicle fill pipe, begin discharging fuel in the open, causing an unacceptable spill situation.

**2306.7.7 Remote pumping systems.** Remote pumping systems for liquid fuels shall comply with Sections 2306.7.7.1 and 2306.7.7.2.

❖ Remote pumping systems (sometimes referred to as “pressure systems”) are systems in which liquid motor fuels are transferred from the storage tank to the dispensing devices by submersible pumps located at the storage tank rather than by suction pumps located within the dispensing device. The intent of this section is to require special safety devices on pumping systems that deliver fuel to the dispenser by pressure rather than suction.

**2306.7.7.1 Leak detection.** Where remote pumps are used to supply fuel dispensers, each pump shall have installed on the discharge side a *listed* leak detection device that will detect a leak in the piping and dispensers and provide an indication. A leak detection device is not required if the piping from the pump discharge to under the dispenser is above ground and visible.

❖ In remote pumping systems, the piping between the remote pump and the dispenser, because it is under pressure, is the number-one location of fuel spills caused by leaks. This section addresses both underground and above-ground piping. If the piping is underground, a line leak detector (LLD) must be installed on the discharge side of the remote pump. These devices detect piping leaks by monitoring the pressure in the dispensing system piping. If the LLD detects a pressure loss due to a leak, it will reduce the flow of product in the system to approximately 3 gallons per hour (14.33 L/h) at the hose nozzle as a visual indicator to the attendant that there is a system problem.

The reduced rate of flow fulfills this section’s requirement that detection of a leak be indicated. While an electronic leak detection system could fulfill the requirements of this section, this section does not require electronic leak detection.

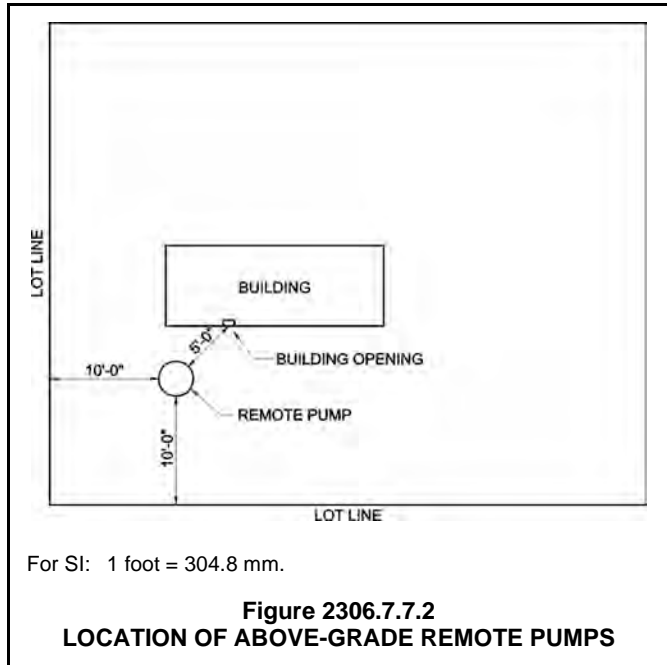
If the system piping is above ground where a leak would be immediately noticed and the piping can be visually inspected, the leak detection device is not required.

**2306.7.7.2 Location.** Remote pumps installed above grade, outside of buildings, shall be located not less than 10 feet (3048 mm) from lines of adjoining property that can be built upon and not less than 5 feet (1524 mm) from any building opening. Where an outside pump location is impractical, pumps are permitted to be installed inside buildings as provided for dispensers in Section 2301.4 and Chapter 57.

Pumps shall be substantially anchored and protected against physical damage.

❖ Commentary Figure 2306.7.7.2 shows the minimum distances between an above-grade remote pump, lot lines and openings into a building. Where outside clearances cannot be achieved or are impractical in a given situation, above-grade remote pumps are allowed to be installed inside of buildings on the same basis as motor fuel dispensers.

**2306.7.8 Gravity and pressure dispensing.** Flammable liq-



uids shall not be dispensed by gravity from tanks, drums, barrels or similar containers. Flammable or *combustible liquids* shall not be dispensed by a device operating through pressure within a storage tank, drum or container.

❖ Delivering fuel by gravity is prohibited because the piping or hose between the tank and the nozzle could rupture or leak, causing the contents of the tank to spill. Tank pressurization is prohibited because the tanks will rupture when excessive pressure is applied. The maximum pressure at which an above-ground tank is tested is 5 pounds per square inch (psi) (34 kPa). Also, the application of air to the tank may lean out the very rich fuel vapors to the point where the atmosphere inside the tank is within the flammable range.

**2306.7.9 Vapor-recovery and vapor-processing systems.** Vapor-recovery and vapor-processing systems shall be in accordance with Sections 2306.7.9.1 through 2306.7.9.2.4.

❖ The following provisions address the requirements for vapor-recovery or vapor-processing systems. Because of clean-air environmental concerns, some jurisdictions prohibit fuel vapors displaced during tanker deliveries or routine fuel-dispensing operations from being

discharged into the atmosphere and require vapor-recovery or vapor-processing systems to prevent pollution. This section contains the provisions for returning the vapors to the tank or processing the vapors on site. Note that the code does not require these systems to be installed, but where they are installed, they must comply with these regulations.

**2306.7.9.1 Vapor-balance systems.** Vapor-balance systems shall comply with Sections 2306.7.9.1.1 through 2306.7.9.1.5.

❖ As fuel enters the fuel tank of the vehicle it displaces fuel vapors. The vapor-balance system simply captures these vapors and returns them to the storage tank.

**2306.7.9.1.1 Dispensing devices.** Dispensing devices incorporating provisions for vapor recovery shall be *listed* and *labeled*. Where existing *listed* or *labeled* dispensing devices are modified for vapor recovery, such modifications shall be *listed* by report by a nationally recognized testing laboratory. The listing by report shall contain a description of the component parts used in the modification and recommended method of installation on specific dispensers. Such report shall be made available on request of the *fire code official*.

Means shall be provided to shut down fuel dispensing in the event the vapor return line becomes blocked.

❖ Motor fuel dispensers equipped with vapor-recovery equipment must be listed and labeled by a recognized testing laboratory attesting that they will function properly when installed in accordance with the terms of their listing (see commentary for the definitions of “Listed” and “Labeled” in Chapter 2). When existing dispensing equipment is retrofitted with vapor-recovery equipment, the equipment being added must be listed to work with the existing equipment. In other words, a person cannot modify an existing dispensing device manufactured by one company with vapor-recovery component parts manufactured by the same or a different company unless a report from a recognized testing laboratory is submitted to the fire code official verifying that the retrofit components will work properly with the dispensing device. This is called “listed by report” and is a service provided by major testing laboratories to document equipment compatibility. The report from the testing laboratory must also include the installation instructions.

Means must be provided to shut down fuel dispensing in the event the vapor-return line becomes blocked. This provision is self-explanatory. To prevent vapors from entering the atmosphere, the dispensing operation must be stopped if the vapor return is blocked.

**2306.7.9.1.2 Vapor-return line closeoff.** An acceptable method shall be provided to close off the vapor return line from dispensers when the product is not being dispensed.

❖ To prevent vapors from escaping after dispensing has stopped, some type of device must be installed

that will prevent vapors in the tank from escaping out of the return line. This could be accomplished by a one-way check valve.

**2306.7.9.1.3 Piping.** Piping in vapor-balance systems shall be in accordance with Sections 5703.6, 5704.2.9 and 5704.2.11. Nonmetallic piping shall be installed in accordance with the manufacturer’s instructions.

Existing and new vent piping shall be in accordance with Sections 5703.6 and 5704.2. Vapor return piping shall be installed in a manner that drains back to the tank, without sags or traps in which liquid can become trapped. If necessary, because of grade, condensate tanks are allowed in vapor return piping. Condensate tanks shall be designed and installed so that they can be drained without opening.

❖ Section 5703.6 addresses the general requirements for piping. Section 5704.2.9 addresses piping for above-ground tanks, and Section 5704.2.11 lists the requirements for underground tanks. Special piping materials, as described in Section 5703.6.2.1, must be used underground or, if used above ground, must be protected from fire exposure.

The vent piping must comply with the general requirements of Section 5703.6, and the specific vent requirements of Section 5704.2.

**2306.7.9.1.4 Flexible joints and shear joints.** Flexible joints shall be installed in accordance with Section 5703.6.9.

An *approved* shear joint shall be rigidly mounted and connected by a union in the vapor return piping at the base of each dispensing device. The shear joint shall be mounted flush with the top of the surface on which the dispenser is mounted.

❖ Flexible joints must be listed, approved and installed in the following locations:

1. Where piping connects to underground piping.
2. Where piping ends at pump islands and vent risers.
3. At points where differential movement in the piping can occur.

The shear joint mentioned here serves the same function for the vapor-recovery lines as the dispenser emergency valve does for the pressurized fuel supply piping to the dispenser (see commentary, Section 2306.7.4). This shear valve must be securely mounted so that the shear groove is located flush or within  $\frac{1}{2}$  inch (12.7 mm) of the surface of the dispenser island or top of the sump. This shear valve is designed to close in case of a dispenser fire or a dispenser knock-down.

**2306.7.9.1.5 Testing.** Vapor return lines and vent piping shall be tested in accordance with Section 5703.6.3.

❖ Section 5703.6.3 addresses the testing for flammable and combustible liquid piping.

**2306.7.9.2 Vapor-processing systems.** Vapor-processing systems shall comply with Sections 2306.7.9.2.1 through 2306.7.9.2.4.

- ❖ Where vapor-recovery systems capture the vapors and return them to the tank, vapor-processing systems do not return the vapors to the tank. Instead, they process the vapors either by refrigeration, absorption or burning them off.

**2306.7.9.2.1 Equipment.** Equipment in vapor-processing systems, including hose nozzle valves, vapor pumps, flame arresters, fire checks or systems for prevention of flame propagation, controls and vapor-processing equipment, shall be individually *listed* for the intended use in a specified manner.

Vapor-processing systems that introduce air into the underground piping or storage tanks shall be provided with equipment for prevention of flame propagation that has been tested and *listed* as suitable for the intended use.

- ❖ Unlisted vapor-processing equipment may not be used. Equipment that is used must be done in accordance with its listing.

Vapor-processing systems that introduce air into the underground piping or storage tanks must be provided with equipment for prevention of flame propagation that has been tested and listed as suitable for the intended use.

When blowers are used to introduce air, equipment, such as listed flame arresters, must be used to prevent vapors in the flammable range from being ignited.

**2306.7.9.2.2 Location.** Vapor-processing equipment shall be located at or above grade. Sources of ignition shall be located not less than 50 feet (15 240 mm) from fuel-transfer areas and not less than 18 inches (457 mm) above tank fill openings and tops of dispenser islands. Vapor-processing units shall be located not less than 10 feet (3048 mm) from the nearest building or *lot line* of a property that can be built upon.

**Exception:** Where the required distances to buildings, *lot lines* or fuel-transfer areas cannot be obtained, means shall be provided to protect equipment against fire exposure. Acceptable means shall include but not be limited to either of the following:

1. *Approved* protective enclosures, which extend not less than 18 inches (457 mm) above the equipment, constructed of fire-resistant or noncombustible materials.
  2. Fire protection using an *approved* water-spray system.
- ❖ This section is intended to protect vapor-processing equipment from fire exposure, not to protect other structures or equipment from a fire involving the vapor-recovery equipment. Clearance to lot lines is intended to provide a measure of exposure protection to the vapor-processing equipment from potential off-site fires. The exception provides several acceptable clearance alternatives, recognizing that the required clearances cannot, in all cases, be achieved. This is especially true in the case of vapor-processing equip-

ment being installed at established motor fuel-dispensing facilities where the area available for proper installation is not subject to design but, rather, to the existing site conditions. Note that where Exception 1 is approved, the resulting enclosure should be ventilated in an approved manner, similar to that required for physical protection enclosures by Section 2306.9.2.2.2.

**2306.7.9.2.2.1 Distance from dispensing devices.** Vapor-processing equipment shall be located not less than 20 feet (6096 mm) from dispensing devices.

- ❖ Twenty feet (6096 mm) is the extent of the Class I, Group D, Division 2, electrically classified area for flammable liquid fuel dispensers established by Article 500 of NFPA 70.

**2306.7.9.2.2.2 Physical protection.** Vapor-processing equipment shall be protected against physical damage by guardrails, curbs, protective enclosures or fencing. Where *approved* protective enclosures are used, *approved* means shall be provided to ventilate the volume within the enclosure to prevent pocketing of flammable vapors.

- ❖ Vapor-processing equipment must not only be physically protected from vehicles and other physical damage but, if the protection means includes an enclosure, the enclosed area must be adequately ventilated to prevent the accumulation of flammable vapors within where it could become a hazard to anyone entering the enclosure.

**2306.7.9.2.2.3 Downslopes.** Where a downslope exists toward the location of the vapor-processing unit from a fuel-transfer area, the *fire code official* is authorized to require additional separation by distance and height.

- ❖ If the vapor-processing equipment is situated downhill from the dispensers, vapors will be more likely to accumulate in or around the vapor-processing equipment from the fuel transfer area. Accordingly, the fire code official may require greater protection for the vapor-processing equipment.

**2306.7.9.2.3 Installation.** Vapor-processing units shall be securely mounted on concrete, masonry or structural steel supports on concrete or other noncombustible foundations. Vapor-recovery and vapor-processing equipment is allowed to be installed on roofs where *approved*.

- ❖ This provision is intended to require the vapor-processing equipment to be mounted on a noncombustible, substantial foundation.

**2306.7.9.2.4 Piping.** Piping in a mechanical-assist system shall be in accordance with Section 5703.6.

- ❖ Section 5703.6 addresses the provisions for flammable and combustible liquid piping.

**2306.8 Alcohol-blended fuel-dispensing operations.** The design, fabrication and installation of alcohol-blended fuel-dispensing systems shall be in accordance with Section 2306.7 and Sections 2306.8.1 through 2306.8.5.

- ❖ This section addresses hazards specifically related to the dispensing of alcohol-blended fuels as compared

to gasoline and the more established gasoline-alcohol blends (“gasohol”), which are treated the same as gasoline in the code.

The fuel-dispensing system consists of all equipment required to get the fuel from the tank into the vehicle being fueled. It consists of the pumps, piping, dispensers, hoses, nozzles, break-away devices and any other equipment required for a particular application. Alternative alcohol-blended fuels, although subject to the requirements of Section 2306.7 for flammable and combustible liquid fuel-dispensing equipment, possess characteristics that require the systems for dispensing them to comply with additional requirements contained in Sections 2306.8.1 through 2306.8.5. The additional provisions are needed because Section 2306.7.1 requires certain dispensing system components to be listed; however, listings for equipment dispensing alcohol-blended fuels, including E85, may not yet be available from nationally recognized testing laboratories. These organizations are currently working with stakeholders to address corrosion and material compatibility issues associated with E85 and other alcohol-blended fuels. In an initial step toward developing a listing standard, UL has developed an Outline of Investigation, UL 87A, for dispensing devices for gasoline/ethanol blend fuels. See also the commentary to Section 202 for the definition of “Alcohol-blended fuels” for further information.

**2306.8.1 Listed equipment.** Dispensers shall be *listed* in accordance with UL 87A. Hoses, nozzles, breakaway fittings, swivels, flexible connectors or dispenser emergency shutoff valves, vapor recovery systems, leak detection devices and pumps used in alcohol-blended fuel-dispensing systems shall be *listed* for the specific purpose.

❖ This section requires dispensing equipment to be listed in accordance with UL 87A. It also identifies dispensing system components that must be listed for use with alcohol-blended fuels. The UL 87A *Outline of Investigation for Power-Operated Dispensing Devices for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations up to 85 Percent* was developed to cover dispensers intended for use with high-concentration ethanol blends. Listed dispensers and the related hanging hardware are listed for high-concentration ethanol blends, and are being installed across the United States.

**2306.8.2 Compatibility.** Dispensers shall be used only with the fuels for which they have been *listed* and which are marked on the product. Field-installed components including hose assemblies, breakaway fittings, swivel connectors and hose nozzle valves shall be provided in accordance with the listing and the marking on the unit.

❖ Dispensers and certain field-installed dispensing system components may be made of materials commonly used with gasoline but which may be incompatible with high-level alcohol blends and may degrade over time in their presence. Zinc, brass, lead and aluminum are some of the more sensitive metals.

This section requires that, as added documentation, dispensers and their field-installed components be marked by the equipment manufacturer with the names of the fuels with which they are compatible, confirming their suitability for use with alcohol-blended fuels.

**2306.8.3 Change of system contents.** Fuel-dispensing systems subject to change in contents from gasoline to alcohol-blended fuels shall be subject to *fire code official* review and approval prior to commencing dispensing operations.

❖ This section provides the fire code official the authority to review and reapprove installations that convert from gasoline dispensing to alcohol-blended fuel dispensing. This allows for verification that the installation complies with the new requirements. It also ensures that the fire code official will know that new fuels will be present on a given site, which might impact local fire suppression operations, including the use of alcohol-resistant foam agents.

The same technologies used to store and dispense gasoline and diesel fuels are used for alcohol-based fuels because, like gasoline, they are liquid at ambient pressures and temperatures. However, only E85-compatible materials should be used in the storage and dispensing systems. In many cases, existing gasoline and diesel fuel systems may be converted to store and dispense E85. Most metal underground storage tanks that meet the U.S. Environmental Protection Agency (EPA) regulations can be used to store E85. Many underground fiberglass tanks that meet EPA standards may also be used to store E85.

If another type of fuel was stored in the tank that is to be converted for E85 use, the tank should be cleaned. During storage, particles and moisture can build up over time to form sludge or what is called “water bottoms.” Since ethanol is miscible with water, when introducing E85 or another ethanol blend into a dirty storage tank, ethanol’s “cleaning action” will mix with the water bottoms and remove the sludge, resulting in contaminated fuel. A simple tank cleaning will prevent any problems. There are several methods for cleaning sludge from storage tanks. Each of the cleaning methods should be completed by an approved company that is familiar with cleaning petroleum storage tanks. Note that a permit is required by Section 105.6.17, Item 8 to change stored contents.

**2306.8.4 Facility identification.** Facilities dispensing alcohol-blended fuels shall be identified by an *approved* means.

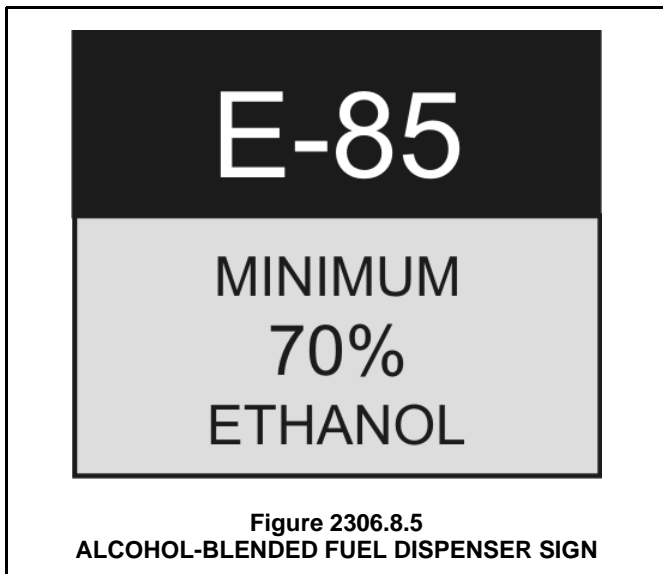
❖ This section addresses dispensing facility identification for alcohol-blended fuels. Identification of the facility is intended to promote first-responder awareness of the presence of alcohol-blended fuels.

According to the U.S. Department of Energy (DOE) *Handbook for Handling, Storing, and Dispensing E85*, each state, along with the U.S. Department of Trans-

portation (DOT), has developed signage to place at refueling stations. Code users should contact their individual state DOT to obtain the correct signage criteria for their area.

**2306.8.5 Marking.** Dispensers shall be marked in an *approved* manner to identify the types of alcohol-blended fuels to be dispensed.

- ❖ Identification of equipment for specific alcohol-blended fuels communicates the intended use of the installed equipment to both customers and emergency personnel. The Federal Trade Commission (FTC) requires a small sticker to be placed on the face of the fuel dispenser as close as possible to the price per unit of fuel. The sticker should have a black background with orange text (see Commentary Figure 2306.8.5).



**2306.8.6 Maintenance and inspection.** Equipment shall be maintained and inspected in accordance with Section 2305.2.

- ❖ Since a major concern with alcohol-blended fuels is their potentially degrading effect on system components, the equipment maintenance provisions of Section 2305.2 must be carefully followed.

**SECTION 2307**  
**LIQUEFIED PETROLEUM GAS MOTOR**  
**FUEL-DISPENSING FACILITIES**

**2307.1 General.** Motor fuel-dispensing facilities for liquefied petroleum gas (LP-gas) fuel shall be in accordance with this section and Chapter 61.

- ❖ The federal government mandates that automakers move toward alternative fuels to replace conventional gasoline and diesel. One of the more popular alternative fuels is liquefied petroleum gas (LP-gas). As more vehicles use alternative fuels, codes will have to

be modified to address the safe dispensing of these fuels. This section addresses the dispensing of LP-gas at motor fuel-dispensing facilities. Chapter 61 addresses the general provisions for LP-gas.

**2307.2 Approvals.** Storage vessels and equipment used for the storage or dispensing of LP-gas shall be *approved* or *listed* in accordance with Sections 2307.2.1 and 2307.2.2.

- ❖ All equipment used in connection with the storage and dispensing of LP-gas motor fuel must be either approved or listed, as specified in the following sections. The terms “approved” and “listed” are defined in Chapter 2. See the commentary to Chapter 2 for these defined terms for further information.

**2307.2.1 Approved equipment.** Containers, pressure relief devices (including pressure relief valves), pressure regulators and piping for LP-gas shall be *approved*.

- ❖ The equipment identified in this section must be approved by the fire code official.

**2307.2.2 Listed equipment.** Hoses, hose connections, vehicle fuel connections, dispensers, LP-gas pumps and electrical equipment used for LP-gas shall be *listed*.

- ❖ The equipment identified in this section must be listed.

**2307.3 Attendants.** Motor fuel-dispensing operations for LP-gas shall be conducted by qualified attendants or in accordance with Section 2307.6 by persons trained in the proper handling of LP-gas.

- ❖ LP-gas must be dispensed into a vehicle by trained and qualified persons. Unattended and self-service LP-gas stations that are open to the public are not allowed. Section 2307.6 does allow self-service as long as it is closed to the public; that is, the vehicles belong to the operator of the LP-gas-fueling facility and the persons dispensing the fuel are employees of the LP-gas-fueling operation and are properly trained.

**2307.4 Location of dispensing operations and equipment.** The point of transfer for LP-gas dispensing operations shall be separated from buildings and other exposures in accordance with the following:

1. Not less than 25 feet (7620 mm) from buildings where the *exterior wall* is not part of a fire-resistance-rated assembly having a rating of 1 hour or greater.
2. Not less than 25 feet (7620 mm) from combustible overhangs on buildings, measured from a vertical line dropped from the face of the overhang at a point nearest the point of transfer.
3. Not less than 25 feet (7620 mm) from the lot line of property that can be built upon.
4. Not less than 25 feet (7620 mm) from the centerline of the nearest mainline railroad track.
5. Not less than 10 feet (3048 mm) from public streets, highways, thoroughfares, sidewalks and driveways.

6. Not less than 10 feet (3048 mm) from buildings where the *exterior wall* is part of a fire-resistance-rated assembly having a rating of 1 hour or greater.

**Exception:** The point of transfer for LP-gas dispensing operations need not be separated from canopies that are constructed in accordance with the *International Building Code* and that provide weather protection for the dispensing equipment.

LP-gas containers shall be located in accordance with Chapter 61. LP-gas storage and dispensing equipment shall be located outdoors.

- ❖ Whereas Section 2303.1 regulates the location of dispensing devices, this section regulates the location of the point of transfer of the LP gas motor fuel into the vehicle fuel tank. The intent of the term “point of transfer” is to describe the location where LP-gas-fueling connections are made and broken and any location where LP-gas is vented during transfer or fueling operations. Whenever LP-gas is dispensed or transferred, there is always at least a “puff” of LP gas released at the point where the LP-gas dispensing hose connects to and disconnects from the vehicle fuel tank or other LP-gas container, and it is at those locations that a flammable mixture will exist, even if momentarily. This section intends to isolate these “movable locations” by regulating how far away from potential ignition sources or other properties they must remain under in all circumstances. This section is also in agreement with NFPA 58 with respect to separation distances.

The IBC has specific construction requirements for canopies located at motor fuel-dispensing facilities. The exception removes any separation requirements between the dispenser area and the canopy when the canopy is constructed in accordance to the special provision for canopies located at motor fuel-dispensing facilities.

Table 6104.3 lists the separation requirements for the containers in relation to buildings, public ways and property lines that are or might be built upon.

**2307.5 Additional requirements for LP-gas dispensers and equipment.** LP-gas dispensers and related equipment shall comply with the following provisions.

1. Pumps shall be fixed in place and shall be designed to allow control of the flow and to prevent leakage and accidental discharge.
  2. Dispensing devices installed within 10 feet (3048 mm) of where vehicle traffic occurs shall be protected against physical damage by mounting on a concrete island 6 inches (152 mm) or more in height, or shall be protected in accordance with Section 312.
  3. Dispensing devices shall be securely fastened to their mounting surface in accordance with the dispenser manufacturer’s instructions.
- ❖ In order to reduce the likelihood of a leak or the accidental discharge of LP-gas, Item 1 requires that dis-

pensing pumps be fixed in place and equipped with a means of controlling the flow of LP-gas. Similar to the provisions of Section 2306.7.3, Items 2 and 3 of this section address two alternatives for mounting dispensers so as to provide impact protection. One is to mount the dispenser on an elevated island. The other is to protect the dispenser in accordance with Section 312, which requires the dispenser to be protected by steel posts filled with concrete (see also Commentary Figure 2306.7.3). Regardless of which alternative is chosen, the stability and protection of an installed dispenser depends on its installation in accordance with the manufacturer’s instructions.

**2307.6 Installation of LP-gas dispensing devices and equipment.** The installation and operation of LP-gas dispensing systems shall be in accordance with Sections 2307.6.1 through 2307.6.4 and Chapter 61. LP-gas dispensers and dispensing stations shall be installed in accordance with the manufacturer’s specifications and their listing.

- ❖ This provision specifically addresses the requirements for valves, hoses and impact protection for LP-gas-dispensing equipment.

**2307.6.1 Product control valves.** The dispenser system piping shall be protected from uncontrolled discharge in accordance with the following:

1. Where mounted on a concrete base, a means shall be provided and installed within  $\frac{1}{2}$  inch (12.7 mm) of the top of the concrete base that will prevent flow from the supply piping in the event that the dispenser is displaced from its mounting.
2. A manual shutoff valve and an excess flow-control check valve shall be located in the liquid line between the pump and the dispenser inlet where the dispensing device is installed at a remote location and is not part of a complete storage and dispensing unit mounted on a common base.
3. An excess flow-control check valve or an emergency shutoff valve shall be installed in or on the dispenser at the point at which the dispenser hose is connected to the liquid piping.
4. A *listed* automatic-closing type hose nozzle valve with or without a latch-open device shall be provided on island-type dispensers.

- ❖ The provisions of this section are similar to certain provisions in Section 2306.7 that are applicable to flammable and combustible liquid dispensers.

Item 1 is based on Section 2306.7.4, but since the hardware performance requirements in that section for gasoline and diesel dispensers differ from what is currently available for LP-gas dispenser systems, the text more closely resembles the performance requirements currently appearing in Section 6.3.9 of NFPA 30A, with the exception that the location for the protective means must be within  $\frac{1}{2}$  inch of the top surface of the concrete island, as is required in Section 2306.7.4.

Item 2 is based on Section 6.25.3.11 of NFPA 58 and provides protection for the piping system where the storage container is located remotely from the dispenser. When the storage container and dispenser are separate components installed remotely from one another, the likelihood of pipe failure increases.

Item 3 is based on the requirements in Section 3.9.3.4 of NFPA 58. An excess flow-control check valve is one that senses the pressure before and after the LP-gas meter and closes when it senses a loss of the pressure differential such as would occur if the dispensing hose were to become disconnected or broken.

Item 4 is adapted from Section 2306.7.6 and is similar to Section 6.25.3.16 of NFPA 58. A listed (for LP-gas dispensing at motor fuel-dispensing facilities) automatic-closing-type hose nozzle with or without a latch-open device is designed to automatically close when it senses that the fuel tank is full. The hose nozzle on island-type dispensers may or may not be equipped with a latch-open device. The fire code official may want to consider the fact that when a latch-open device is not installed, the dispenser operator may use some unapproved device to hold the nozzle open.

**2307.6.2 Hoses.** Hoses and piping for the dispensing of LP-gas shall be provided with hydrostatic relief valves. The hose length shall not exceed 18 feet (5486 mm). An *approved* method shall be provided to protect the hose against mechanical damage.

❖ To prevent overpressurization of the hoses and piping, a relief valve must be installed in the system. The hose length is limited to 18 feet (5486 mm) to prevent excessive amounts of hose from lying on the ground and being damaged by vehicles. The general public is familiar with the 18-foot (5486 mm) length because of the 18-foot (5486 mm) requirement for liquid fuel-dispensing hoses in Section 2306.7.5 and they know where to position their vehicles for refueling. See the commentary to Section 2306.7.5 for further discussion of hose length.

**2307.6.3 Emergency breakaway devices.** Dispenser hoses shall be equipped with a *listed* emergency breakaway device designed to retain liquid on both sides of the breakaway point. Where hoses are attached to hose-retrieving mechanisms, the emergency breakaway device shall be located such that the breakaway device activates to protect the dispenser from being displaced.

❖ Similar to Section 2306.7.5.1 of the code and Section 6.25.4.2 of NFPA 58, this section requires a breakaway device on dispenser hoses delivering LP-gas motor fuel. These devices are installed to prevent a pull-down of the motor fuel dispenser in the event that a car drives away with the hose nozzle valve still attached to the car's fill pipe. The design of these valves is such that when they operate, the separated sections of the hose are sealed to prevent leakage of fuel from the hose.

This section differs from Section 2306.7.5.1 in that

it does not specify the location of the emergency breakaway device connection to the hose. Where a hose is equipped with a hose retrieval mechanism, placing the breakaway device between the mechanism's clamp and nozzle is important to the proper operation of the valve by preventing the pulling force of the drive-off from being transmitted via the retrieving cable directly to the dispenser.

**2307.6.4 Vehicle impact protection.** Where installed within 10 feet of vehicle traffic, LP-gas storage containers, pumps and dispensers shall be protected in accordance with Section 2307.5, Item 2.

❖ This section is intended to prevent leaks and spills caused by vehicle impact by requiring vehicle impact protection in the form of a 6-inch concrete island or the installation of 4-inch-diameter (102 mm), concrete-filled steel posts on 4-foot (1219 mm) centers, 3 feet (914 mm) high. See Section 312 for more specific construction details, and the commentary to Section 2307.5, Item 2 for further discussion of such protection.

**2307.7 Public fueling of motor vehicles.** Self-service LP-gas dispensing systems, including key, code and card lock dispensing systems, shall be limited to the filling of permanently mounted containers providing fuel to the LP-gas powered vehicle.

The requirements for self-service LP-gas dispensing systems shall be in accordance with the following:

1. The arrangement and operation of the transfer of product into a vehicle shall be in accordance with this section and Chapter 61.
2. The system shall be provided with an emergency shut-off switch located within 100 feet (30 480 mm) of, but not less than 20 feet (6096 mm) from, dispensers.
3. The *owner* of the LP-gas motor fuel-dispensing facility or the owner's designee shall provide for the safe operation of the system and the training of users.
4. The dispenser and hose-end valve shall release not more than 1/8 fluid ounce (4 cc) of liquid to the atmosphere upon breaking the connection with the fill valve on the vehicle.
5. Portable fire extinguishers shall be provided in accordance with Section 2305.5.
6. Warning signs shall be provided in accordance with Section 2305.6.
7. The area around the dispenser shall be maintained in accordance with Section 2305.7.

❖ While the 2012 and earlier editions of the code prohibited self-service LP-gas motor fuel dispensing operated by the public, the 2015 edition allows public refueling from LP-gas dispensers. This revision occurred in response to new technologies available to safeguard refueling operations. If the vehicles being refueled do not belong to the owner of the fuel-dispensing facility and the fuel-dispensing operator is not an employee of the owner, the facility is consid-

ered to be “public.” This section allows vehicle owners to refuel their own vehicles under the supervision of, or after having been trained by, the LP-gas motor fuel-dispensing facility owner or the owner’s designee.

This section contains provisions for the safe operation of the facility and an emergency shutoff switch similar to the emergency shutoff switch required at motor fuel-dispensing facilities in Section 2303.2.



**Figure 2307.7**  
**PUBLIC LP-GAS FUEL DISPENSER**

**2307.8 Overfilling.** LP-gas containers shall not be filled with LP-gas in excess of the volume determined using the fixed maximum liquid level gauge installed on the container, the volume determined by the overfilling prevention device installed on the container or the weight determined by the required percentage of the water capacity marked on the container.

- ❖ To prevent release of gas by pressure relief due to expansion of the gas, the LP-gas container must not be filled beyond the volume determined by one of the methods in this section.

## SECTION 2308 COMPRESSED NATURAL GAS MOTOR FUEL-DISPENSING FACILITIES

**2308.1 General.** Motor fuel-dispensing facilities for compressed natural gas (CNG) fuel shall be in accordance with this section and Chapter 53.

- ❖ The federal government is mandating that automakers move toward alternative fuels to replace conventional gasoline and diesel. One of the more popular alternative fuels is compressed natural gas (CNG). As more vehicles use alternative fuels, codes will have to be modified to address the safe dispensing of these fuels. This section addresses the dispensing of

CNG at motor fuel-dispensing facilities. Chapter 53 contains the general provisions for CNG.

**2308.2 Approvals.** Storage vessels and equipment used for the storage, compression or dispensing of CNG shall be *approved* or *listed* in accordance with Sections 2308.2.1 and 2308.2.2.

- ❖ All equipment used in connection with the storage and dispensing of CNG motor fuel must be either approved or listed, as specified in the following sections. The terms “Approved” and “Listed” are defined in Chapter 2. See the commentary to these defined terms for further information.

**2308.2.1 Approved equipment.** Containers, compressors, pressure relief devices (including pressure relief valves), and pressure regulators and piping used for CNG shall be *approved*.

- ❖ The equipment identified in this section must be approved by the fire code official. Listing of the specified components could be the basis for approval, but listing is not mandated. Any such components must be designed for the application and recommended for the application by the manufacturer.

**2308.2.2 Listed equipment.** Hoses, hose connections, dispensers, gas detection systems and electrical equipment used for CNG shall be *listed*. Vehicle-fueling connections shall be *listed* and *labeled*.

- ❖ The specified components must be listed and labeled by an approved testing agency as complying with the relevant product standards. As with all listed products, the testing/listing agency will apply its seal or mark to the product.

**2308.3 Location of dispensing operations and equipment.** Compression, storage and dispensing equipment shall be located above ground, outside.

### Exceptions:

1. Compression, storage or dispensing equipment shall be allowed in buildings of noncombustible construction, as set forth in the *International Building Code*, that are unenclosed for three-quarters or more of the perimeter.
  2. Compression, storage and dispensing equipment shall be allowed indoors or in vaults in accordance with Chapter 53.
- ❖ Because of the potential for leakage, the compression, storage and dispensing equipment must be located either outdoors or in a noncombustible, substantially open building, except as allowed by Chapter 53. This section allows compression, storage and dispensing equipment to be located:
    1. Outdoors, above ground.
    2. Inside noncombustible buildings where at least 75 percent of the wall area is open to the outside atmosphere.

3. Indoors or in vaults in accordance with Chapter 53, which, in turn, references NFPA 52 and Section 413 of the IFGC.

**2308.3.1 Location on property.** In addition to the requirements of Section 2303.1, compression, storage and dispensing equipment not located in vaults complying with Chapter 53 shall be installed as follows:

1. Not beneath power lines.
2. Ten feet (3048 mm) or more from the nearest building or *lot line* that could be built on, public street, sidewalk or source of ignition.

**Exception:** Dispensing equipment need not be separated from canopies that are constructed in accordance with the *International Building Code* and that provide weather protection for the dispensing equipment.

3. Twenty-five feet (7620 mm) or more from the nearest rail of any railroad track and 50 feet (15 240 mm) or more from the nearest rail of any railroad main track or any railroad or transit line where power for train propulsion is provided by an outside electrical source, such as third rail or overhead catenary.
  4. Fifty feet (15 240 mm) or more from the vertical plane below the nearest overhead wire of a trolley bus line.
- ❖ Natural gas is lighter than air. The requirements for the location of the equipment that compresses and dispenses the gas must take this into consideration. The separation distances from overhead ignition sources should be noted.

**2308.4 Private fueling of motor vehicles.** Self-service CNG-dispensing systems, including key, code and card lock dispensing systems, shall be limited to the filling of permanently mounted fuel containers on CNG-powered vehicles.

In addition to the requirements in Section 2305, the *owner* of a self-service CNG motor fuel-dispensing facility shall ensure the safe operation of the system and the training of users.

- ❖ Unlike LP-gas self-service dispensing stations, CNG self-service dispensing systems can be open to the public. The owner of the system must provide for the training of any users of the system.

**2308.5 Pressure regulators.** Pressure regulators shall be designed and installed or protected so that their operation will not be affected by the elements (freezing rain, sleet, snow or ice), mud or debris. The protection is allowed to be an integral part of the regulator.

- ❖ The pressure regulator must be protected from the elements and is intended to prevent the overpressurization of the vehicle fuel tank and the delivery hose. Pressure regulator failure could result in dangerous overpressure and the opening of relief valves; therefore, they must be dependable. The regulator vent is susceptible to blockage by debris and ice.

**2308.6 Valves.** Gas piping to equipment shall be provided with a remote, readily accessible manual shutoff valve.

- ❖ Shutoff valves allow isolation of components for service, repair, replacement and emergency shutdown (see the definition of “Ready access” in the IFGC). This valve is independent of the emergency shutdown device required by Section 2308.7.

**2308.7 Emergency shutdown control.** An emergency shutdown control shall be located within 75 feet (22 860 mm) of, but not less than 25 feet (7620 mm) from, dispensers and shall also be provided in the compressor area. Upon activation, the emergency shutdown system shall automatically shut off the power supply to the compressor and close valves between the main gas supply and the compressor and between the storage containers and dispensers.

- ❖ CNG systems take natural gas from the utility supply line, compress it to very high pressures and store the compressed gas in vessels from which the dispensers draw the gas for transfer to the vehicle onboard containers. The emergency shutdown device must be located no farther than 75 feet (22 860 mm) from and no closer than 25 feet (7620 mm) to the dispensers. An additional shutdown device must be located near the compressors; the compressors may be remote from the dispensers. The shutdown device must disconnect the power to the compressors, must actuate automatic valves that isolate the gas supply from the compressors and isolate the storage vessels from the dispenser, thus limiting accidental gas discharge.

**2308.8 Discharge of CNG from motor vehicle fuel storage containers.** The discharge of CNG from motor vehicle fuel cylinders for the purposes of maintenance, cylinder certification, calibration of dispensers or other activities shall be in accordance with Sections 2308.8.1 through 2308.8.1.2.6.

- ❖ The equipment referred to in this section is the fixed equipment located at the CNG motor fuel-dispensing facility. Periodically, equipment must be maintained, certified and recalibrated. To do this, the CNG must be discharged from the system. This section regulates how the discharge must be done.

**2308.8.1 Methods of discharge.** The discharge of CNG from motor vehicle fuel cylinders shall be accomplished through a closed transfer system in accordance with Section 2308.8.1.1 or an *approved* method of atmospheric venting in accordance with Section 2308.8.1.2.

- ❖ The intentional discharge of gas from vehicle containers is done for several reasons, including vehicle repairs, certification of container integrity and container replacement. The gas must be discharged in a safe manner as dictated by either Section 2308.8.1.1 or 2308.8.1.2. The vehicle storage container is referred to as a “vessel” and as a “cylinder” in the text to follow.

**2308.8.1.1 Closed transfer system.** A documented procedure that explains the logical sequence for discharging the

cylinder shall be provided to the *fire code official* for review and approval. The procedure shall include what actions the operator will take in the event of a low-pressure or high-pressure natural gas release during the discharging activity. A drawing illustrating the arrangement of piping, regulators and equipment settings shall be provided to the *fire code official* for review and approval. The drawing shall illustrate the piping and regulator arrangement and shall be shown in spatial relation to the location of the compressor, storage vessels and emergency shutdown devices.

- ❖ A closed transfer system uses the same basic components as a dispensing system and withdraws the gas from the vehicle container, storing it in vessels. Drawings and a description of the sequence of operation of the transfer system must be provided to the *fire code official* for approval. This information may then be shared with the fire department for use in case of an emergency where CNG cylinders might need to be discharged.

**2308.8.1.2 Atmospheric venting.** Atmospheric venting of CNG shall comply with Sections 2308.8.1.2.1 through 2308.8.1.2.6.

- ❖ The six subsections that follow provide the conditions and requirements under which gas is allowed to be discharged to the atmosphere. Such discharge should be avoided wherever practical because: 1. There is an inherent hazard in doing so; 2. Methane is an air contaminant and 3. Natural resources should never be wasted. A closed transfer system is the preferable way to remove gas from vehicle containers.

**2308.8.1.2.1 Plans and specifications.** A drawing illustrating the location of the vessel support, piping, the method of grounding and bonding, and other requirements specified herein shall be provided to the *fire code official* for review and approval.

- ❖ Plans of the proposed atmospheric venting apparatus and piping system must be reviewed by the *fire code official* and approved before atmospheric venting can take place.

**2308.8.1.2.2 Cylinder stability.** A method of rigidly supporting the vessel during the venting of CNG shall be provided. The selected method shall provide not less than two points of support and shall prevent the horizontal and lateral movement of the vessel. The system shall be designed to prevent the movement of the vessel based on the highest gas-release velocity through valve orifices at the vessel’s rated pressure and volume. The structure or appurtenance shall be constructed of noncombustible materials.

- ❖ Vehicle CNG containers (vessels) can hold extremely high pressures, which, if released quickly, can produce large thrust forces that would propel the container like a rocket. Natural gas does not liquefy at normal ambient temperatures; therefore, in order to hold the required amount of fuel on board the vehicle, the gaseous fuel must be compressed to extreme pressures of up to 3,600 pounds per square inch absolute (psia) (24 736 kPa).

**2308.8.1.2.3 Separation.** The structure or appurtenance used for stabilizing the cylinder shall be separated from the site equipment, features and exposures and shall be located in accordance with Table 2308.8.1.2.3.

- ❖ This section is intended to separate the combustible vapor produced by venting from buildings, building openings, lot lines, public ways, vehicles, CNG compressor and storage vessels and CNG dispensers. This precaution is reasonable considering the potential hazard of working with highly pressurized containers of a flammable gas.

**TABLE 2308.8.1.2.3  
SEPARATION DISTANCE FOR ATMOSPHERIC VENTING OF CNG**

EQUIPMENT OR FEATURE	MINIMUM SEPARATION (feet)
Buildings	25
Building openings	25
CNG compressor and storage vessels	25
CNG dispensers	25
Lot lines	15
Public ways	15
Vehicles	25

For SI: 1 foot = 304.8 mm.

- ❖ The distances listed in Table 2308.8.1.2.3 are the distances between the equipment or feature and the termination of the vent opening where the gas is entering the atmosphere.

**2308.8.1.2.4 Grounding and bonding.** The structure or appurtenance used for supporting the cylinder shall be grounded in accordance with NFPA 70. The cylinder valve shall be bonded prior to the commencement of venting operations.

- ❖ “Grounding” means to intentionally connect to the earth. This could be accomplished by installing a conductor between the cylinder support and the building grounding electrode system. “Bonding” means to join metallic parts together to form a continuous electrical pathway. Grounding and bonding required by this section are intended to control sparking that could result from current flow produced by voltage differentials across parts of the venting set-up and the building components. Grounding the venting setup and attaching a bonding jumper to the cylinder valve will put all such components and the building components at the same voltage potential, thereby reducing the possibility of sparks that could ignite flammable vapors or harm the cylinder assembly. The provisions of this section will also help prevent the buildup of static electrical charges that could be a source of ignition.

**2308.8.1.2.5 Vent tube.** A vent tube that will divert the gas flow to atmosphere shall be installed on the cylinder prior to commencement of the venting and purging operation. The vent tube shall be constructed of pipe or tubing materials *approved* for use with CNG in accordance with Chapter 53.

The vent tube shall be capable of dispersing the gas not less than 10 feet (3048 mm) above grade level. The vent tube shall not be provided with a rain cap or other feature that would limit or obstruct the gas flow.

At the connection fitting of the vent tube and the CNG cylinder, a *listed* bidirectional *detonation* flame arrester shall be provided.

- ❖ The cylinder must be discharged through a vent tube/pipe constructed of a material compatible with the gas and that has the strength to withstand the pressure to which it will be exposed. The pressure that the vent will be exposed to must be calculated based on the size of the vent tube, the length of the vent, the friction loss through the vent and the maximum pressure and discharge rate of the cylinder. Vent failure could cause injury resulting from projectile debris and could cause a severe fire/explosion hazard. This section is intended to divert the vented vapor upward and away from any potential ignition source.

**2308.8.1.2.6 Signage.** *Approved* “No Smoking” signs complying with Section 310 shall be posted within 10 feet (3048 mm) of the cylinder support structure or appurtenance. *Approved* CYLINDER SHALL BE BONDED signs shall be posted on the cylinder support structure or appurtenance.

- ❖ The purpose of this section is to prevent ignition sources caused by smoking and stray currents. The provision requires two signs: a “No Smoking” sign and a sign reminding the operator that the cylinder must be bonded to divert stray electrical currents.

## SECTION 2309 HYDROGEN MOTOR

### FUEL-DISPENSING AND GENERATION FACILITIES

**2309.1 General.** Hydrogen motor fuel-dispensing and generation facilities shall be in accordance with this section and Chapter 58. Where a fuel-dispensing facility includes a repair garage, the repair operation shall comply with Section 2311.

- ❖ The federal government is mandating that automakers move toward alternative fuels to replace conventional gasoline and diesel. Hydrogen is one alternative fuel likely to grow in popularity.

The United States Department of Energy (DOE), in accordance with the Hydrogen Future Act of 1996, supports a program based on an industry-led cost-sharing approach called the Hydrogen Energy Program. In some markets, government agencies have mandated that automakers move ahead with production of alternative-fuel vehicles to help offset the atmospheric implications of an economy almost entirely driven by petroleum-based fuels, and facilitate a shift to renewable energy supplies. Hydrogen is one of those alternative fuels, and the commercial products industry is responding. As more vehicles use alternative fuels, codes will have to be modified

to address the safe use, dispensing, storage and generation of hydrogen fuels.

Section 2309, along with the provisions of Chapter 58, clearly defines gaseous hydrogen refueling and generating stations within the scope of the code and provides fire code officials with the necessary tools to create a safe consumer environment as the use of hydrogen as a motor fuel increases.

In many cases, the hydrogen fuel is utilized, with air, within a fuel cell to produce electricity and, in some cases, cogenerate heat. Typically, fire code officials will be faced with two classes of equipment—those that generate hydrogen (for use by other devices) and those that utilize hydrogen as their energy input.

Often, hydrogen will be utilized in a manner similar to the current use of natural gas, but two important differences that must be noted. First, while both hydrogen and natural gas are lighter than air, hydrogen is lighter, more diffusive and more buoyant than natural gas. This means that in well-ventilated situations (e.g., outdoors) hydrogen will dissipate more quickly than natural gas, and much more quickly than either propane or gasoline, both of which have fumes that are heavier than air and will linger at an accident scene or release site. However, hydrogen and natural gas can both accumulate in unventilated pockets at the top of indoor structures and could represent a risk in such situations. Similarly, propane and gasoline fumes can accumulate at the floor level in unventilated spaces, posing a different risk. Thus, ignition sources must be regulated at the top of any unventilated spaces for hydrogen and natural gas, while also being regulated near the floor for gasoline or propane vehicles indoors. Second, hydrogen is odorless, colorless and burns with a flame that is not visible to the human eye. This means it is unlikely, without appropriate instrumentation, that people will be able to detect unsafe conditions if they develop (similar to a carbon monoxide buildup in a structure).

It is important to note that a given volume of natural gas has more than three times the energy of the same volume of hydrogen. Therefore, a given volume of pipe containing natural gas will contain the same energy (potential hazard) as a three-times larger volume of hydrogen.

**2309.2 Equipment.** Equipment used for the generation, compression, storage or dispensing of hydrogen shall be designed for the specific application in accordance with Sections 2309.2.1 through 2309.2.3.

- ❖ All equipment used in connection with the storage and dispensing of hydrogen motor fuel must be either approved or listed, as specified in the following sections. The terms “approved” and “listed” are defined in Chapter 2. See the commentary to these defined terms for further information.

**2309.2.1 Approved equipment.** Cylinders, containers and tanks; pressure relief devices, including pressure valves; hydrogen vaporizers; pressure regulators; and piping used for gaseous hydrogen systems shall be designed and constructed in accordance with Chapters 53, 55 and 58.

❖ The equipment identified in this section must be approved by the fire code official. Listing of the specified components could be the basis for approval, but listing is not mandated. Any such components must be designed and recommended for the application by the manufacturer.

Design requirements for various types of storage vessels, pressure relief devices (including pressure valves), hydrogen vaporizers, pressure regulators and piping used for hydrogen, are directly dependent on the type, conditions of use and quantity of material involved. This section is intended to rely on design requirements for this equipment as referenced in Sections 5303 and 5503 and NFPA 55.

**2309.2.2 Listed or approved equipment.** Hoses, hose connections, compressors, hydrogen generators, dispensers, detection systems and electrical equipment used for hydrogen shall be *listed* or *approved* for use with hydrogen. Hydrogen motor-fueling connections shall be *listed* and *labeled* or *approved* for use with hydrogen.

❖ The specified components must be listed and labeled by an approved testing agency as complying with the relevant product standards or they must be approved by the fire code official. As with all listed products, the testing/listing agency will apply its seal or mark to the product. However, although piping, hoses, hose connections, compressors, hydrogen generators, dispensers, detection systems and electrical equipment used for hydrogen service should be built to recognized standards and be compatible with the material handled, this equipment may not always be listed or labeled and labeled given the evolving nature of hydrogen technologies. Accordingly, this section provides an alternative provision that the equipment be approved and provides the fire code official with a means to regulate hydrogen equipment installations. It is also consistent with Section 5003.2.3, which mandates that equipment and machinery associated with the use of hazardous materials be listed or approved.

ASME B31.3 or CGA G-5.4, which references ASME B31.3, may be appropriate for design and construction of the piping involved in hydrogen service and both are examples of common standards employed by industry for piping, tubing and associated distribution equipment involving hazardous materials. Though not specifically referenced here, there are other American Society of Mechanical Engineers (ASME) and industry standards providing further guidance that are considered appropriate for

many aspects of gaseous and liquefied hydrogen systems.

**2309.2.3 Electrical equipment.** Electrical installations shall be in accordance with NFPA 70.

❖ This section addresses electrical equipment at hydrogen motor fuel-dispensing facilities and is correlated with NFPA 70. Electrical equipment must be approved for the particular hazards anticipated at hydrogen motor fuel-dispensing facilities.

**2309.3 Location on property.** In addition to the requirements of Section 2303.1, dispensing equipment shall be located in accordance with Sections 2309.3.1 through Section 2309.3.2.

❖ In order to reduce the likelihood of hydrogen motor fuels coming into contact with ignition sources or posing a hazard to persons, adjoining property or on-site buildings, this section provides equipment location requirements in relation to outdoor equipment, canopies and overhead power lines.

**2309.3.1 Location of operations and equipment.** Generation, compression, storage and dispensing equipment shall be located in accordance with Sections 2309.3.1.1 through 2309.3.1.5.5.

❖ Because of the physical characteristics of hydrogen and the potential for leakage, generation, compression, storage and dispensing equipment must be located above ground outdoors or indoors under rigidly controlled equipment or separation requirements, all in accordance with Sections 2309.3.1.1 through 2309.3.1.5.5.

**2309.3.1.1 Outdoors.** Generation, compression, or storage equipment shall be allowed outdoors in accordance with Chapter 58 and NFPA 2.

❖ This section requires that hydrogen generation, compression and storage equipment installed outdoors be provided with the minimum separations prescribed by Chapter 58 and NFPA 2.

**2309.3.1.2 Indoors.** Generation, compression, storage and dispensing equipment shall be located in indoor rooms or areas constructed in accordance with the requirements of the *International Building Code*, the *International Fuel Gas Code*, the *International Mechanical Code* and NFPA 2.

❖ The overriding theme of the indoor location requirements for the generation, compression, storage or dispensing of hydrogen motor fuel is to never permit the maximum concentration of flammable contaminants in air to exceed 25 percent of the lower flammable limit (LFL) for hydrogen during the period that a credible leak exists. This can be accomplished using natural or mechanical means to maintain adequate ventilation to prevent a hazardous buildup of hydrogen gas in buildings or confined spaces.

**2309.3.1.2.1 Maintenance.** Gaseous hydrogen systems and detection devices shall be maintained in accordance with the manufacturer’s instructions.

- ❖ Key to the safety requirements for the generation, compression, storage or dispensing of hydrogen motor fuel is the ongoing maintenance of the systems and their safety devices. The best approach to proper maintenance is following the instructions and recommendations of the company that made the equipment, as required by this section.

**2309.3.1.2.2 Smoking.** Smoking shall be prohibited in hydrogen cutoff rooms. “No Smoking” signs shall be provided at all entrances to hydrogen fuel gas rooms.

- ❖ Establishing “No Smoking” zones in, around and at the entrance to hydrogen fuel gas rooms is another means of controlling a common ignition source. Section 5003.7.1, Item 4 requires signage within the room or area where flammable materials are stored, dispensed or used. Unless the entire facility is designated as a “No Smoking” facility, entrance doors to flammable gas areas are required to be posted (see Section 5003.7.1, Item 3).

There are a multitude of other instances where flammable gases are used where posting should be provided to warn users of the potential presence of hydrogen prior to entering a room or area in which they are present. Posting at the entrance to the room or area in which hydrogen is compressed or generated provides early warning of the hazard prior to entering the space. Signage on the outside entrances to such areas, as well as inside the area, is warranted. Signs should be in accordance with Section 310.

**2309.3.1.2.3 Ignition source control.** Open flames, flame-producing devices and other sources of ignition shall be controlled in accordance with Chapter 58.

- ❖ See the commentary to Section 5803.1.4.

**2309.3.1.2.4 Housekeeping.** Hydrogen fuel gas rooms shall be kept free from combustible debris and storage.

- ❖ Hydrogen fuel gas rooms are, by definition, “...intended exclusively to house a gaseous hydrogen system.” This section is key to maintaining that limitation by prohibiting unnecessary combustible fuel loads in the rooms.

**2309.3.1.3 Gaseous hydrogen storage.** Storage of gaseous hydrogen shall be in accordance with Chapters 53 and 58.

- ❖ Although Section 2309 includes substantial safeguards for the generation, compression, storage or dispensing of hydrogen motor fuel, gaseous hydrogen is also classified as a flammable gas requiring compliance with Chapter 58 and possesses compressed gas hazards requiring compliance with Chapter 53.

**2309.3.1.4 Liquefied hydrogen storage.** Storage of liquefied hydrogen shall be in accordance with Chapters 55 and 58.

- ❖ Although Section 2309 includes substantial safeguards for the generation, compression, storage or dispensing of hydrogen motor fuel, stored liquefied hydrogen is also classified as a flammable cryogenic fluid requiring compliance with Chapter 55, which in turn requires compliance with NFPA 55. Chapter 58 is referenced because it includes requirements for underground liquid hydrogen storage tanks.

**2309.3.1.5 Canopy tops.** Gaseous hydrogen compression and storage equipment located on top of motor fuel-dispensing facility canopies shall be in accordance with Sections 2309.3.1.5.1 through 2309.3.1.5.5, Chapters 53 and 58 and the *International Fuel Gas Code*.

- ❖ This section allows for the optional placement of hydrogen generation, compression and storage equipment on top of motor fuel-dispensing facility overhead canopies. Overhead placement enhances safety because the equipment remains removed from possible vehicular impact and ground-level ignition sources. This option has gained popularity, especially in more congested urban areas where real estate prices prohibit the purchase of sufficient property to meet the separation requirements of Section 2309.3.2.5.1 for new motor fuel-dispensing facilities. Similarly, existing motor fuel-dispensing facilities that might wish to expand their operations to include hydrogen are usually “land locked” and would benefit from using their existing canopy tops in the manner described in this section.

**2309.3.1.5.1 Construction.** Canopies shall be constructed in accordance with the motor fuel-dispensing facility canopy requirements of Section 406.7 of the *International Building Code*.

- ❖ IBC Section 406.7.2 regulates motor fuel-dispensing facility canopies and includes special requirements for canopies used to support hydrogen motor fuel equipment. See the commentary to that section for additional information.

**2309.3.1.5.2 Fire-extinguishing systems.** Fuel-dispensing areas under canopies shall be equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1. The design of the sprinkler system shall be not less than that required for Extra Hazard Group 2 occupancies. Operation of the sprinkler system shall activate the emergency functions of Sections 2309.3.1.5.3 and 2309.3.1.5.4.

- ❖ This section requires the same scope of sprinkler protection for the area under canopies as is required for buildings with walls, i.e., “equipped throughout” as defined in NFPA 13 (referenced in Section 903.3.1.1) with an Extra Hazard Group 2 design. The automatic sprinkler system is to protect the canopy top-mounted hydrogen equipment from any fire scenario that could

develop in the fueling area below. In areas subject to freezing, the automatic sprinkler system must be protected from freezing in an approved manner consistent with NFPA 13. Note that because of the very specific requirement for an automatic sprinkler system in this section, the alternative automatic fire-extinguishing system provisions of Section 904 would not apply.

**2309.3.1.5.3 Emergency discharge.** Operation of the *automatic sprinkler system* shall activate an automatic emergency discharge system, which will discharge the hydrogen gas from the equipment on the canopy top through the vent pipe system.

❖ As part of protecting the hydrogen equipment mounted on top of the canopy from a fire developing below, this section requires that an approved emergency discharge system be provided to “dump” the hydrogen content of the system safely into the atmosphere in the event of water flow in the automatic sprinkler system.

**2309.3.1.5.4 Emergency shutdown control.** Operation of the *automatic sprinkler system* shall activate the emergency shutdown control required by Section 2309.5.3.

❖ Whereas Section 2309.3.2.6.2.1 requires a precautionary hydrogen “dump” from the canopy-mounted hydrogen equipment when the automatic sprinkler system operates, this section provides additional protection to the hydrogen equipment by requiring that the emergency shutoff required by Section 2309.5.3 be automatically activated upon water flow in the automatic sprinkler system. This would complement the automatic emergency discharge required by Section 2309.3.2.6.2.1 by automatically disconnecting the power supply to the hydrogen storage, compression and dispensing equipment, thus preventing the system from contributing any residual hydrogen to a fire or trying to replenish the hydrogen supply.

**2309.3.1.5.5 Signage.** *Approved* signage having 2-inch (51 mm) block letters shall be affixed at *approved* locations on the exterior of the canopy structure stating: CANOPY TOP HYDROGEN STORAGE.

❖ The signs required by this section provide a visual warning to the fire department or other first responders that the canopy includes the presence of hydrogen storage, compression and dispensing equipment. Sign locations must be decided on a case-by-case basis but at a minimum must be posted so as to be readily visible from all possible tactical approaches used by the fire department. Based on site configuration and conditions, multiple signs could be required.

**2309.3.2 Canopies.** Dispensing equipment need not be separated from canopies of Type I or II construction that are constructed in a manner that prevents the accumulation of

hydrogen gas and in accordance with Section 406.7 of the *International Building Code*.

❖ IBC Section 406.7.2 has specific construction requirements for canopies located at motor fuel-dispensing facilities. This section removes any separation requirements between the dispenser area and the canopy when the canopy is constructed in accordance to the special provision for canopies located at motor fuel-dispensing facilities. Note that this section places a condition on the application of IBC canopy construction requirements (i.e., that the canopy be sufficiently open to preclude the accumulation of hydrogen in its construction).

**2309.4 Dispensing into motor vehicles at self-service hydrogen motor fuel-dispensing facilities.** Self-service hydrogen motor fuel-dispensing systems, including key, code and card lock dispensing systems, shall be limited to the filling of permanently mounted fuel containers on hydrogen-powered vehicles.

In addition to the requirements in Section 2311, the *owner* of a self-service hydrogen motor fuel-dispensing facility shall provide for the safe operation of the system through the institution of a fire safety plan submitted in accordance with Section 404, the training of employees and operators who use and maintain the system in accordance with Section 406, and provisions for hazard communication in accordance with Section 407.

❖ This section provides regulations for the dispensing of gaseous hydrogen. The dispensing facility owner must demonstrate minimum competency and control of the dispensing of hydrogen, including training and supervision for the employees and operators who use and maintain the system.

**2309.4.1 Dispensing systems.** Dispensing systems shall be equipped with an overpressure protection device set at not greater than 140 percent of the service pressure of the fueling nozzle it supplies.

❖ This section provides the overpressure protection of the vehicle fuel system by the fuel-dispensing system. The Canadian Standards Association (CSA) publishes a hydrogen dispensing standard, CSA-HGV 4.1. These provisions were written prior to this standard being published. Nearly all of the hydrogen fuel cell vehicles that are currently deployed or will be deployed in the near future rely on the fuel dispenser for overpressure protection. Similar language appears in NFPA 52 and in some state hydrogen storage and dispensing rules.

**2309.5 Safety precautions.** Safety precautions at hydrogen motor fuel-dispensing and generation facilities shall be in accordance with Sections 2309.5.1 through 2309.5.3.1.

❖ This section establishes a minimum level of safety for hydrogen motor fuel generation and dispensing.

**2309.5.1 Protection from vehicles.** Guard posts or other *approved* means shall be provided to protect hydrogen storage systems and use areas subject to vehicular damage in accordance with Section 312.

❖ This provision seeks to prevent hydrogen leaks or catastrophic releases caused by vehicle impact. The provision recognizes that vehicle damage can be reduced by placing 4-inch (102 mm) steel posts filled with concrete and spaced on 4-foot (1219 mm) centers, among other requirements of Section 312, around the hydrogen storage system.

**2309.5.1.1 Vehicle fueling pad.** The vehicle shall be fueled on noncoated concrete or other *approved* paving material having a resistance not exceeding 1 megohm as determined by the methodology specified in EN 1081.

❖ This section provides a requirement that addresses the potential for stray currents that can ignite hydrogen when it is used as a motor vehicle fuel. The same requirement is also found in IBC Section 406.7.1. Motor vehicles can acquire an electrostatic charge while traveling. The resistance offered by the tires through an uncoated concrete surface is low enough that this charge dissipates to ground very quickly (seconds or less). However, under dry conditions, an asphalt surface may offer sufficient resistance that the charge will not dissipate in a timely manner. A small number of incidents have occurred in Europe where a nonabsorbent polymer, having unusually high resistance, was used at motor fuel-dispensing facilities to prevent soil contamination from gasoline spills. Therefore, paved surfaces that result in a resistance greater than 1 megohm should not be used.

Fueling surfaces for hydrogen-powered vehicles should be at least as protective regarding electrostatic discharge (ESD) issues as those fueling surfaces used for petroleum-powered vehicles. This section provides precautions to dissipate static electricity built up on the vehicle from driving before the driver's door is opened upon arrival at the fueling facility to initiate refueling. Plain concrete is allowed for construction of the fueling pad with no resistance measurements needed; however, an alternative material can be used as long as it has a measured resistance less than or equal to 1 megohm. Both the concrete and 1 megohm criteria are cited from the American Petroleum Institute (API) RP 2003. NFPA 77 also points out that a resistance of 1 megohm or less is considered adequate to dissipate any charges. The 1 megohm requirement is also found in Section 5706.5.1.7 as a maximum electrical resistance requirement for loading racks transferring liquid petroleum products into cargo tank vehicles. That requirement has been consistently shown to be a reliable value and design basis for ensuring stray currents are sent to ground.

The referenced standard, EN 1081 is the available standard applicable to measuring the resistance of vehicle fueling pads. It establishes the testing criteria for surface coverings that may be used if the fueling

surface is not concrete or is a coated concrete. Tests are performed in the laboratory and again in the field upon installation of the vehicle fueling pad to demonstrate if the installed material has an electrical resistance of less than 1 megohm. For vehicle fueling pads with an area less than 107 square feet (9.9 m<sup>2</sup>), EN 1081 requires at least three tests. For vehicle fueling pads with a larger area, the standard specifies the number of tests shall be established by the owner and the individual or company contractually obligated to perform the tests.

**2309.5.2 Emergency shutoff valves.** A manual emergency shutoff valve shall be provided to shut down the flow of gas from the hydrogen supply to the piping system.

❖ To prevent spillage and to allow servicing of equipment, a remote accessible manual shutoff valve must be installed. This valve is independent of the emergency shutdown equipment required in Section 2309.5.3.

**2309.5.2.1 Identification.** Manual emergency shutoff valves shall be identified and the location shall be clearly visible, accessible and indicated by means of a sign.

❖ In order to be effective, the manual emergency shutoff valve must be clearly and prominently identified by a sign that will achieve those goals in all types of weather. Section 5003.6 provides some guidance on signage that could be used as a basis for the design of the required sign.

**2309.5.3 Emergency shutdown controls.** In addition to the manual emergency shutoff valve required by Section 2309.5.2, a remotely located, manually activated emergency shutdown control shall be provided. An emergency shutdown control shall be located within 75 feet (22 860 mm) of, but not less than 25 feet (7620 mm) from, dispensers and hydrogen generators.

❖ Two emergency shutdown devices must be installed, one in the compressor area in accordance with Section 2309.5.2 and the other no closer than 25 feet (7620 mm) or farther than 75 feet (22 860 mm) from the dispenser. These distances are such that the emergency shutdown control is, at its furthest, no further from the hydrogen dispensers or generators than a portable fire extinguisher would be but not close enough to put personnel at risk of injury in the event of an emergency.

**2309.5.3.1 System requirements.** Activation of the emergency shutdown control shall automatically shut off the power supply to all hydrogen storage, compression and dispensing equipment; shut off natural gas or other fuel supply to the hydrogen generator; and close valves between the main supply and the compressor and between the storage containers and dispensing equipment.

❖ Emergency shutdown controls must shut down the power supply to the hydrogen storage, compression and dispensing equipment and close the valves leading to and from the compressor and between the storage containers and dispensers in the event of an

emergency. Activation of any one emergency shutdown device would activate total shutdown of all generation and dispensing operations on site.

**2309.6 Defueling of hydrogen from fuel storage containers.** The discharge or defueling of hydrogen from fuel storage tanks for the purpose of maintenance, cylinder certification, calibration of dispensers or other activities shall be in accordance with Sections 2309.6.1 through 2309.6.1.2.4.

❖ Because of the emerging use of alternative fuels and the differences in their properties, repair garages must be designed for the anticipated vehicles and the materials fueling them. Section 2311 includes the provisions for many different fuels, including lighter-than-air fuels. Accordingly, if a repair garage makes hydrogen, which is a lighter-than-air fuel, available for dispensing to motor vehicles, the repair garage must also meet the applicable requirements and hazard-mitigation criteria for servicing hydrogen-fueled vehicles. These requirements were formerly located in Section 2311.8 and were applicable only to motor vehicle fuel storage containers. The benefit of relocating these requirements and modifying the language to apply to “fuel storage,” instead of “motor vehicle fuel storage” is that the ability to defuel hydrogen is needed when repair and servicing of the fixed hydrogen fuel compression, storage and dispensing equipment located at these facilities becomes necessary.

**2309.6.1 Methods of discharge.** The discharge of hydrogen from fuel storage tanks shall be accomplished through a closed transfer system in accordance with Section 2309.6.1.1 or an *approved* method of atmospheric venting in accordance with Section 2309.6.1.2.

❖ The intentional discharge of gas from vehicle containers is done for several reasons, including vehicle repairs, certification of the container integrity and container replacement. The gas must be discharged in a safe manner as dictated by either Section 2311.8.1.1 or 2311.8.1.2. The vehicle storage container is referred to as a “vessel” and as a “cylinder” in the text to follow.

**2309.6.1.1 Closed transfer system.** A documented procedure that explains the logic sequence for discharging the storage tank shall be provided to the *fire code official* for review and approval. The procedure shall include what actions the operator is required to take in the event of a low-pressure or high-pressure hydrogen release during discharging activity. Schematic design documents shall be provided illustrating the arrangement of piping, regulators and equipment settings. The *construction documents* shall illustrate the piping and regulator arrangement and shall be shown in spatial relation to the location of the compressor, storage vessels and emergency shutdown devices.

❖ A closed transfer system uses the same basic components as a dispensing system and withdraws the gas from the vehicle container and stores it in vessels. Drawings and a description of the sequence of operation of the transfer system must be provided to

the fire code official for approval. This information may then be shared with the fire department for use in case of an emergency where hydrogen cylinders might need to be discharged.

**2309.6.1.2 Atmospheric venting of hydrogen from fuel storage containers.** Where atmospheric venting is used for the discharge of hydrogen from fuel storage tanks, such venting shall be in accordance with Sections 2309.6.1.2.1 through 2309.6.1.2.1.4.

❖ The subsections that follow provide the conditions and requirements under which hydrogen is allowed to be discharged to the atmosphere. Such discharge should be avoided wherever practical because there is an inherent hazard in doing so and because resources should never be wasted. A closed transfer system is the preferable way to remove hydrogen from vehicle containers.

**2309.6.1.2.1 Defueling equipment.** Equipment used for defueling shall be listed and labeled or *approved* for the intended use.

❖ The hazards of hydrogen are such that using “jerry-rigged” tools and equipment could have disastrous results. As a further precaution, all defueling equipment must be both listed and labeled for that purpose.

**2309.6.1.2.1.1 Manufacturer’s equipment required.** Equipment supplied by the manufacturer shall be used to connect the storage tanks to be defueled to the vent pipe system.

❖ Since the manufacturer provides the necessary equipment and fittings to mate tanks and containers to the vent system, only that equipment is to be used. The use of incompatible equipment could result in an unexpected gas discharge and possible ignition.

**2309.6.1.2.1.2 Vent pipe maximum diameter.** Defueling vent pipes shall have a maximum inside diameter of 1 inch (25 mm).

❖ When discharging hydrogen to the atmosphere, it is important that the size of the vent pipe be such that it will provide sufficient discharge velocity to disperse the hydrogen in the air.

**2309.6.1.2.1.3 Maximum flow rate.** The maximum rate of hydrogen flow through the vent pipe system shall not exceed 1,000 cfm at NTP (0.47 m<sup>3</sup>/s) and shall be controlled by means of the manufacturer’s equipment, at low pressure and without adjustment.

❖ When gas flows through piping, friction with the pipe wall generates heat. Limiting the flow rate limits the amount of heat generated by the flow of gas.

**2309.6.1.2.1.4 Isolated use.** The vent pipe used for defueling shall not be connected to another venting system used for any other purpose.

❖ To avoid contamination or the reaction of potentially incompatible materials, this section requires that the defueling vent pipe be dedicated to hydrogen-only use.

**2309.6.1.2.2 Construction documents.** *Construction documents* shall be provided illustrating the defueling system to be utilized. Plan details shall be of sufficient detail and clarity to allow for evaluation of the piping and control systems to be utilized and include the method of support for cylinders, containers or tanks to be used as part of a closed transfer system, the method of grounding and bonding and other requirements specified herein.

- ❖ Construction documents, as defined in Section 202, must be drawn to scale with sufficient clarity to be understood by the fire code official, contractors and owners and must address the requirements of the code. State or local laws may require preparation of the construction documents by a registered design professional (see the commentary to IBC Section 106.1 for further information).

**2309.6.1.2.3 Stability of cylinders, containers and tanks.** A method of rigidly supporting cylinders, containers or tanks used during the closed transfer system discharge or defueling of hydrogen shall be provided. The method shall provide not less than two points of support and shall be designed to resist lateral movement of the receiving cylinder, container or tank. The system shall be designed to resist movement of the receiver based on the highest gas-release velocity through valve orifices at the receiver's rated service pressure and volume. Supporting structures or appurtenances used to support receivers shall be constructed of noncombustible materials in accordance with the *International Building Code*.

- ❖ Vehicle hydrogen fuel containers can hold extremely high pressures, which, if released quickly, can produce large thrust forces that would propel the container like a rocket. Hydrogen does not liquefy at normal ambient temperatures; therefore, in order to hold the required amount of fuel on board the vehicle, the gaseous fuel must be compressed to extreme pressures of 3,000 to 5,000 psia (20 613 to 34 355 kPa).

**2309.6.1.2.4 Grounding and bonding.** Cylinders, containers or tanks and piping systems used for defueling shall be bonded and grounded. Structures or appurtenances used for supporting the cylinders, containers or tanks shall be grounded in accordance with NFPA 70. The valve of the vehicle storage tank shall be bonded with the defueling system prior to the commencement of discharge or defueling operations.

- ❖ "Grounding" means to intentionally connect to the earth. This could be accomplished by installing a conductor between the cylinder support and the building grounding electrode system. Bonding means to join metallic parts together to form a continuous electrical pathway. Grounding and bonding required by this section are intended to control sparking that could result from current flow produced by voltage differentials across parts of the venting setup and the building components. Grounding the venting setup and attaching a bonding jumper to the cylinder valve will

put all such components and the building components at the same voltage potential, thereby reducing the possibility of sparks that could ignite flammable vapors or harm the cylinder assembly. The provisions of this section will also help prevent the buildup of static electrical charges that could be a source of ignition.

**2309.6.2 Repair of hydrogen piping.** Piping systems containing hydrogen shall not be opened to the atmosphere for repair without first purging the piping with an inert gas to achieve 1-percent hydrogen or less by volume. Defueling operations and exiting purge flow shall be vented in accordance with Section 2309.6.1.2.

- ❖ To prevent the release of flammable hydrogen gas to the atmosphere and to prevent an explosive hydrogen-air mixture (above 1-percent hydrogen based on the pipe volume) within system piping, this section requires that piping be purged with an inert gas before being disconnected and repaired.

**2309.6.3 Purging.** Each individual manufactured component of a hydrogen generating, compression, storage or dispensing system shall have a label affixed as well as a description in the installation and owner's manuals describing the procedure for purging air from the system during startup, regular maintenance and for purging hydrogen from the system prior to disassembly (to admit air).

For the interconnecting piping between the individual manufactured components, the pressure rating must be not less than 20 times the absolute pressure present in the piping when any hydrogen meets any air.

- ❖ This section places the burden of the purging requirement on the equipment manufacturer. Commensurately, these requirements can be verified by the fire code official before, during and after installation. Requirements for rating the interconnecting piping at 20 times the initial pressure reduces the likelihood that a detonation will rupture the vent piping.

**2309.6.3.1 System purge required.** After installation, repair or maintenance, the hydrogen piping system shall be purged of air in accordance with the manufacturer's procedure for purging air from the system.

- ❖ Reliable purging procedures are essential to the safe use of hydrogen gas systems. This section requires that the system manufacturer's purge method be used. Such methods could include any of several methodologies in common use in the industry, as outlined in ASME B31.3 (see commentary, IFGC Section 705.3). The continuous flow method uses a continuous flow of the inert purge gas to remove the hydrogen gas and prevent air or moisture from entering the system. The dilution method uses a sequence of pressurization and venting. This sequence is repeated several times and is very effective in removing gas from dead-end piping, such as pressure gauge lines.

## SECTION 2310 MARINE MOTOR FUEL-DISPENSING FACILITIES

**2310.1 General.** The construction of marine motor fuel-dispensing facilities shall be in accordance with the *International Building Code* and NFPA 30A. The storage of Class I, II or IIIA liquids at marine motor fuel-dispensing facilities shall be in accordance with this chapter and Chapter 57.

- ❖ This section contains code provisions for marine fuel-dispensing facilities that use automotive-type dispensing equipment. This section does not address bulk fuel transfer facilities that use flange-to-flange connections between the shore and the marine vessel.

**2310.2 Storage and handling.** The storage and handling of Class I, II or IIIA liquids at marine motor fuel-dispensing facilities shall be in accordance with Sections 2310.2.1 through 2310.2.3.

- ❖ This section introduces provisions for the storage and handling of Class I, II and IIIA flammable and combustible liquids at marine motor fuel-dispensing facilities. Class IIIB combustible liquids do not have specific regulations in the sections that follow because of their relatively low hazard due to their higher flash points.

**2310.2.1 Class I, II or IIIA liquid storage.** Class I, II or IIIA liquids stored inside of buildings used for marine motor fuel-dispensing facilities shall be stored in *approved* containers or portable tanks. Storage of Class I liquids shall not exceed 10 gallons (38 L).

**Exception:** Storage in liquid storage rooms in accordance with Section 5704.3.7.

- ❖ This section addresses the storage of flammable and combustible liquids inside marine motor fuel-dispensing facility buildings. The provision limits the storage of Class I liquids (e.g., gasoline) to 10 gallons (38 L), unless the building has a flammable and combustible liquid storage room constructed in accordance with the code.

**2310.2.2 Class II or IIIA liquid storage and dispensing.** Class II or IIIA liquids stored or dispensed inside of buildings used for marine motor fuel-dispensing facilities shall be stored in and dispensed from *approved* containers or portable tanks. Storage of Class II and IIIA liquids shall not exceed 120 gallons (454 L).

- ❖ The storage and dispensing inside of marine motor fuel-dispensing facility buildings of Class II (e.g., diesel or kerosene) or IIIA liquids is limited to 120 gallons (454 L) in aggregate. Lubricating oils and gear lubricants (Class III B) are not limited by this provision.

**2310.2.3 Heating equipment.** Heating equipment installed in Class I, II or IIIA liquid storage or dispensing areas shall comply with Section 2301.6.

- ❖ When flammable and combustible liquids are stored or dispensed inside of marine motor fuel-dispensing facility buildings, heating equipment must comply with

Section 2301.6, which references NFPA 30A, the IFGC and the IMC.

**2310.3 Dispensing.** The dispensing of liquid fuels at marine motor fuel-dispensing facilities shall comply with Sections 2310.3.1 through 2310.3.5.

- ❖ The dispensing of fuel at a marine service station requires special consideration because of the location of the dispensing equipment on piers and floating docks, and the movement of the pier or dock in relationship to the shore. Dispensing of fuel at marinas generally requires longer dispensing hoses and greater quantities of fuel.

**2310.3.1 General.** Wharves, piers or floats at marine motor fuel-dispensing facilities shall be used exclusively for the dispensing or transfer of petroleum products to or from marine craft, except that transfer of essential ship stores is allowed.

- ❖ This section restricts the use of the area adjacent to the fuel-dispensing area to the exclusive use of transferring fuel, with the exception of transferring essential ships' stores. This provision is not intended to restrict the berthing and other uses on the pier or floating structure away from the fuel-transferring docking area. Fuel-dispensing hoses must not be stretched over one vessel to reach another; that is, one vessel cannot be docked parallel and alongside another vessel while taking on fuel.

**2310.3.2 Supervision.** Marine motor fuel-dispensing facilities shall have an attendant or supervisor who is fully aware of the operation, mechanics and hazards inherent to fueling of boats on duty whenever the facility is open for business. The attendant's primary function shall be to supervise, observe and control the dispensing of Class I, II or IIIA liquids or flammable gases.

- ❖ Because of the uniqueness of dispensing fuel at marinas and the inherent dangers, the dispensing must be supervised by a trained attendant or supervisor who knows how to control fuel spills, eliminate possible ignition sources, operate emergency shutoff equipment and notify emergency responders.

**2310.3.3 Hoses and nozzles.** Dispensing of Class I, II or IIIA liquids into the fuel tanks of marine craft shall be by means of an *approved*-type hose equipped with a *listed* automatic-closing nozzle without a latch-open device.

Hoses used for dispensing or transferring Class I, II or IIIA liquids, when not in use, shall be reeled, racked or otherwise protected from mechanical damage.

- ❖ The automatic-closing-type nozzle is designed to operate with automotive-type fuel receivers. Many marine craft are not equipped with automotive-type fuel receivers with the vent line terminating in the receiver tube. It is the fuel returning in the vent line that shuts off the automatic-type nozzle. Therefore, the latch-open device must not be used on marine craft.

Hoses at marinas are not restricted to an 18-foot-maximum (5486 mm) length as are those at automotive motor fuel-dispensing facilities. Therefore, the

longer hoses are more susceptible to damage and must be properly protected by being placed on a rack or rolled on a reel. It is also wise to mark the nozzle to identify it with a certain dispenser. Because of the length of hose, the operator may attempt to use the wrong nozzle when multiple dispensers are on the pier.

**2310.3.4 Portable containers.** Dispensing of Class I, II or IIIA liquids into containers, other than fuel tanks, shall be in accordance with Section 2304.4.1.

❖ See the commentary to Section 2304.4.1.

**2310.3.5 Liquefied petroleum gas.** Liquefied petroleum gas cylinders shall not be filled at marine motor fuel-dispensing facilities unless *approved*. *Approved* storage facilities for LP-gas cylinders shall be provided. See also Section 2307.

❖ Many marine vessels use LP-gas for heating and cooking. LP-gas cylinders may not be refilled at a marina, unless specifically approved by the fire code official. Section 2307 has requirements for dispensing LP-gas at motor fuel-dispensing facilities, and this section can be used by the fire code official in making the decision on whether to approve the dispensing of LP-gas at marinas.

**2310.4 Fueling of marine vehicles at other than approved marine motor fuel-dispensing facilities.** Fueling of floating marine craft at other than a marine motor fuel-dispensing facility shall comply with Sections 2310.4.1 and 2310.4.2.

❖ This section introduces the requirements for dispensing motor fuels into marine vehicles at locations other than approved marine motor fuel-dispensing facilities.

**2310.4.1 Class I liquid fuels.** Fueling of floating marine craft with Class I fuels at other than a marine motor fuel-dispensing facility is prohibited.

❖ The dispensing of fuel into floating marine craft at locations other than approved marine motor fuel-dispensing facilities is limited to Class II and III liquids (e.g., diesel fuel) in accordance with Section 2310.4.2. Because of the inherent dangers of Class I liquid fuels (very low flash point, high vapor pressure, low specific gravity, etc.), gasoline must be dispensed only at approved marine motor fuel-dispensing facilities complying with this chapter.

**2310.4.2 Class II or III liquid fuels.** Fueling of floating marine craft with Class II or III fuels at other than a marine motor fuel-dispensing facility shall be in accordance with all of the following:

1. The premises and operations shall be *approved* by the *fire code official*.
2. Tank vehicles and fueling operations shall comply with Section 5706.6.
3. The dispensing nozzle shall be of the *listed* automatic-closing type without a latch-open device.
4. Nighttime deliveries shall only be made in lighted areas.

5. The tank vehicle flasher lights shall be in operation while dispensing.

6. Fuel expansion space shall be left in each fuel tank to prevent overflow in the event of temperature increase.

❖ Because of their lesser hazard characteristics, Class II and III liquid marine vehicle motor fuels are allowed to be dispensed at other than a marine motor fuel-dispensing facility but must be dispensed in accordance with all of the six special provisions, which provide a level of safety in keeping with that required for a marine motor fuel-dispensing facility.

**2310.5 Fire prevention regulations.** General fire safety regulations for marine motor fuel-dispensing facilities shall comply with Sections 2310.5.1 through 2310.5.7.

❖ This section contains special provisions regarding fire safety at marinas.

**2310.5.1 Housekeeping.** Marine motor fuel-dispensing facilities shall be maintained in a neat and orderly manner. Accumulations of rubbish or waste oils in excessive amounts shall be prohibited.

❖ This provision limits fuel sources that may readily ignite if subjected to an ignition source or may spontaneously combust.

**2310.5.2 Spills.** Spills of Class I, II or IIIA liquids at or on the water shall be reported immediately to the fire department and jurisdictional authorities.

❖ The key point in this requirement is to immediately report spills. Petroleum products have a lower specific gravity than water; thus, they will float on the surface of the water and a small amount of fuel can be spread over a large area of water.

**2310.5.3 Rubbish containers.** Containers with tight-fitting or self-closing lids shall be provided for temporary storage of combustible debris, rubbish and waste material. The rubbish containers shall be constructed entirely of materials that comply with any one of the following:

1. Noncombustible materials.
2. Materials that meet a peak rate of heat release not exceeding 300 kW/m<sup>2</sup> when tested in accordance with ASTM E 1354 at an incident heat flux of 50 kW/m<sup>2</sup> in the horizontal orientation.

❖ Rubbish containers can be constructed of metal or other noncombustible materials, including materials that have been shown to be safe by meeting a very severe fire test, like those required by Section 808 for Group I-1, I-2 and I-3 occupancies. Note that the requirement covers all types of rubbish and is not intended to address spills of combustible or flammable liquids (or Class I, II or IIIA liquids) covered by Section 2310.5.2. The best fire extinguisher for a fire in a sturdy trash can is the lid. A tight-fitting lid will extinguish the fire by starving the fire of oxygen. Furthermore, if the lid is in place, the combustibles are not likely to ignite in the first place.

**2310.5.4 Marine vessels and craft.** Vessels or craft shall not be made fast to fuel docks serving other vessels or craft occupying a berth at a marine motor fuel-dispensing facility.

❖ The intent of this provision is to prevent two or more vessels from mooring alongside each other at a fuel dock. If an accident happens at a marine fuel-dispensing facility, the vessels should be able to cast off their docking lines and get underway without having to untie another vessel. Also, the fuel-dispensing hose should never cross one vessel to get to another.

**2310.5.5 Sources of ignition.** Construction, maintenance, repair and reconditioning work involving the use of open flames, arcs or spark-producing devices shall not be performed at marine motor fuel-dispensing facilities or within 50 feet (15 240 mm) of the dispensing facilities, including piers, wharves or floats, except for emergency repair work *approved* in writing by the *fire code official*. Fueling shall not be conducted at the pier, wharf or float during the course of such emergency repairs.

❖ The intent of this requirement is to control possible ignition sources within 50 feet (15 240 mm) of the fuel-dispensing area. In order to control the common ignition hazard of smoking, all hot work within 50 feet (15 240 mm) of a fuel-dispensing area requires a permit from the fire code official in writing and the fuel-dispensing operation must be placed out of service.

**2310.5.5.1 Smoking.** Smoking or open flames shall be prohibited within 50 feet (15 240 mm) of fueling operations. “No Smoking” signs complying with Section 310 shall be posted conspicuously about the premises. Such signs shall have letters not less than 4 inches (102 mm) in height on a background of contrasting color.

❖ “No Smoking” signs must be conspicuously placed around the fuel-dispensing area.

**2310.5.6 Preparation of tanks for fueling.** Boat *owners* and operators shall not offer their craft for fueling unless the tanks being filled are properly vented to dissipate fumes to the outside atmosphere.

❖ Most liquid fuel vapors are heavier than air. Therefore, the vapors, if not properly vented to the atmosphere, will accumulate in the vessel’s bilges, causing a very dangerous explosion hazard.

**2310.5.7 Warning signs.** Warning signs shall be prominently displayed at the face of each wharf, pier or float at such elevation as to be clearly visible from the decks of marine craft being fueled. Such signs shall have letters not less than 3 inches (76 mm) in height on a background of contrasting color bearing the following or *approved* equivalent wording:

WARNING

NO SMOKING—STOP ENGINE WHILE FUELING,  
SHUT OFF ELECTRICITY

DO NOT START ENGINE UNTIL AFTER BELOW  
DECK SPACES ARE VENTILATED.

❖ One of the greatest dangers in dispensing fuel into marine craft is the accumulation of explosive vapors

in the vessel’s bilges and below-deck spaces. The intent here is to warn the vessel operators to control ignition sources until the bilges and below-deck spaces have been cleared of explosive vapors.

**2310.6 Fire protection.** Fire protection features for marine motor fuel-dispensing facilities shall comply with Sections 2310.6.1 through 2310.6.4.

❖ This section addresses the requirements for fire protection at marine fuel-dispensing facilities.

**2310.6.1 Standpipe hose stations.** Fire hose, where provided, shall be enclosed within a cabinet, and hose stations shall be labeled: FIRE HOSE—EMERGENCY USE ONLY.

❖ Section 2310.1 states that the construction requirements for marine motor fuel-dispensing facilities will be found in the IBC and NFPA 30A. NFPA 30A states that marine fuel-dispensing facilities that are located on piers that extend more than a 500-foot (152 400 mm) travel distance from shore are required to have a Class III standpipe installed in accordance with NFPA 14.

**2310.6.2 Obstruction of fire protection equipment.** Materials shall not be placed on a pier in such a manner as to obstruct access to fire-fighting equipment or piping system control valves.

❖ The intent of this section is to make all fire protection equipment, including means for turning off fuel supply lines in an emergency, readily accessible in an emergency.

**2310.6.3 Access.** Where the pier is accessible to vehicular traffic, an unobstructed roadway to the shore end of the wharf shall be maintained for access by fire apparatus.

❖ See Chapter 5 and Appendix D for guidance on fire apparatus access roads.

**2310.6.4 Portable fire extinguishers.** Portable fire extinguishers in accordance with Section 906, each having a minimum rating of 20-B:C, shall be provided as follows:

1. One on each float.
2. One on the pier or wharf within 25 feet (7620 mm) of the head of the gangway to the float, unless the office is within 25 feet (7620 mm) of the gangway or is on the float and an extinguisher is provided thereon.

❖ Section 906 lists the requirements for where and how to mount the portable fire extinguishers. They should be conspicuous and unobstructed.

## SECTION 2311 REPAIR GARAGES

**2311.1 General.** Repair garages shall comply with this section and the *International Building Code*. Repair garages for vehicles that use more than one type of fuel shall comply with the applicable provisions of this section for each type of fuel used.

Where a repair garage includes a motor fuel-dispensing facility, the fuel-dispensing operation shall comply with the

requirements of this chapter for motor fuel-dispensing facilities.

- ❖ Because of the popularity of alternative fuels and the differences in their properties, repair garages must be designed for the anticipated vehicles and the fuels contained in them. This section includes the provisions for many of the different fuels.

If the repair garage dispenses fuel into vehicles, the repair garage must also meet the requirements for a motor fuel-dispensing facility based on the fuels available.

**2311.2 Storage and use of flammable and combustible liquids.** The storage and use of flammable and *combustible liquids* in repair garages shall comply with Chapter 57 and Sections 2311.2.1 through 2311.2.4.

- ❖ For obvious reasons, the storage of flammable and combustible liquids is always a concern, especially inside buildings. Chapter 57 lists the provisions for the storage and quantity limitations on flammable and combustible liquids. This section addresses specific uses associated with repair garages.

**2311.2.1 Cleaning of parts.** Cleaning of parts shall be conducted in *listed* and *approved* parts-cleaning machines in accordance with Chapter 57.

- ❖ Section 5705.3.6 refers to the cleaning operation, the equipment and the quantity limits associated with parts cleaning. Caution must be used when cleaning automotive parts because they may contain Class I liquids that may contaminate the cleaning solvents.

**2311.2.2 Waste oil, motor oil and other Class IIIB liquids.** Waste oil, motor oil and other Class IIIB liquids shall be stored in *approved* tanks or containers, which are allowed to be stored and dispensed from inside repair garages.

- ❖ In addition to waste oil and virgin motor oil, other Class IIIB liquids typically found in repair garages include antifreeze, lubricating oils and greases, power steering fluid, brake fluid, transmission fluid and certain formulations of windshield washer fluid.

Storage tanks for Class IIIB liquids inside buildings must be approved above-ground tanks as required by Section 5704.2, Item 2, and Section 5704.2.7 (e.g., meeting the requirements of UL 142, UL 2080 or UL 2085 as listed in Section 4.2.3.1.1 of NFPA 30). Containers for Class IIIB liquids inside buildings must also be of an approved type as required by Section 5704.3.1 of the code and Section 6.2.1 of NFPA 30.

**2311.2.2.1 Tank location.** Tanks storing Class IIIB liquids in repair garages are allowed to be located at, below or above grade, provided that adequate drainage or containment is provided.

- ❖ The intent of this section is to allow storage of Class IIIB liquids inside when spill protection is provided, as determined by the fire code official. Though the section is not specifically referenced, guidance on this topic may be found in the commentary to Section 5004.2.

**2311.2.2.2 Liquid classification.** Crankcase drainings shall be classified as Class IIIB liquids unless otherwise determined by testing.

- ❖ The declaration of crankcase drainings (waste oil) as being a Class IIIB liquid originated in the 1990 edition of NFPA 30A and resulted from a testing project sponsored by one of the major “quick lube” chains wherein almost 300 waste oil samples from across the nation were actually tested to determine their flash point. The results of the testing indicated that the average flash point determined by the tests was 343°F (173°C), with the lowest flash point result being 296°F (147°C), thus placing all the samples in the Class IIIB liquid category. Based on similar testing results on virgin motor oil conducted in 1976 by the U.S. DOE, it can be concluded that waste motor oil is no more hazardous than fresh motor oil. The waste oil testing project dispelled an old concern that the flash point of used motor oil could be much lower than Class IIIB due to the unknown impact of the variety of impurities that it can contain. See the commentary to Section 5701.5 for a discussion of how the mixing of liquids is regulated.

This section also provides for investigative testing of waste oil if it is suspected that volatile foreign substances, such as raw gasoline, may have been put into a waste oil tank or container in such quantities as to dangerously lower the liquid’s flash point. Some repair garages, in a well-meaning effort to prevent improper disposal of waste gasoline by homeowners, have accepted waste gasoline into their waste oil storage tank or container. In one such incident, the amount of waste gasoline accepted apparently reduced the flash point of the stored liquid to a much more volatile level. An employee of the repair garage apparently went to check the liquid level in the basement tank by opening and looking into one of the fill openings. A spark was apparently accidentally produced near the opening, explosively igniting the vapors and resulting in the employee’s death and substantial damage to the shop. Therefore, care must be taken that repair garage owners and employees do not accept anything from the public for disposal in their waste oil tank unless they are absolutely certain that it is a Class IIIB liquid.

**2311.2.3 Drainage and disposal of liquids and oil-soaked waste.** Garage floor drains, where provided, shall drain to *approved* oil separators or traps discharging to a sewer in accordance with the *International Plumbing Code*. Contents of oil separators, traps and floor drainage systems shall be collected at sufficiently frequent intervals and removed from the premises to prevent oil from being carried into the sewers.

- ❖ This section does not require floor drains but, rather, requires the installation of oil separators or traps when floor drains are provided. Oil separators must be installed in accordance with IPC Sections 1003.4 through 1003.4.2.2. See the commentary to the listed sections of the IPC for further information.

**2311.2.3.1 Disposal of liquids.** Crankcase drainings and liquids shall not be dumped into sewers, streams or on the ground, but shall be stored in *approved* tanks or containers in accordance with Chapter 57 until removed from the premises.

❖ Careless disposal of crankcase drainings by dumping them into sewers, waterways or simply on the ground can lead to dangerous, sometimes deadly and always costly environmental damage. Do-it-yourself weekend oil-changers sometimes take a course of least effort, as noted above, when disposing of their spent motor oil rather than keeping it in an approved container until the next community hazardous materials collection day sponsored by the local environmental protection agency. Another means of proper disposal for home-generated waste oil could be taking it to a local repair garage that will allow it to be added to its approved waste oil storage tank for a modest fee.

**2311.2.3.2 Disposal of oily waste.** Self-closing metal cans shall be used for oily waste.

❖ This provision refers to the storage of oily rags, etc. See the commentary to Section 304.3.1 for further discussion of waste cans.

**2311.2.4 Spray finishing.** Spray finishing with flammable or combustible liquids shall comply with Chapter 24.

❖ Chapter 24 regulates the spraying of flammable and combustible finishes and requires a permit from the fire code official. The spray operation must comply with Section 2404.

**2311.3 Sources of ignition.** Sources of ignition shall not be located within 18 inches (457 mm) of the floor and shall comply with Chapters 3 and 35.

❖ No open flame device or other sources of ignition may be within 18 inches (457 mm) of the floor in a repair garage. Flammable and combustible vapors found in repair garages are heavier than air and will accumulate below the 18-inch (457 mm) level.

**2311.3.1 Equipment.** Appliances and equipment installed in a repair garage shall comply with the provisions of the *International Building Code*, the *International Mechanical Code* and NFPA 70.

❖ Special care must be taken in selecting and installing appliances and equipment in repair garages due to the 18-inch (457 mm) hazard zone identified in Section 2311.3. Electrical equipment must be suitable for classified hazardous locations. Appliances, such as furnaces, must be installed with their fire boxes above the 18-inch (457 mm) hazard zone to reduce the likelihood of them becoming an ignition source for flammable vapors that may have escaped and settled to the floor. See the commentary to the applicable sections of the IBC and the IMC for further information.

**2311.3.2 Smoking.** Smoking shall not be allowed in repair garages except in *approved* locations.

❖ Smoking is a common ignition hazard that does not occur within 18 inches (457 mm) of the floor but can

drop hot ashes into the 18-inch (457 mm) hazard zone near the floor with the potential to ignite any accumulated vapors.

**2311.4 Below-grade areas.** Pits and below-grade work areas in repair garages shall comply with Sections 2311.4.1 through 2311.4.3.

❖ Note that this section describes this area as a pit or a below-grade work area and not a basement.

**2311.4.1 Construction.** Pits and below-grade work areas shall be constructed in accordance with the *International Building Code*.

❖ Construction requirements are found in the IBC.

**2311.4.2 Means of egress.** Pits and below-grade work areas shall be provided with *means of egress* in accordance with Chapter 10.

❖ Section 202 defines a “Motor vehicle repair garage” as a moderate-hazard storage occupancy.

Section 1006 allows one means of egress if the building is a storage occupancy with only one level below grade, the occupancy load is less than 30 occupants and the travel distance does not exceed 100 feet (30 500 mm) for a single-story storage occupancy.

**2311.4.3 Ventilation.** Where Class I liquids or LP-gas are stored or used within a building having a *basement* or pit wherein flammable vapors could accumulate, the *basement* or pit shall be provided with mechanical ventilation in accordance with the *International Mechanical Code*, at a minimum rate of 1½ cubic feet per minute per square foot (cfm/ft<sup>2</sup>) [0.008 m<sup>3</sup>/(s · m<sup>2</sup>)] to prevent the accumulation of flammable vapors.

❖ A ventilation system must be installed in any below-grade area where flammable and combustible vapors might accumulate. The ventilation system must be in operation any time the repair garage is open for business, if a vehicle is left parked over the pit when the garage is closed for business or anytime there is a chance that vapors may accumulate in the below-grade area.

**2311.5 Preparation of vehicles for repair.** For vehicles powered by gaseous fuels, the fuel shutoff valves shall be closed prior to repairing any portion of the vehicle fuel system.

Vehicles powered by gaseous fuels in which the fuel system has been damaged shall be inspected and evaluated for fuel system integrity prior to being brought into the repair garage. The inspection shall include testing of the entire fuel delivery system for leakage.

❖ Gaseous fuels include such fuels as LP-gas and CNG, among other gases. If a leak is detected in the fuel system, it must be stopped or the system purged of fuel before the vehicle can be brought into the garage. The intent is to prevent fuel gases from entering the garage area.

Although vehicles equipped with LP-gas systems for other than propulsion are not specifically

addressed in this section, (e.g., cooking, etc., in a recreational vehicle), they should be prepared for repair in accordance with Section 6111.3 of the code and Section 6.24.9 of NFPA 58.

**2311.6 Fire extinguishers.** Fire extinguishers shall be provided in accordance with Section 906.

❖ A motor vehicle repair garage is classified as a moderate-hazard storage occupancy. See Table 906.3(1) for the size and placement of portable fire extinguishers.

**2311.7 Repair garages for vehicles fueled by lighter-than-air fuels.** Repair garages for the conversion and repair of vehicles that use CNG, liquefied natural gas (LNG), hydrogen or other lighter-than-air motor fuels shall be in accordance with Sections 2311.7 through 2311.7.2.3 in addition to the other requirements of Section 2311.

**Exceptions:**

1. Repair garages where work is not performed on the fuel system and is limited to exchange of parts and maintenance not requiring open flame or welding on the CNG-, LNG-, hydrogen- or other lighter-than-air-fueled motor vehicle.
  2. Repair garages for hydrogen-fueled vehicles where work is not performed on the hydrogen storage tank and is limited to the exchange of parts and maintenance not requiring open flame or welding on the hydrogen-fueled vehicle. During the work, the entire hydrogen fuel system shall contain a quantity that is less than 200 cubic feet (5.6 m<sup>3</sup>) of hydrogen.
- ❖ Repair garages that install and repair CNG, liquefied natural gas (LNG), hydrogen or other lighter-than-air motor fuels must be equipped with ventilation and gas detection systems in accordance with Sections 2311.7.1 through 2311.7.2.3.

An example of Exception 1 would be a garage that works on automobile mufflers, brakes and shock absorbers and does not repair the fuel systems. This type of garage would not have to comply with this section even if the vehicles being repaired are equipped with lighter-than-air fuel systems.

Exception 2 allows work on hydrogen-fueled vehicles (but not on the fuel system of the vehicles) to be conducted provided there is no open flame in use and the vehicle's hydrogen fuel system contains not more than 200 cubic feet of the gas, which is less than 20 percent of the flammable gas MAQ in Table 5003.1.1(1). This would also eliminate the need for an operating permit for these repairs since the permit threshold amount in Section 105.6.9 and Table 105.6.9 is greater than pounds. This exception is intended to be consistent with NFPA 2 requirements on this topic.

In either exception, the fuel shutoff valve must be closed before any maintenance or repair work may begin, as required by Section 2307.5.

**2311.7.1 Ventilation.** Repair garages used for the repair of natural gas- or hydrogen-fueled vehicles shall be provided

with an *approved* mechanical ventilation system. The mechanical ventilation system shall be in accordance with the *International Mechanical Code* and Sections 2311.7.1.1 and 2311.7.1.2.

**Exception:** Repair garages with natural ventilation when *approved*.

❖ This section is intended to prevent the accumulation of lighter-than-air flammable and combustible gases inside the repair garage.

An example of natural ventilation that a fire code official may approve at his or her discretion is a repair garage with at least two opposite sides open all the way to the ceiling. The two opposite sides would allow for cross ventilation. Having the walls open to the ceiling would prevent lighter-than-air gases from accumulating at the ceiling level. The ceiling would have to be sealed to prevent gasses from entering the attic space; otherwise, mechanical ventilation would be required.

**2311.7.1.1 Design.** Indoor locations shall be ventilated utilizing air supply inlets and exhaust outlets arranged to provide uniform air movement to the extent practical. Inlets shall be uniformly arranged on exterior walls near floor level. Outlets shall be located at the high point of the room in exterior walls or the roof.

Ventilation shall be by a continuous mechanical ventilation system or by a mechanical ventilation system activated by a continuously monitoring natural gas detection system or, for hydrogen, a continuously monitoring flammable gas detection system, each activating at a gas concentration of not more than 25 percent of the lower flammable limit (LFL). In all cases, the system shall shut down the fueling system in the event of failure of the ventilation system.

The ventilation rate shall be not less than 1 cubic foot per minute per 12 cubic feet [ $0.00139 \text{ m}^3 \times (\text{s} \cdot \text{m}^3)$ ] of room volume.

❖ This section is intended to provide uniform ventilation throughout the garage area that will exchange at least 1 cubic foot (0.03 m<sup>3</sup>) of air for every 12 cubic feet (0.34 m<sup>3</sup>) of room volume every minute. In garages servicing CNG- or LNG-fueled vehicles, the ventilation must be continuous or be operated by a natural gas detection system. If the repair garage services hydrogen-fueled vehicles, the ventilation must be continuous or be operated by a continuously monitoring flammable gas detection system. In garages servicing vehicles fueled by all manner of lighter-than-air fuels, both types of systems would be required. Both systems must have an activation threshold of not more than 25 percent of the LFL of their respective gas.

**2311.7.1.2 Operation.** The mechanical ventilation system shall operate continuously.

**Exceptions:**

1. Mechanical ventilation systems that are interlocked with a gas detection system designed in accordance with Sections 2311.7.2 through 2311.7.2.3.

2. Mechanical ventilation systems in repair garages that are used only for repair of vehicles fueled by liquid fuels or odorized gases, such as CNG, where the ventilation system is electrically interlocked with the lighting circuit.

❖ The intent of this provision is to prevent the accumulation of lighter-than-air gases inside vehicle repair garages.

**2311.7.2 Gas detection system.** Repair garages used for repair of vehicles fueled by nonodorized gases including, but not limited to, hydrogen and nonodorized LNG, shall be provided with a flammable gas detection system.

❖ Some gases contain additives that produce pungent odors for easy recognition. If the vehicle contains fuel systems that do not use these odorized gases, a gas detection system must be installed.

**2311.7.2.1 System design.** The flammable gas detection system shall be *listed* or *approved* and shall be calibrated to the types of fuels or gases used by vehicles to be repaired. The gas detection system shall be designed to activate when the level of flammable gas exceeds 25 percent of the lower flammable limit (LFL). Gas detection shall be provided in lubrication or chassis service pits of repair garages used for repairing nonodorized LNG-fueled vehicles.

❖ The flammable gas detection system is designed to produce an alarm or signal when exposed to different concentrations of gases or vapor. This section requires quick-lube-type facilities that change oil and lubricate vehicles to install gas detection systems in the pit area if they service vehicles that are equipped with LNG fuel systems using nonodorized LNG.

**2311.7.2.1.1 Gas detection system components.** Gas detection system control units shall be *listed* and *labeled* in accordance with UL 864 or UL 2017. Gas detectors shall be *listed* and *labeled* in accordance with UL 2075 for use with the gases and vapors being detected.

❖ This section requires gas detection equipment to be listed in accordance with UL 2075 for use with the different gases it will detect. Under UL 2075, a set of flammable gases and concentrations, measured in parts per million (ppm), is developed for each detector or sensor, and the manufacturer is required to provide information as to what gases and concentrations the device is designed to detect. Tests under the standard then verify the performance of each detector or sensor for each gas it is designed to detect. The gases that the equipment will detect may be shown in the manufacturer's instructions rather than on the product. This section is also intended to ensure that gas detection system control components are listed in accordance with nationally recognized safety standards. These standards include a comprehensive set of construction and performance requirements that are used to evaluate and list gas detection system control units and gas detectors.

**2311.7.2.2 Operation.** Activation of the gas detection system shall result in all the following:

1. Initiation of distinct audible and visual alarm signals in the repair garage.
2. Deactivation of all heating systems located in the repair garage.
3. Activation of the mechanical ventilation system, where the system is interlocked with gas detection.

❖ The intent of this section is to identify the equipment that the gas detection system must activate in the event the system detects the presence of gas above 25 percent of the LFL.

**2311.7.2.3 Failure of the gas detection system.** Failure of the gas detection system shall result in the deactivation of the heating system, activation of the mechanical ventilation system where the system is interlocked with the gas detection system and cause a trouble signal to sound in an *approved* location.

❖ This section requires all equipment that the gas detector would normally activate when it detects gas to also activate if the detector fails.

**2311.8 Defueling equipment required at vehicle maintenance and repair facilities.** Facilities for repairing hydrogen fuel systems on hydrogen-fueled vehicles shall have equipment to defuel vehicle storage tanks. Where work must be performed on a vehicle's fuel storage tank for the purpose of maintenance, repair or cylinder certification, defueling and purging shall be conducted in accordance with Section 2309.6.

❖ It only makes sense that, if a motor vehicle repair garage offers service for hydrogen-powered vehicles, it must have the proper equipment available for all aspects of that purpose. Section 2309.6 and its subsections (formerly located in Section 2311.8) contain all the requirements for defueling operations. See the commentary to those sections.

## Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

*Code Changes Resource Collection—2015 International Fire Code.* Washington, DC: International Code Council, 2014.

CGA G-5.4—05, *Standard for Hydrogen Piping Systems at Consumer Locations*, 3rd ed. Arlington, VA: Compressed Gas Association, 2005.

*Handbook for Handling, Storing, and Dispensing E85.* Washington, DC: U.S. Department of Energy, 2006.

Renkes, Robert N. *Fires at Refueling Sites that Appear to be Static Related.* Tulsa, OK: Petroleum Equipment Institute, 2006.



# Chapter 24: Flammable Finishes

## General Comments

Roughly one out of every six fires occurring in industrial occupancies involves the ignition of a flammable or combustible liquid. This extraordinary statistic underscores the importance of proper fire prevention and protection practices where flammable and combustible coatings are applied using spraying, dipping or flow-coating methods.

Chapter 24 requirements govern operations where flammable or combustible finishes are applied by spraying, dipping, powder coating or flow-coating processes. Like all operations involving flammable or combustible liquids and combustible dusts, controlling ignition sources and methods of reducing or controlling flammable vapors or combustible dusts at or near these operations is emphasized. Open flames and smoking are prohibited near spray areas and dip tanks. Electrical installations must comply with the requirements of NFPA 70, especially requirements for electrical equipment and wiring in areas classified as spraying spaces and flammable vapor areas, as defined in this chapter.

Good housekeeping and maintenance practices will significantly reduce fuel supply hazards. Additionally, care must be taken to control the accumulation and dissipation of static electricity. Managing the quantity of flammable and combustible liquids used and stored in and around spraying and dipping operations also discourages ignition. Because ample fuel and adequate oxygen are available in spraying and dipping operations, safeguards must be installed and maintained to manage the impact of a fire, should it occur. For exam-

ple, if a match is dropped into a closed jar full of flammable liquids, the match is typically quenched because the fuel-to-air ratio does not allow flammable vapors to ignite; there is not enough oxygen. If the same liquid is poured onto a large surface, such as the floor, the vapors in the air are mixed in ratios that allow ignition to take place much more easily. The same phenomenon applies to atomization of flammable liquids where the liquid droplets have a greater surface area. Please note that, in addition to this chapter, other chapters such as Chapters 50 (Hazardous Materials—General Provisions), 57 (Flammable and Combustible Liquids) and 62 (Organic Peroxides) are applicable for additional requirements for storage and handling of hazardous materials.

## Purpose

Compliance with the requirements of this chapter is intended to reduce the likelihood of fires involving the application of flammable or combustible liquids/powders through spraying, dipping or flow-coating operations. Additionally, compliance with the requirements of this chapter will reduce the impact of a fire, should one occur. Emphasis is placed on controlling ignition sources, managing the quantity and location of fuels/vapors/dust and maintaining fire protection features.

More information on the development of this chapter, as well as all other revised chapters in the code, can be found in the *Code Changes Resource Collection—2015 International Fire Code*.

## SECTION 2401 GENERAL

**2401.1 Scope.** This chapter shall apply to locations or areas where any of the following activities are conducted:

1. The application of flammable finishes to articles or materials by means of spray apparatus.
2. The application of flammable finishes by dipping or immersing articles or materials into the contents of tanks, vats or containers of flammable or *combustible liquids* for coating, finishing, treatment or similar processes.
3. The application of flammable finishes by applying combustible powders to articles or materials utilizing powder spray guns, electrostatic powder spray guns, fluidized beds or electrostatic fluidized beds.

4. Floor surfacing or finishing operations using Class I or II liquids in areas exceeding 350 square feet (32.5 m<sup>2</sup>).
5. The application of flammable finishes consisting of dual-component coatings or Class I or II liquids when applied by brush or roller in quantities exceeding 1 gallon (4 L).

❖ This section establishes the applicability of this chapter to a variety of locations, areas, operations and activities involving the hazards of atomizing flammable and combustible liquids and spraying of combustible powders. It is important to note that spray-finishing activities do not specifically relate to the maximum allowable quantity (MAQ) per control area as used in Chapters 50 and 57. However, storage related to spray-finishing supplies would be regulated by those chapters, which would require applying the MAQ.

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**2401.2 Nonapplicability.** This chapter shall not apply to spray finishing utilizing flammable or *combustible liquids* that do not sustain combustion, including:

1. Liquids that have no fire point when tested in accordance with ASTM D 92.
  2. Liquids with a flashpoint greater than 95°F (35°C) in a water-miscible solution or dispersion with a water and inert (noncombustible) solids content of more than 80 percent by weight.
- ❖ Chapter 24 regulates spray finishing with any material defined as a flammable or combustible liquid by requiring that the spraying operation be confined to either a spray booth or an approved spray room. There are a variety of water-based paint products available on the market today that have a flash point and meet the definition of a “Flammable or Combustible liquid” but cannot sustain combustion due to the sheer quantity of inert solids and water present in their composition. Many consumer latex paints fall into this category.

This section clarifies that liquids having no fire point, and water-miscible liquids with a flash point greater than 95°F (35°C) having an aggregate water and inert solid content by weight of at least 80 percent, are not regulated by Chapter 24. Materials meeting these same criteria have been exempted from the storage and use requirements in Chapter 57 (see Section 5701.2, Exceptions 6 and 7), but it has been unclear to code users whether the same two exemptions should apply when these products are used in spray-finishing operations.

**2401.3 Permits.** Permits shall be required as set forth in Sections 105.6 and 105.7.

- ❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit and Section 105.7 for construction permits. The permit process also notifies the fire department of the need for prefire planning for the hazardous property. Because of the extremely hazardous processes described in this chapter, multiple operational permits are required by Sections 105.6.17, 105.6.18 and 105.6.43. A construction permit is required by Section 105.7.16.

## SECTION 2402 DEFINITIONS

**2402.1 Definitions.** The following terms are defined in Chapter 2:

**DETEARING.**  
**DIP TANK.**

**ELECTROSTATIC FLUIDIZED BED.**

**FLAMMABLE FINISHES.**

**FLAMMABLE VAPOR AREA.**  
**FLUIDIZED BED.**

**LIMITED SPRAYING SPACE.**

**RESIN APPLICATION AREA.**

**ROLL COATING.**

**SPRAY BOOTH.**

**SPRAY ROOM.**

**SPRAYING SPACE.**

- ❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

## SECTION 2403 PROTECTION OF OPERATIONS

**2403.1 General.** Operations covered by this chapter shall be protected as required by Sections 2403.2 through 2403.4.4.

- ❖ This section states that the general protection requirements that apply to all processes (spraying, dipping and powder coating) are contained in this section. The regulation and mitigation of hazards common to all processes described in Section 2401.1 are set forth here.

**2403.2 Sources of ignition.** Protection against sources of ignition shall be provided in accordance with Sections 2403.2.1 through 2403.2.8.

- ❖ Protection against sources of ignition is one of the most critical aspects of fire prevention in flammable finish operations. Flammable finish materials are finely divided or atomized during spraying operations, making them much more volatile and subject to ignition. Controlling sources of ignition is a preventive measure in a hazardous area where vapors can exist and potential ignition sources are readily available in the operations (ovens, electrical outlets, etc.).

**2403.2.1 Electrical wiring and equipment.** Electrical wiring and equipment shall comply with this chapter and NFPA 70.

- ❖ In order to control the ignition and personnel hazards of electrical wiring and equipment, they must meet the requirements of NFPA 70. Those requirements are found in Article 516 of NFPA 70 for areas in and around the spraying equipment, which places restrictions on the use of portable electric lamps. The classification of an area is based on the amount of flammable vapors, combustible mists, residues, dust or deposits present.

**2403.2.1.1 Flammable vapor areas.** Electrical wiring and equipment in flammable vapor areas shall be of an explosion-proof type *approved* for use in such hazardous locations. Such areas shall be considered to be Class I, Division 1 or Class II, Division 1 hazardous locations in accordance with NFPA 70.

❖ The areas where flammable vapors [defined as flammable constituents in air that exceed 25 percent of the lower flammable limit (LFL)] are present must meet the requirements for Class I, Division 1 hazardous locations. The areas where combustible residues (such as dusts or deposits) are present must meet the requirements for the Class II, Division 1 (for dusts and residue) electrical classification. This is a very critical aspect of prevention of sources of ignition. Based on the definition of “Flammable vapor area,” the fire code official is authorized to define the extent of the flammable vapor area in any specific case. Otherwise, the areas described in that definition, such as the interior of spray booths, are used for electrical classification. See Commentary Figures 2403.2.1.1(1) and 2403.2.1.1(2) for examples of locations classified according to NFPA 70, Section 516.

**2403.2.1.2 Areas subject to deposits of residues.** Electrical equipment, flammable vapor areas or drying operations that are subject to splashing or dripping of liquids shall be specifically *approved* for locations containing deposits of readily ignitable residue and explosive vapors.

**Exceptions:**

1. This provision shall not apply to wiring in rigid conduit, threaded boxes or fittings not containing taps, splices or terminal connections.

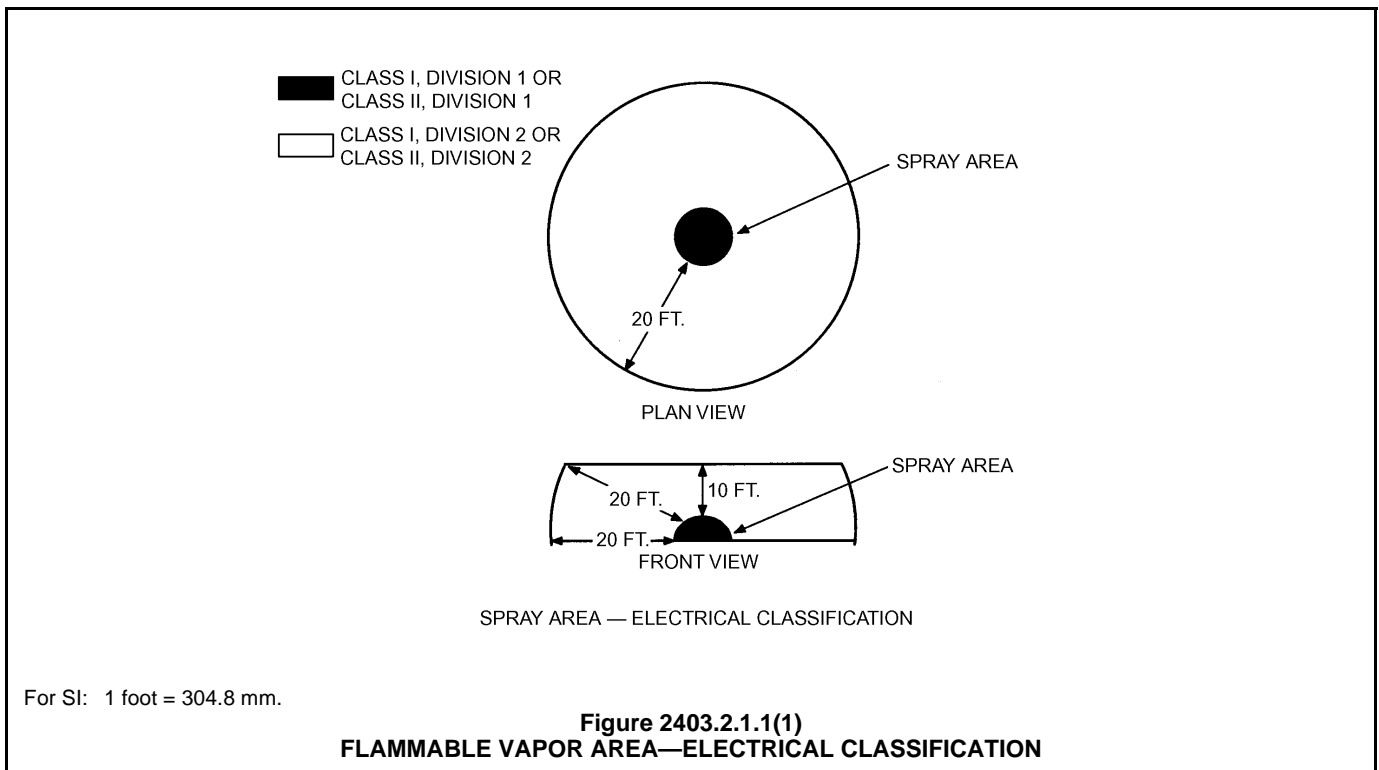
2. This provision shall not apply to electrostatic equipment allowed by Section 2407.

In resin application areas, electrical wiring and equipment that is subject to deposits of combustible residues shall be *listed* for such exposure and shall be installed as required for hazardous (classified) locations. Electrical wiring and equipment not subject to deposits of combustible residues shall be installed as required for ordinary hazard locations.

❖ It is critical that only specifically approved electrical equipment be allowed in spraying spaces where deposits of combustible residues may readily accumulate. This section limits the use of electrical equipment in the above-mentioned area subject to deposit of residue for two primary reasons:

1. Sparks from such equipment could cause ignition of flammable vapors or overspray residue.
2. Buildup of combustible overspray or splashed residue accumulating on the surfaces of electrical equipment subject to heating may cause equipment to overheat and ignite. See Commentary Figures 2403.2.1.1(1) and 2403.2.1.1(2) for examples of electrically classified locations.

Taps, splices or terminal connections (similar to those of connections within flammable liquid transfer systems) are the areas where accidents are most likely to occur. By removing risks associated with such fittings and installing rigid conduit to protect against splashing or dripping of liquids, the hazards associated with such electrical equipment are



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reduced substantially. Because the electrostatic equipment is part of many flammable-finish processes, Section 2407 requires that the equipment be approved. "Approved" is defined in Chapter 2 as "accepted by the fire code official" (see the commentary to this definition).

**2403.2.1.3 Areas adjacent to spray booths.** Electrical wiring and equipment located outside of, but within 5 feet (1524 mm) horizontally and 3 feet (914 mm) vertically of openings in a spray booth or a spray room, shall be *approved* for Class I, Division 2 or Class II, Division 2 hazardous locations, whichever is applicable.

❖ Class I, Division 2, and Class II, Division 2 typically apply to areas where accumulation of flammable vapors and combustible dust are prevented through ventilation and dust collection systems. However, flammable vapors and combustible dusts may be present in these areas if the ventilation system fails.

**2403.2.1.4 Areas subject to overspray deposits.** Electrical equipment in flammable vapor areas located such that deposits of combustible residues could readily accumulate thereon

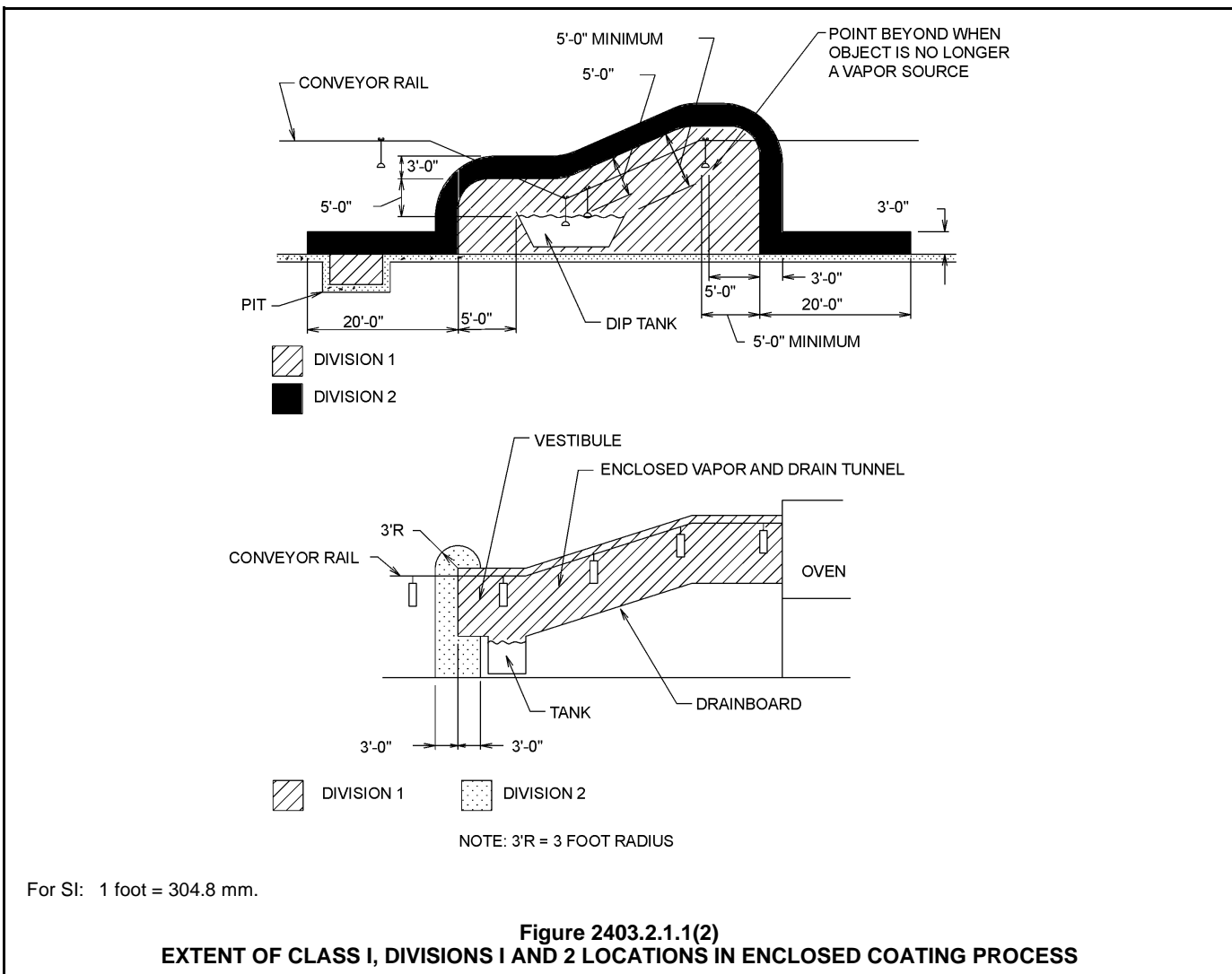
shall be specifically *approved* for locations containing deposits of readily ignitable residue and *explosive* vapors in accordance with NFPA 70.

### Exceptions:

1. Wiring in rigid conduit.
2. Boxes or fittings not containing taps, splices or terminal connections.
3. Equipment allowed by Sections 2404 and 2407 and Chapter 30.

❖ Hazards associated with overspray deposit are similar to areas subject to deposits of residues specified in Section 2403.2.1.2 (see commentary, Section 2403.2.1.2). Exception 1 allows the use of rigid conduit to protect against splashing or dripping of liquids, which substantially reduces the hazards associated with electrical equipment.

Exception 2 acknowledges that where boxes do not contain taps, splices or terminal connections (similar to those of connections within flammable liquid transfer systems), the hazards associated with such electrical equipment are reduced substantially.



Exception 3 exempts equipment allowed by the code (approved or listed) for hazardous uses, such as equipment allowed by Sections 2404 and 2407 and Chapter 30 because those items are designed to protect against ignition or explosion hazards.

**2403.2.2 Open flames and sparks.** Open flames and spark-producing devices shall not be located in flammable vapor areas and shall not be located within 20 feet (6096 mm) of such areas unless separated by a permanent partition.

**Exception:** Drying and baking apparatus complying with Section 2404.6.1.2.

❖ For obvious prevention reasons, open flames and spark-producing devices are not allowed in areas considered as flammable vapor areas and areas that could contain flammable vapors should the ventilation system fail. Open flames are prohibited where flammable or combustible liquids are stored, dispensed or applied. Heaters and all types of open-flame appliances are prohibited in and within 20 feet (6096 mm) of spray spaces and vapor areas, such as dip tanks and spray-finishing areas.

The exception recognizes that there are additional safety requirements in Section 2404.6.1.2 and Chapter 30 that reduce the probability of an ignition associated with open flames and sparks from drying and baking apparatus.

**2403.2.3 Hot surfaces.** Heated surfaces having a temperature sufficient to ignite vapors shall not be located in flammable vapor areas. Space-heating appliances, steam pipes or hot surfaces in a flammable vapor area shall be located such that they are not subject to accumulation of deposits of combustible residues.

**Exception:** Drying apparatus complying with Section 2404.6.1.2.

❖ Where practical, auxiliary heating appliances (regardless of them being tested or listed) should not be installed inside a spray booth, room or area. Heating equipment and appliances approved for use only in Class I, Division 1 (flammable spray); or Class II, Division 1 (powder coating) hazardous locations are to be installed in spray booths, rooms or areas. Even the hot surfaces of indirect heating appliances can ignite combustible dusts or flammable or combustible vapors produced by spray or resin application operations.

The exception, as mentioned previously, notes that there are additional safety requirements in Section 2404.6.1.2 and Chapter 30 that prevent or reduce the probability of an ignition associated with open flames and sparks.

**2403.2.4 Equipment enclosures.** Equipment or apparatus that is capable of producing sparks or particles of hot metal that would fall into a flammable vapor area shall be totally enclosed.

❖ Equipment in areas considered as vapor areas and areas that could contain flammable vapors and com-

combustible residue such as dusts or deposits is restricted. The same reasoning as for open flames required by Section 2403.2.2 applies. An example of this equipment is a metal grinding machine that produces sparks. Also see Section 2403.2.7 for welding requirements and signage.

**2403.2.5 Grounding.** Metal parts of spray booths, exhaust ducts and piping systems conveying Class I or II liquids shall be electrically grounded in accordance with NFPA 70. Metallic parts located in resin application areas, including but not limited to exhaust ducts, ventilation fans, spray application equipment, workpieces and piping, shall be electrically grounded.

❖ Static electricity is one of the most insidious and most common of all ignition sources. According to D.R. Scarborough in 2003, static sparks are the most common ignition sources involving spray-finishing operations. Additionally, humans are conductors of electricity, meaning that operators must also be considered when grounding systems are determined. NFPA 77 provides additional guidance on mitigating static electricity.

**2403.2.6 Smoking prohibited.** Smoking shall be prohibited in flammable vapor areas and hazardous materials storage rooms associated with flammable finish processes. “No Smoking” signs complying with Section 310 shall be conspicuously posted in such areas.

❖ Smoking is a significant ignition source and is therefore prohibited where flammable or combustible liquids or combustible dusts are stored, dispensed or applied. “No smoking” signs must be conspicuously located throughout the work area. Designated smoking areas should be located well outside the spray-finishing area and preferably in a separate room. The requirements of Sections 5003.7.1 and 5706.4.8 can also apply in facilities where flammable finish processes occur (see also commentary, Section 310).

**2403.2.7 Welding warning signs.** Welding, cutting and similar spark-producing operations shall not be conducted in or adjacent to flammable vapor areas or dipping or coating operations unless precautions have been taken to provide safety. Conspicuous signs with the following warning shall be posted in the vicinity of flammable vapor areas, dipping operations and paint storage rooms:

NO WELDING  
THE USE OF WELDING OR CUTTING  
EQUIPMENT IN OR NEAR THIS AREA  
IS DANGEROUS BECAUSE OF FIRE  
AND EXPLOSION HAZARDS. WELDING  
AND CUTTING SHALL BE DONE ONLY  
UNDER THE SUPERVISION OF THE  
PERSON IN CHARGE.

❖ For obvious reasons, open flames and spark-producing devices are not allowed in areas considered as flammable vapor areas (and areas that could potentially contain flammable vapors should the prevention

system components, such as ventilation, fail). Open flames are prohibited where flammable or combustible liquids are stored, dispensed or applied. Although no specific separation distance between the welding area and spraying space is required, the 20 feet (6096 mm) beyond the spraying space or to a permanent partition as also mentioned in Section 2403.2.2 may be a good general separation guideline for these incompatible operations. Because welding and cutting processes can typically be found in buildings that house flammable-finish processes, they create a potentially hazardous environment, especially for personnel unaware of such hazards. As with other hazardous conditions, such as smoking, warning signs and placards must be posted to give appropriate notice to warn personnel of the hazards of welding near spraying spaces.

**2403.2.8 Powered industrial trucks.** Powered industrial trucks used in electrically classified areas shall be *listed* for such use.

- ❖ Similar language is used in Section 5003.7.3. Again, because these types of industrial trucks are powered by an electrical motor or internal combustion engine, the ignition of flammable vapors or combustible dusts is likely unless they are listed for such use (see also commentary, Sections 309 and 5003.7.3).

**2403.3 Storage, use and handling of flammable and combustible liquids.** The storage, use and handling of flammable and *combustible liquids* shall be in accordance with this section and Chapter 57.

- ❖ Provisions of Chapter 57 and this section govern the storage and handling of flammable and combustible liquids for flammable finishes. As mentioned previously, Section 2403 applies to all flammable-finishing operations within the scope of this chapter; therefore, Section 2403.3 applies to flammable-finish operations that use flammable and combustible liquids.

**2403.3.1 Use.** Containers supplying spray nozzles shall be of a closed type or provided with metal covers that are kept closed. Containers not resting on floors shall be on noncombustible supports or suspended by wire cables. Containers supplying spray nozzles by gravity flow shall not exceed 10 gallons (37.9 L) in capacity.

- ❖ Requirements in this section are intended to prevent spills or the release of flammable vapors from flammable liquid containers. Tight-fitting metal lids or covers must be installed on all containers during use. Only those containers used to supply spray apparatus should be in the spraying space or spray-finishing enclosure during spray-finishing operations. Containers supplying spray apparatus must rest on a floor or noncombustible stand when in use or be suspended from the ceiling by wire cables. Gravity dispensing of flammable liquids to spray nozzles is permitted for quantities not exceeding 10 gallons (38 L) to control the size of an uncontrolled gravity-fed leak.

**2403.3.2 Valves.** Containers and piping to which a hose or flexible connection is attached shall be provided with a shut-off valve at the connection. Such valves shall be kept shut when hoses are not in use.

- ❖ Shutoff valves must be installed at the juncture between flexible hoses or tubing and fixed piping used to dispense flammable liquids to spray-finishing apparatus to allow prompt stoppage of liquid flow if a hose or tubing failure occurs. Shutoff valves must be closed when spray apparatus is not in use.

**2403.3.3 Pumped liquid supplies.** Where flammable or *combustible liquids* are supplied to spray nozzles by positive displacement pumps, pump discharge lines shall be provided with an *approved* relief valve discharging to pump suction or a safe detached location.

- ❖ In order to prevent excess flows or line ruptures from positive-pressure pumps, pressure relief valves or other devices must be installed on the discharge side of positive-displacement pumps supplying flammable liquids to spray apparatus. These devices must operate before the discharge pressure exceeds the safe operating pressure of the connected valves, piping and equipment. Any discharge from the devices must be controlled to prevent ignition or environmental damage.

**2403.3.4 Liquid transfer.** Where a flammable mixture is transferred from one portable container to another, a bond shall be provided between the two containers. Not less than one container shall be grounded. Piping systems for Class I and II liquids shall be permanently grounded.

- ❖ The uncontrolled discharge of static electricity is a common ignition source during flammable liquid transfer. Proper bonding and grounding precautions must be followed for the safe discharge of static charges produced during flammable liquid transfer. See Section 5705.2 for general flammable and combustible liquid transfer requirements.

**2403.3.5 Class I liquids as solvents.** Class I liquids used as solvents shall be used in spray gun and equipment cleaning machines that have been *listed* and *approved* for such purpose or shall be used in spray booths or spray rooms in accordance with Sections 2403.3.5.1 and 2403.3.5.2.

- ❖ Another hazardous aspect of spray finishing is the use of solvents to clean spray guns and related equipment. When spray booths require cleaning, the use of solvents may often pose a greater hazard than the normally used spray-finishing material. Usually an integral part of the labeling process, manufacturer's installation, operation and maintenance instructions must be carefully followed. The type of solvent to be used in any given machine must be as recommended by the machine manufacturer.

**2403.3.5.1 Listed devices.** Cleaning machines for spray guns and equipment shall not be located in areas open to the public and shall be separated from ignition sources in accordance

with their listings or by a distance of 3 feet (914 mm), whichever is greater. The quantity of solvent used in a machine shall not exceed the design capacity of the machine.

❖ Cleaning machines for spray guns and equipment are commonly used in the industry. See Commentary Figure 2403.3.5.1 for an illustration of a spray gun cleaning machine. Such machines use solvents powerful enough to dissolve paint residues in the thin tubing and small orifices of the spray equipment. They are similar to the automotive parts cleaners that have been in widespread use since the early 1970s, and consist of a metal sink-like bowl set on a base unit that houses a storage container for retrieval of spent solvent after the cleaning process. The solvent is circulated in the machine by a pneumatic pump. Vapors are captured in the sink bowl and are vented to the outdoors, either directly or, where located inside a spray booth, by directing vapors to the spray booth operating exhaust system inlets (see Section 2403.3.5.2). A safety interlock prevents the solvent pump from operating if the exhaust system fails. Installation of such machines must be restricted to areas not accessible to the general public to avoid exposure to the potential hazards of the cleaning operations and prevent the inadvertent introduction of ignition sources to the cleaning area.

**2403.3.5.2 Within spray booths and spray rooms.** When solvents are used for cleaning spray nozzles and auxiliary

equipment within spray booths and spray rooms, the ventilating equipment shall be operated during cleaning.

❖ The safety systems that are an integral part of operating spray booths and spray rooms can be used when solvents are used for equipment cleaning. These systems help, as they would during application of flammable finishes, in reducing the chances of ignition or the severity of a fire, should an ignition occur.

**2403.3.6 Class II and III liquids.** Solvents used outside of spray booths, spray rooms or *listed* and *approved* spray gun and equipment cleaning machines shall be restricted to Class II and III liquids.

❖ Cleaning spray equipment inside a spray booth or room designed to accommodate the hazards of spray painting and equipment maintenance should be the primary choice of operators. The code recognizes that this is not always a feasible option and thus allows for cleaning spray equipment outside an approved spray booth or room, or a labeled spray gun and equipment cleaning machine, provided that the cleaning solvents used are limited to combustible liquids having a flashpoint greater than 100°F (38°C).

**2403.4 Operations and maintenance.** Flammable vapor areas, exhaust fan blades and exhaust ducts shall be kept free from the accumulation of deposits of combustible residues. Where excessive residue accumulates in such areas, spraying

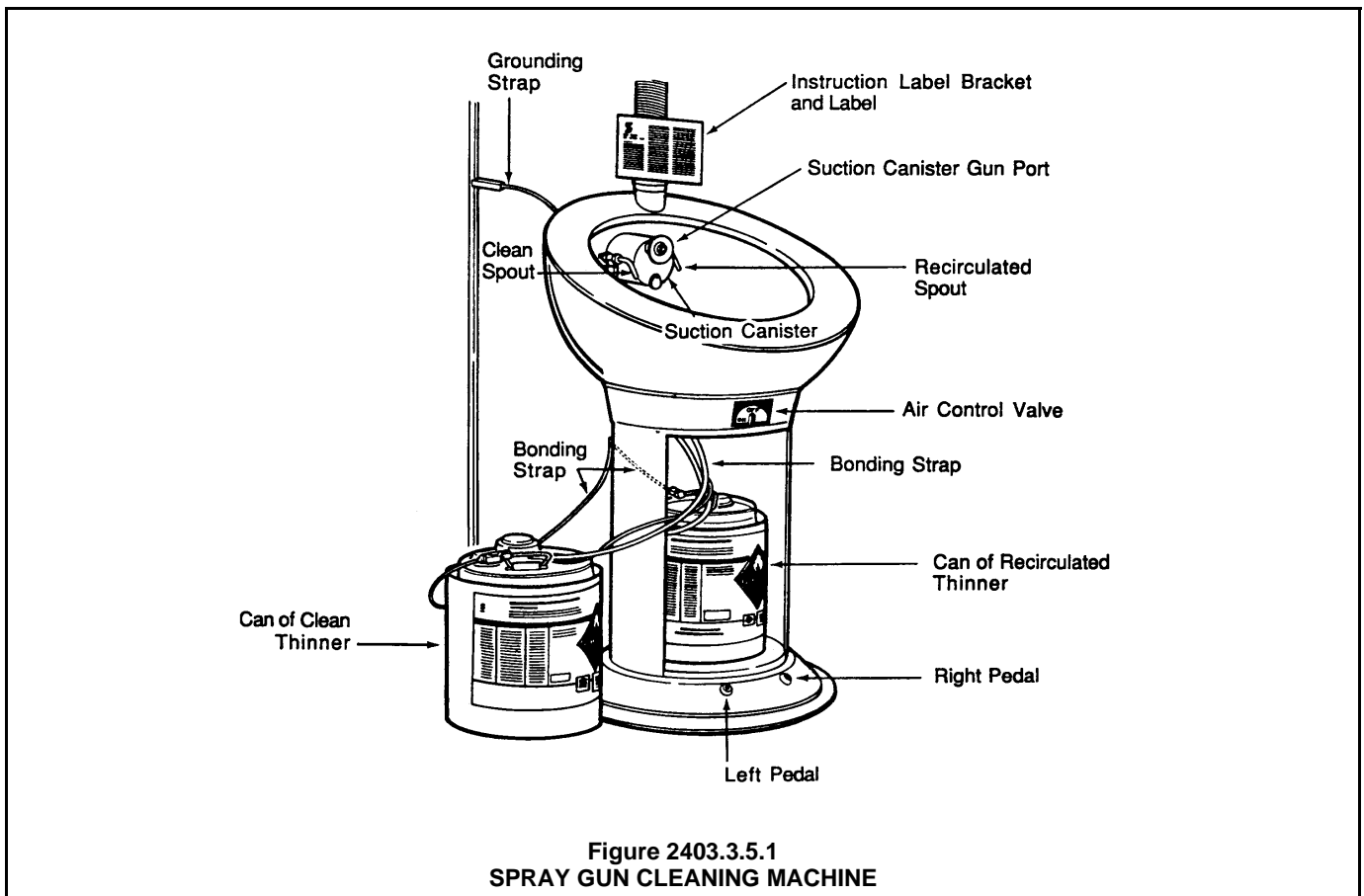


Figure 2403.3.5.1  
SPRAY GUN CLEANING MACHINE

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operations shall be discontinued until conditions are corrected.

❖ A regular cleaning schedule should be adopted for spraying spaces and spray-finishing enclosures. Accumulations of spray residue in interior spray booths or rooms or on exhaust duct surfaces should be removed at least daily or more frequently when accumulations become excessive. Any time overspray residue accumulations become excessive, the operator must suspend spray operations until the spray booth or area is thoroughly and properly cleaned. Water-wash nozzles, strainers and eliminator packs must be checked or cleaned daily or at the end of each shift, and tank sludge removed and discarded in a safe manner. Interior surfaces of ductwork and fan blades should be inspected regularly for accumulations of overspray residue caused by fouled nozzles, strainers or eliminator packs. The use of soap-based, water-soluble coatings makes it easier to strip surfaces using high-pressure water spray without greatly increasing the fire hazard. Determination of whether the accumulation of residue has become excessive in a particular location must be made by the fire code official on a case-by-case basis.

**2403.4.1 Tools.** Scrapers, spuds and other tools used for cleaning purposes shall be constructed of nonsparking materials.

❖ Because of the potential ignition problem that exists, the cleaning tools need to be of the nonsparking type. The term “nonsparking” is somewhat inaccurate. Tools made of brass and similar nonsparking materials do produce sparks but the sparks have ignition energies too low to ignite flammable vapors. Nonetheless, such tools should be used carefully to avoid producing sufficient frictional heat to cause an ignition.

**2403.4.2 Residue.** Residues removed during cleaning and debris contaminated with residue shall be immediately removed from the premises and properly disposed.

❖ Paint and solvent residue, cleaning rags and used protective coverings may be susceptible to spontaneous ignition. Residue and cleaning debris must be removed from the building and stored in approved containers located well away from the building. Removing residue and cleaning debris on a regular schedule, such as at the end of each work shift, are highly recommended.

**2403.4.3 Waste cans.** *Approved* metal waste cans equipped with self-closing lids shall be provided wherever rags or waste are impregnated with finishing material. Such rags and waste shall be deposited therein immediately after being utilized. The contents of waste cans shall be properly disposed of not less than once daily and at the end of each shift.

❖ Waste cans (sometimes called “oily rag cans”) used for storing materials that might auto-ignite as a result of the spontaneous combustion process must be tested and listed for that use by a recognized testing

laboratory or agency and must bear a label showing that they have been tested and including the name of the testing agency (see Section 304.3.1). Such containers are most commonly round and generally available in sizes ranging from 5 to 40 gallons (19 to 152 L). They are equipped with a manual or foot treadle-operated lid that opens to a maximum angle of 60 degrees (1 rad) and closes by gravity. These containers are designed to prevent continuing combustion of the contents if ignition occurs.

The container design includes features that keep the can body from coming into contact with combustible surfaces of walls or floors. Daily disposal of container contents reduces the amount of time that oily materials will lie dormant, generating internal heat that can lead to ignition. UL 32 provides further information on the construction, testing and listing of these containers (see the commentary to the Section 202 definition of “Listed”). Note that the general requirements of the daily removal and disposal of the contents of such waste cans found in Section 304.3.1 is superseded by the more specific disposal requirements of this section.

**2403.4.4 Solvent recycling.** Solvent distillation equipment used to recycle and clean dirty solvents shall comply with Section 5705.4.

❖ Section 5705.4 includes detailed requirements for solvent distillation processes and equipment, such as labeling, unit capacity, location and prohibited processes. Note that the terms “solvent distillation unit,” “appliance” and “equipment” are used interchangeably in the code.

## SECTION 2404 SPRAY FINISHING

**2404.1 General.** The application of flammable or *combustible liquids* by means of spray apparatus in continuous or intermittent processes shall be in accordance with the requirements of Sections 2403 and 2404.2 through 2404.9.4.

❖ This section establishes the applicability of the general requirements of Section 2403 to spraying operations, in addition to the provisions of Sections 2404.2 through 2404.9.4.

**2404.2 Location of spray-finishing operations.** Spray-finishing operations conducted in buildings used for Group A, E, I or R occupancies shall be located in a spray room protected with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1 and separated vertically and horizontally from other areas in accordance with the *International Building Code*. In other occupancies, spray-finishing operations shall be conducted in a spray room, spray booth or spraying space *approved* for such use.

### Exceptions:

1. Automobile undercoating spray operations and spray-on automotive lining operations conducted in areas with *approved* natural or mechanical ventilation shall be exempt from the provisions of Section

2404 when *approved* and where utilizing Class IIIA or IIIB *combustible liquids*.

2. In buildings other than Group A, E, I or R occupancies, *approved* limited spraying space in accordance with Section 2404.9.
  3. Resin application areas used for manufacturing of reinforced plastics complying with Section 2409 shall not be required to be located in a spray room, spray booth or spraying space.
- ❖ In the listed occupancy groups, separating spray-finishing operations from other portions of the building and protecting those portions from spraying-associated hazards are critical for several reasons. Spray-finishing operations are generally too hazardous to be conducted in occupancies with a high life or property exposure. The number of occupants in such buildings and the physical conditions of those occupants vary. People exposed to the danger of a fire involving spray finishing must be able to evacuate or protect themselves promptly and effectively to avoid the risk of serious injury or death. Also, the psychology of people in a Group A, E, I or R occupancy is very different from those in a Group F manufacturing occupancy where spraying operations are usually found. A person walking in a manufacturing environment where flammable-finish processes take place in a large area where spray booths and signs are in plain view, for example, is more aware of the physical dangers associated with these processes than someone in a Group R occupancy who may be merely relaxing with a cigarette. Also note that the protection provided in these occupancies is, in many cases, less than would be found in manufacturing occupancies. Separation and protection in the form of fire-resistance-rated construction and automatic fire suppression must be provided where such operations are to be conducted in the same building.

Note that Section 307.1, Exception 1, of the *International Building Code*® (IBC®) excludes spraying operations from being classified in Group H as long as they comply with IBC Section 416 and the provisions of the fire code. Section 416.2 requires that spray rooms be separated from the rest of the building by 1-hour fire barriers and horizontal assemblies constructed in accordance with IBC Sections 707 and 711, respectively.

Exception 1 recognizes that most automobile undercoating and corrosion-inhibitor application operations use combustible liquids with flash points greater than 140°F (60°C). Precautions must be taken to prevent these materials from being heated above their flash points or ignited in finely divided or atomized form. Ventilation to reduce the accumulation of hazardous vapors and mists must comply with the requirements of Chapter 57 and the *International Mechanical Code*® (IMC®).

Exception 2 recognizes the reduced hazard of limited spray applications in compliance with the special requirements in Section 2404.9, including small job

size, noncontinuous operation and substantial mechanical ventilation requirements.

Exception 3 defers to the specific safeguards applicable to resin application areas used in the manufacture of reinforced plastics in Section 2409.

**2404.3 Design and construction.** Design and construction of spray rooms, spray booths and spray spaces shall be in accordance with Sections 2404.3.1 through 2404.3.3.1.

- ❖ This section establishes the applicability of Sections 2404.3.1 through 2404.3.3.1 to the design and construction of spaces where spray-finishing operations may be carried out.

**2404.3.1 Spray rooms.** Spray rooms shall be constructed and designed in accordance with Section 2404.3.1.1 and the *International Building Code*, and shall comply with Sections 2404.4 through 2404.8.

- ❖ A spray room is a power-ventilated, fully enclosed room used exclusively for the open spraying of flammable and combustible materials. The entire spray room is considered a spraying space. The primary difference between a spray room and a spray booth is that spray booths are partially open.

Spray rooms, as with the other locations for spraying operations, are very highly regulated by the code and the IBC. As such, IBC Section 307.1, Exception 1 excludes spraying operations from being classified in Group H as long as they comply with IBC Section 416 and the provisions of the fire code. IBC Section 416.2 requires that spray rooms be separated from the rest of the building by 1-hour fire barriers and horizontal assemblies constructed in accordance with IBC Sections 707 and 711, respectively.

The occupancy of portions of buildings storing supplies of hazardous materials for these coating operations may be classified as Group H-2 or H-3 because of the presence of flammable or combustible liquids where the quantity of liquid stored exceeds the MAQ per control area listed in Table 5003.1.1(1). However, the occupancy is to be classified as Group F-1 for processes where the quantities do not exceed the MAQ. See also the commentary to the Section 202 definition of “Spray room.”

**2404.3.1.1 Floor.** Combustible floor construction in spray rooms shall be covered by *approved*, noncombustible, non-sparking material, except where combustible coverings, including but not limited to thin paper or plastic and strippable coatings, are utilized over noncombustible materials to facilitate cleaning operations in spray rooms.

- ❖ In spray rooms, noncombustible floors would be the preferred type of floor construction so as not to contribute to the fuel load available to an unwanted fire. However, if the floor is not noncombustible, noncombustible and nonsparking material must be used to cover the floor. Kraft paper and similar coverings are commonly used in spraying spaces to protect against overspray. Such coverings must be removed and discarded when accumulation becomes excessive.

Note that IBC Section 416.2 further requires that

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spray room floors be "...waterproofed and drained in an approved manner." Waterproof floors are to be arranged to drain either to the outside of the building, to internal drains or to other suitable places. Properly designed and guarded drains or scuppers of sufficient number and size to dispose of all surplus water likely to be discharged by automatic sprinklers must be provided.

**2404.3.2 Spray booths.** The design and construction of spray booths shall be in accordance with Sections 2404.3.2.1 through 2404.3.2.6, Sections 2404.4 through 2404.8 and NFPA 33.

❖ Sections 2404.3.2.1 through 2404.3.2.6 and 2404.4 through 2404.8 and NFPA 33 contain requirements for controlling hazards associated with spray booths. Much of the hazard prevention and mitigation of flammable-finish fires in a spray booth depend on the proper construction and design of the spray booth. See the commentary to the Section 202 definition of "Spray booth." Note that, by definition, a spray booth is considered to be an appliance.

**2404.3.2.1 Construction.** Spray booths shall be constructed of *approved* noncombustible materials. Aluminum shall not be used. Where walls or ceiling assemblies are constructed of sheet metal, single-skin assemblies shall be no thinner than 0.0478 inch (18 gage) (1.2 mm) and each sheet of double-skin assemblies shall be no thinner than 0.0359 inch (20 gage) (0.9 mm). Structural sections of spray booths are allowed to be sealed with latex-based or similar caulks and sealants.

❖ Even though spray booths are not required to meet the fire-resistance-rated construction requirements of the IBC, the requirements of this section recognize the need to minimize the spread of a fire and prevent a spray booth from contributing to a fire should one start within the booth. Aluminum is not suitable for structurally sound construction of enclosures because of its low melting point; it would be likely to melt in case of a substantial fire within the booth. For a spray booth to maintain its structural integrity in a fire, it should be constructed of steel, masonry or equivalent noncombustible materials. Section 5003.8 also requires hazardous materials storage cabinets to be constructed of 18-gage [0.0478 inch (1.2 mm)] steel. Both booths and cabinets are viewed as equipment used to control and contain spills or fires.

**2404.3.2.2 Surfaces.** The interior surfaces of spray booths shall be smooth; shall be constructed so as to permit the free passage of exhaust air from all parts of the interior, and to facilitate washing and cleaning; and shall be designed to confine residues within the booth. Aluminum shall not be used.

❖ Rough, corrugated or uneven surfaces are difficult to clean. Periodic cleaning of the interior surfaces reduces the fire hazard posed by the accumulation of flammable or combustible coatings. Because flammable or combustible vapors and dusts are typically heavier than air, design considerations should include the passage of exhaust air and proper air cir-

ulation to all parts of the spray booth, especially at or near the floor level. Due to the physical properties of aluminum, it is unsuitable for cleaning and scraping of overspray residue. See the commentary to Section 2404.3.2.1 for further discussion on the use of aluminum in spray-booth construction.

**2404.3.2.3 Floor.** Combustible floor construction in spray booths shall be covered by *approved*, noncombustible, non-sparking material, except where combustible coverings, including but not limited to thin paper or plastic and strippable coatings, are utilized over noncombustible materials to facilitate cleaning operations in spray booths.

❖ The spray-booth floor requirements in this section parallel those for spray rooms in Section 2404.3.1.1 (see commentary, Section 2404.3.1.1).

**2404.3.2.4 Means of egress.** *Means of egress* shall be provided in accordance with Chapter 10.

**Exception:** *Means of egress* doors from premanufactured spray booths shall be not less than 30 inches (762 mm) in width by 80 inches (2032 mm) in height.

❖ As with any room or space within a building from which occupants may need to egress, spray booths must comply with the exiting requirements of Chapter 10. See Section 1015, which establishes the minimum number of exits from rooms and spaces within a building, based on occupant load.

In typical spray booths, only a single egress door will be required. A premanufactured spray booth is considered to be an appliance or equipment and not a true separate room or space. Spray booths will also be occupied only by authorized personnel who are familiar with that environment. Accordingly, for booth design and listing purposes the exception specifically allows the egress door to be slightly smaller than the generally applicable minimum required width of 32 inches (813 mm) for means-of-egress doors specified in Section 1010.1.1. This is consistent with the door width exceptions for residential and Group I-3 occupancies in that section, which are based on familiarity with the occupancy in Group R and the controlled environment of Group I-3.

**2404.3.2.5 Clear space.** Spray booths shall be installed so that all parts of the booth are readily accessible for cleaning. A clear space of not less than 3 feet (914 mm) shall be maintained on all sides of the spray booth. This clear space shall be kept free of any storage or combustible construction.

### Exceptions:

1. This requirement shall not prohibit locating a spray booth closer than 3 feet (914 mm) to or directly against an interior partition, wall or floor/ceiling assembly that has a *fire-resistance rating* of not less than 1 hour, provided the spray booth can be adequately maintained and cleaned.
2. This requirement shall not prohibit locating a spray booth closer than 3 feet (914 mm) to an exterior wall or a roof assembly, provided the wall or roof is con-

structed of noncombustible material and the spray booth can be adequately maintained and cleaned.

- ❖ Spray booths are viewed as equipment where accessibility is essential to cleaning and maintenance. This section is also included for housekeeping reasons, and to keep combustible debris and materials away from the spray booth to reduce the chances of an ignition on its exterior from a fire that might occur within the booth. This clearance also serves to prevent heat from a fire within a booth from being transferred to adjacent combustible material. It also will prevent a fire near a booth (from combustible storage, for example) from acting as an ignition source for the booth (see Commentary Figure 2404.3.2.5).

Under Exception 1, if the construction materials of an interior partition further inhibit the spread of a fire and if there are proper means of cleaning the spray booth, the intent of the section is considered met. This exception, however, still does not allow any storage within 3 feet (914 mm) of the spray booth. Note that the 1-hour partition, wall or floor/ceiling assembly is a generic description of an assembly and not a specific type of assembly (e.g., fire wall, fire barrier, fire partition, etc.) with a specific assigned purpose. As such, no continuity requirements apply for such assemblies as would be applicable to assemblies with a specific required fire protection function and their designation as a specific type of assembly.

Exception 2 recognizes that if an exterior wall or roof assembly is of noncombustible construction, it will not contribute to the fuel load or spread of the fire to other interior parts of the building. This meets the intent of this section as long as there are proper means of cleaning the spray booth. This exception

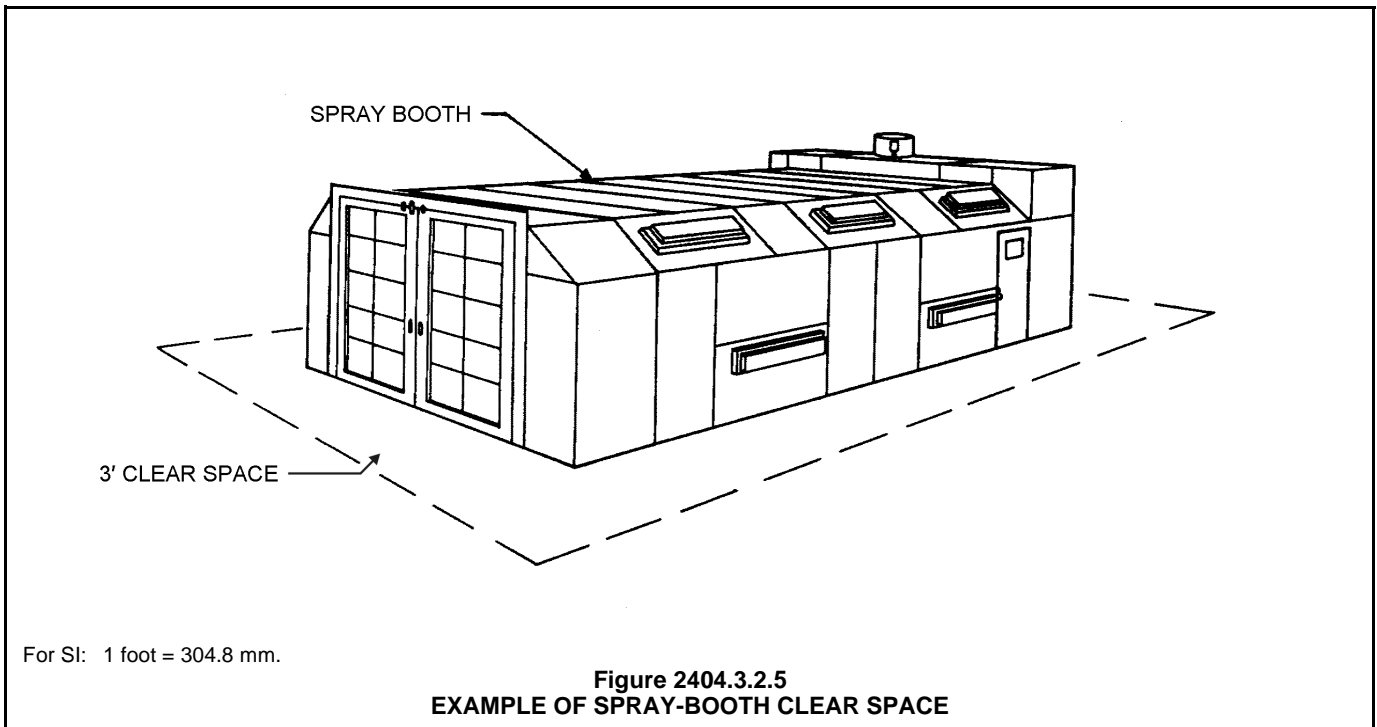
still does not allow any storage within 3 feet (914 mm) of the spray booth.

**2404.3.2.6 Size.** The aggregate area of spray booths in a building shall not exceed the lesser of 10 percent of the area of any floor of a building or the basic area allowed for a Group H-2 occupancy without area increases, as set forth in the *International Building Code*. The area of an individual spray booth in a building shall not exceed the lesser of the aggregate size limit or 1,500 square feet (139 m<sup>2</sup>).

**Exception:** One individual booth not exceeding 500 square feet (46 m<sup>2</sup>).

- ❖ The intent of limiting the size of a spray booth is to compartmentalize or provide passive fire protection. This limits the size of a fire and the processes to a more manageable condition. Section 2404.2 requires spraying operations to be conducted in an approved spray booth, spraying space or spray room. As stated in this section, the size of an approved spray booth is limited to the lesser of 1,500 square feet (139 m<sup>2</sup>) or 10 percent of the area of any floor of a building or the basic area allowed for a Group H-2 occupancy without area increases, as set forth in the IBC. If the area limits for an approved spray booth are exceeded, then the operation must be conducted in a spray room in accordance with Section 2404.3.1. The term “spray room” is defined in Section 202.

The exception references the first paragraph of the section. In businesses where the building is small [typically less than 5,000 square feet (465 m<sup>2</sup>)], it may be impractical to design for a spray booth that is less than 10 percent of the overall building area. In case of a fire, smaller buildings are easier to control from a passive fire protection standpoint than larger operations.



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**2404.3.3 Spraying spaces.** Spraying spaces shall be designed and constructed in accordance with the *International Building Code*, and Section 2404.3.3.1 and Sections 2404.4 through 2404.8 of this code.

❖ Because spraying spaces are not enclosed, the occupancy classification of the room in which the spraying space is located depends on whether the MAQs of hazardous materials per control area are exceeded. The occupancy of buildings or portions of buildings housing these coating operations is typically classified as Group H-2 [because flammable liquids are typically in open system use or under pressure greater than 15 pounds per square inch (psi) (103 kPa)] where the aggregate quantity of flammable/combustible liquids or dusts stored or used in a single control area exceeds the MAQ per control area listed in Table 5003.1.1(1). However, the occupancy is to be classified as Group F-1 or as a mixed use (such as Group F-1/S-1) for processes where the quantities do not exceed the MAQ per control area.

**2404.3.3.1 Floor.** Combustible floor construction in spraying spaces shall be covered by *approved*, noncombustible, non-sparking material, except where combustible coverings, such as thin paper or plastic and strippable coatings, are utilized over noncombustible materials to facilitate cleaning operations in spraying spaces.

❖ The spray-booth floor requirements in this section parallel those for spray rooms in Section 2404.3.1.1 and spray booths in Section 2404.3.2.3 (see commentary, Section 2404.3.1.1).

**2404.4 Fire protection.** Spray booths and spray rooms shall be protected by an *approved* automatic fire-extinguishing system complying with Chapter 9. Protection shall also extend to exhaust plenums, exhaust ducts and both sides of dry filters when such filters are used.

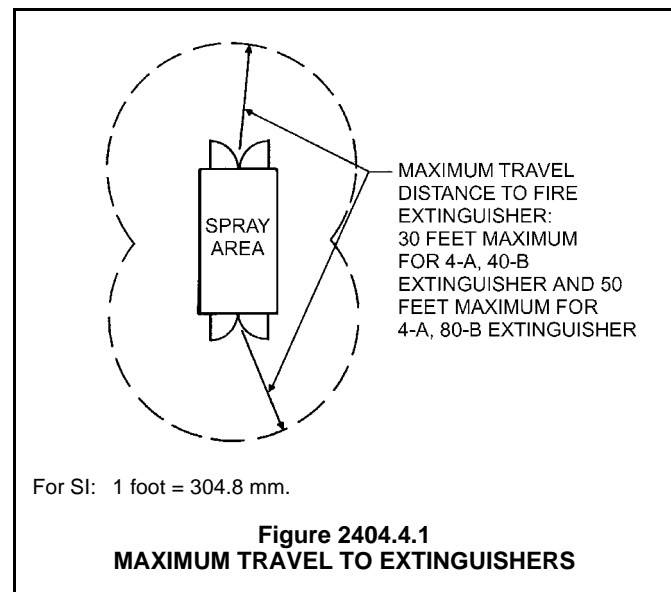
❖ Automatic sprinkler protection is the preferred method of protection for spray booths and spray rooms where the building is otherwise sprinklered. In nonsprinklered buildings that contain spray booths and spray rooms, alternative automatic fire-extinguishing systems, such as clean agents, carbon dioxide, dry chemical, etc., are allowed to be installed when approved by the fire code official. See the commentary to Section 904 for further discussion of specific types of alternative fire-extinguishing systems. Fire protection systems, equipment and devices must be installed and maintained in accordance with Chapter 9. Because the flammable-finish operations are subject to accumulation of residue, failure of the system as a result of poor maintenance is more likely in these areas than in most other types of facilities.

**2404.4.1 Fire extinguishers.** Portable fire extinguishers complying with Section 906 shall be provided for spraying areas in accordance with the requirements for an extra (high) hazard occupancy.

❖ Portable fire extinguishers for fighting incipient fires must be installed for ready access by the spray-booth, spray-room or spraying-space operator. Addi-

tionally, they should be selected on the basis of extra-hazard criteria contained in NFPA 10 to provide sufficient extinguishing agents and discharge time for the hazard to be protected. Because a spraying-space fire would involve ordinary combustibles as well as flammable/combustible liquids and dusts, the selection of a fire extinguisher will include Class A and B ratings.

Section 906 and NFPA 10 require no less than a 4-A:40-B:C extinguisher when the maximum travel distance to the extinguisher does not exceed 30 feet (9144 mm). A 4-A:40-B:C extinguisher is also acceptable when the maximum travel distance does not exceed 50 feet (15 240 mm) (see Commentary Figure 2404.4.1). Employees who are expected to fight incipient fires should receive instruction in the operation of the installed fire protection equipment.



**2404.5 Housekeeping, maintenance and storage of hazardous materials.** Housekeeping, maintenance, storage and use of hazardous materials shall be in accordance with Sections 2403.3, 2403.4, 2404.5.1 and 2404.5.2.

❖ This section establishes the applicability of the requirements of Sections 2403.3, 2403.4, 2404.5.1 and 2404.5.2 for controlling hazards associated with housekeeping, maintenance and the storage of hazardous materials.

**2404.5.1 Different coatings.** Spray booths, spray rooms and spraying spaces shall not be alternately utilized for different types of coating materials where the combination of materials is conducive to spontaneous ignition, unless all deposits of one material are removed from the booth, room or space and exhaust ducts prior to spraying with a different material.

❖ Spray operations involving potentially reactive coating materials must be confined to separate spray booths or purged after use. Using the same spray booth for separate operations involving materials that react with each other may produce a reaction

between the overspray residues of such materials once they are captured by the filters. Therefore, the entire system, including the ducts/filters, must be purged.

Spontaneous ignition, also known as autoignition or self-ignition, is defined by Burklin and Purington as “ignition due to chemical reaction or bacterial action in which there is slow oxidation of organic compounds until the material ignites; usually there is sufficient air for oxidation but insufficient ventilation to carry heat away as it is generated.” A detailed treatment of the subject appears in the NFPA *Fire Protection Handbook*.

The One Meridian Plaza office building fire in 1991 was allegedly started by the spontaneous ignition of oil-soaked rags that were improperly stored during a remodeling operation. This high-rise building in the heart of Philadelphia, Pennsylvania, was so seriously damaged in the fire that it was razed in 1999. A listed container for the storage of the oily rags as required by Section 2403.4.3 (see commentary, Section 2403.4.3) was not used. The fire code official should determine the kinds of oils or solvents used and research their potential for spontaneous ignition (see commentary, Section 304.3.2).

**2404.5.2 Protection of sprinklers.** Automatic sprinklers installed in flammable vapor areas shall be protected from the accumulation of residue from spraying operations in an *approved* manner. Bags used as a protective covering shall be 0.003-inch-thick (0.076 mm) polyethylene or cellophane or shall be thin paper. Automatic sprinklers contaminated by overspray particles shall be replaced with new automatic sprinklers.

❖ Automatic sprinkler heads must be protected from accumulations of spray residue to reduce the likelihood of residue build-up, which could insulate the fusible element and lead to failure of the head to respond in a timely manner in case of fire. Protective lightweight paper or plastic bags is allowed to be installed over sprinkler heads but must be replaced at regular intervals or when they become heavily coated. A regular inspection of the sprinkler heads in flammable-vapor areas should be undertaken by spray process operators to identify and replace any sprinklers that may have become coated with residue.

**2404.6 Sources of ignition.** Control of sources of ignition shall be in accordance with Section 2403.2 and Sections 2404.6.1 through 2404.6.2.4.

❖ This section establishes the applicability of the requirements of Sections 2403.2, 2404.6.1 and 2404.6.2.4 for controlling ignition hazards.

**2404.6.1 Drying operations.** Spray booths and spray rooms shall not be alternately used for the purpose of drying by arrangements or methods that could cause an increase in the surface temperature of the spray booth or spray room except in accordance with Sections 2404.6.1.1 and 2404.6.1.2. Except as specifically provided in this section, drying or baking units utilizing a heating system having open flames or

that are capable of producing sparks shall not be installed in a flammable vapor areas.

❖ Drying apparatus that causes significant heating of the workpiece or spray-booth surface may ignite finishing vapors or overspray residue located inside the spray booth. Separate drying apparatus or enclosures free of overspray residue should be installed when a drying apparatus is used.

Introduction of additional sources of ignition, including drying and baking units that do not meet the requirements of Section 2404.6.1.2, is not permitted in spraying areas.

**2404.6.1.1 Spraying procedure.** The spraying procedure shall use low-volume spray application.

❖ This section would apply only to smaller applications/processes where smaller amounts of flammable finishes are used. This is intended for spray booths and spray rooms that are used only occasionally for spraying and drying operations.

**2404.6.1.2 Drying apparatus.** Fixed drying apparatus shall comply with this chapter and the applicable provisions of Chapter 30. When recirculation ventilation is provided in accordance with Section 2404.7.2, the heating system shall not be within the recirculation air path.

❖ The practice of drying finished work pieces in the same enclosure where spray finishing is in progress is common in the automobile refinishing industry. This practice must be confined to spray-finishing enclosures designed for this purpose in compliance with the requirements of this section. Although the recirculated air should not be flammable (less than 25-percent LFL or dust residue is removed) as required by Section 2404.7.2, the heating system should be positioned to avoid possible ignition as a result of any malfunctions or unforeseen incidents.

Although this section appears to require fixed drying apparatus, the section is intended to require both fixed and portable infrared apparatus. This is further evident in Section 2404.6.1.2.2, in which the additional requirements for portable infrared apparatus are given.

**2404.6.1.2.1 Interlocks.** The spraying apparatus, drying apparatus and ventilating system for the spray booth or spray room shall be equipped with interlocks arranged to accomplish all of the following:

1. Prevent operation of the spraying apparatus while drying operations are in progress.
2. Where the drying apparatus is located in the spray booth or spray room, prevent operation of the drying apparatus until a timed purge of spray vapors from the spray booth or spray room is complete. This purge time shall be based upon completing at least four air changes of spray booth or spray room volume or for a period of not less than 3 minutes, whichever is greater.
3. Have the ventilating system maintain a safe atmosphere within the spray booth or spray room during the drying

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process and automatically shut off drying apparatus in the event of a failure of the ventilating system.

4. Shut off the drying apparatus automatically if the air temperature within the booth exceeds 200°F (93°C).
- ❖ This section prescribes requirements for the safe use of infrared drying units in spray-finishing enclosures used for automobile refinishing and other similar applications. The interlocks listed in this section are required to reduce the likelihood that a potential source of ignition (drying apparatus) and the fuel (flammable vapors) are not present in the spray booth or spray room simultaneously. Also, the hazard of the ease with which heated flammable vapors are ignited is further mitigated by controlling the temperature of the room. Without these features, and the greater of four air changes or a 3-minute purge for the spraying space, right conditions for ignition of vapors or residue could easily develop.

**2404.6.1.2.2 Portable infrared apparatus.** Where a portable infrared drying apparatus is used, electrical wiring and portable infrared drying equipment shall comply with NFPA 70. Electrical equipment located within 18 inches (457 mm) of floor level shall be *approved* for Class I, Division 2 hazardous locations. Metallic parts of drying apparatus shall be electrically bonded and grounded. During spraying operations, portable drying apparatus and electrical connections and wiring thereto shall not be located within spray booths, spray rooms or other areas where spray residue would be deposited thereon.

- ❖ In addition to the drying apparatus requirements stated throughout Section 2404.6.1, portable infrared apparatus is required to meet the provisions of this section. These requirements, such as bonding and grounding of apparatus, are intended to prevent the ignition of vapors in the transport of the apparatus.

**2404.6.2 Illumination.** Where spraying spaces, spray rooms or spray booths are illuminated through glass panels or other transparent materials, only fixed luminaires shall be utilized as a source of illumination.

- ❖ Fixed lighting units (luminaires) can be designed to minimize the possibility of ignition caused by the accidental heating of vapors above their autoignition temperature. Radiant heat from the source of illumination on the flammable finishes may cause ignition.

**2404.6.2.1 Glass panels.** Panels for luminaires or for observation shall be of heat-treated glass, wired glass or hammered wire glass and shall be sealed to confine vapors, mists, residues, dusts and deposits to the flammable vapor area. Panels for luminaires shall be separated from the luminaire to prevent the surface temperature of the panel from exceeding 200°F (93°C).

- ❖ The surface of incandescent bulbs, halogen lamps and other light fixtures (luminaires) often exceeds the ignition temperature of common flammable and combustible liquids. Separation of light fixtures (luminaires) from the glazing will help reduce the surface temperature on the unexposed side of the glass.

Glass panels must be designed, arranged and protected to ease cleaning and prevent breakage.

**2404.6.2.2 Exterior luminaires.** Luminaires attached to the walls or ceilings of a flammable vapor area, but outside of any classified area and separated from the flammable vapor areas by vapor-tight glass panels, shall be suitable for use in ordinary hazard locations. Such luminaires shall be serviced from outside the flammable vapor areas.

- ❖ Safety features, such as ventilation and separation using vapor-tight glass panels, allow for the use of ordinary light fixtures (luminaires) that are not electrically classified for hazardous locations. To maintain the integrity of the separation (that is, vapor-tight glass panels and installation outside of the classified area), these light fixtures (luminaires) must be serviced from outside the spraying area.

**2404.6.2.3 Integral luminaires.** Luminaires that are an integral part of the walls or ceiling of a flammable vapor area are allowed to be separated from the flammable vapor area by glass panels that are an integral part of the luminaire. Such luminaires shall be *listed* for use in Class I, Division 2 or Class II, Division 2 locations, whichever is applicable, and also shall be suitable for accumulations of deposits of combustible residues. Such luminaires are allowed to be serviced from inside the flammable vapor area.

- ❖ Light fixtures (luminaires) with construction that includes a glass panel for separation and that are installed within the construction of the wall or ceiling flammable-vapor area must be Class I, Division 2 because flammable vapors are present. Class II, Division 2 light fixtures are required where combustible residue, such as dust, is present.

**2404.6.2.4 Portable electric lamps.** Portable electric lamps shall not be used in flammable vapor areas during spraying operations. Portable electric lamps used during cleaning or repairing operations shall be of a type *approved* for hazardous locations.

- ❖ Portable electric lamps are unsuitable for use in spraying spaces during spraying operations due to their increased exposure to dropping and other use-related damage. Portable electric lamps vary in type and electrical classification. It would be a difficult judgment call for an operator to determine the appropriate type and location of a portable lamp in spraying spaces. Although portable electric lamps, if approved for hazardous locations, are allowed to be utilized during cleaning or repairing operations, they should be avoided if possible.

**2404.7 Ventilation.** Mechanical ventilation of flammable vapor areas shall be provided in accordance with Section 502.7 of the *International Mechanical Code*.

- ❖ Flammable-vapor areas, as defined in Section 202, include, but are not limited to, the interior of spray booths and spray rooms. The proper design and installation of exhaust ventilation systems in spraying spaces is critical because of the potential production of large amounts of flammable vapors in the processes.

Exhaust systems in spray-finishing areas must also comply with IMC Section 502.7, which regulates hazardous exhaust systems. Additionally, because IMC Section 502.7.3 is identical to this section, compliance with the general section of IMC Section 502, especially Section 502.1.1 (“...the inlet to an exhaust system shall be located in the area of heaviest concentration of contaminants...”), is recommended. The location of heaviest concentration resulting from the physical characteristics of a material (for example, vapor density) or the process (such as atomization of the material) must be considered when inlets to exhaust systems are designed.

**2404.7.1 Operation.** Mechanical ventilation shall be kept in operation at all times while spraying operations are being conducted and for a sufficient time thereafter to allow vapors from drying coated articles and finishing material residue to be exhausted. Spraying equipment shall be interlocked with the ventilation of the flammable vapor areas such that spraying operations cannot be conducted unless the ventilation system is in operation.

❖ Ventilation must be functioning during the spraying operation phase and the drying phase of a process when vapors are generated. The interlock between the ventilation and spraying equipment will reduce the likelihood of human error, such as operator failure to activate the ventilation system prior to the use of the spray equipment. Operating spray equipment without having the exhaust system in operation could allow fugitive flammable vapors to migrate to areas that may contain unprotected ignition sources and ignite. Continuous operation of ventilation systems could also be an integral component of the design of certain alternative fire-extinguishing systems, such as dry chemical systems. Note that this section parallels Section 502.7.3.1 of the IMC.

**2404.7.2 Recirculation.** Air exhausted from spraying operations shall not be recirculated.

**Exceptions:**

1. Air exhausted from spraying operations is allowed to be recirculated as makeup air for unmanned spray operations, provided that all of the following conditions exist:
  - 1.1. The solid particulate has been removed.
  - 1.2. The vapor concentration is less than 25 percent of the LFL.
  - 1.3. *Approved* equipment is used to monitor the vapor concentration.
  - 1.4. When the vapor concentration exceeds 25 percent of the LFL, both of the following shall occur:
    - a. An alarm shall sound.
    - b. Spray operations shall automatically shut down.
  - 1.5. In the event of shutdown of the vapor concentration monitor, 100 percent of the air

volume specified in Section 510 of the *International Mechanical Code* is automatically exhausted.

2. Air exhausted from spraying operations is allowed to be recirculated as makeup air to manned spraying operations where all of the conditions provided in Exception 1 are included in the installation and documents have been prepared to show that the installation does not pose a life safety hazard to personnel inside the spray booth, spraying space or spray room.

❖ The prohibition of recirculation in this section and in IMC Section 502.7.3.2 is specifically directed to the concern that exhaust system makeup air does not add to the fire hazard of the spraying space. The exceptions are fairly specific and focus on the LFL and the monitoring of that limit. The exceptions are based on the environmental community’s concerns about the volume of emissions generated by spray finishing. The permissible exposure limit (PEL) is generally more restrictive than the LFL.

The recirculation of exhausted air containing flammable vapors could help spread the hazard of flash fires from the area of vapor generation to other parts of the building. At best, it would adversely affect only the area of vapor generation in that it could render the exhaust ventilation useless. It may also give the operators of the facility a false sense that the level of ventilation is safe for the system.

Exception 1 lists five conditions that must be met for the recirculation of exhausted air in unmanned spray operations. If solid particulates (dusts) are removed from the exhausted air, the exhausted air is no longer considered a fire hazard because the potential for a dust explosion is eliminated. Flammable vapors are defined in Section 202 as “flammable constituents in air that exceed 25 percent of the LFL.” By reducing the flammable vapor concentrations to less than 25 percent of the LFL, the exhausted air is no longer considered a flammable vapor. To increase the likelihood that the concentrations remain at less than 25 percent of the LFL, flammable vapor detection systems must automatically shut down the operations, set off an alarm and exhaust 100 percent of the air. This would allow for energy conservation in unmanned operations, without compromising the safety features typically associated with such ventilation systems. Exception 2 is applicable to manned operations where additional documentation is needed to reduce the risk to personnel, such as people operating the spray equipment, from an injury or life safety standpoint. This documentation may include a risk analysis of fire and health hazards associated with the operation of this equipment when some portion of the exhausted air is recirculated.

In general, fire safety efforts have received some assistance from the environmental regulations that have placed restrictions on the amount of volatile organic compounds (VOCs) emitted to the atmo-

sphere. This in turn limits the types of materials used and lowers the flammability characteristics through the use of less volatile liquids.

**2404.7.3 Air velocity.** The ventilation system shall be designed, installed and maintained so that the flammable contaminants are diluted in noncontaminated air to maintain concentrations in the exhaust airflow below 25 percent of the contaminant’s lower flammable limit (LFL). In addition, the spray booth shall be provided with mechanical ventilation so that the average air velocity through openings is in accordance with Sections 2404.7.3.1 and 2404.7.3.2.

❖ This section contains performance-based criteria to quantify the amount of exhaust in relation to the control of the contaminant source. In other words, a direct solution is to restrict the concentration of all known contaminants of concern to a specified and acceptable level. That “level” is below 25 percent of the LFL for a particular contaminant. Where the concentration of a flammable contaminant in air is maintained below 25 percent of the LFL for that contaminant, there is insufficient fuel vapor in the gas phase to sustain homogeneous ignition. Managing the contaminant(s) in a diluted state means there is less chance of catastrophic flame propagation, ignition or explosion. The quantity or volume of exhaust required is source specific.

**2404.7.3.1 Open-face or open-front spray booth.** For spray application operations conducted in an open-face or open-front spray booth, the ventilation system shall be designed, installed and maintained so that the average air velocity into the spray booth through all openings is not less than 100 feet per minute (0.51 m/s).

**Exception:** For fixed or automated electrostatic spray application equipment, the average air velocity into the spray booth through all openings shall be not less than 50 feet per minute (0.25 m/s).

❖ To help keep flammable vapors in a designated spraying space and limit the amount of overspray, the code requires that the exhaust system be adequately sized to maintain an average velocity over the open face of the booth or booth cross section of no less than 100 feet per minute (0.51 m/s), which is the minimum velocity to capture particulate spray material. To determine the minimum ventilation/exhaust capacity in cubic feet per minute [cfm (m<sup>3</sup>/s)], multiply the booth width [feet (mm)] by booth height [feet (mm)] by 100 [linear feet per minute (m/s)].

In electrostatic spray application, paint, in the form of either powdered particles or atomized liquid, is initially projected toward a conductive workpiece using normal spraying methods, and is then accelerated toward the workpiece by a powerful electrostatic charge. This process is much more efficient than ordinary spray finishing, using 95 percent of sprayed paint, thus reducing overspray. The exception recognizes this efficiency by allowing the air velocity across

openings to be one-half of that required for ordinary spraying. See the commentary to Section 2407 for further discussion of electrostatic apparatus.

**2404.7.3.2 Enclosed spray booth or spray room with openings for product conveyance.** For spray application operations conducted in an enclosed spray booth or spray room with openings for product conveyance, the ventilation system shall be designed, installed and maintained so that the average air velocity into the spray booth through openings is not less than 100 feet per minute (0.51 m/s).

**Exceptions:**

1. For fixed or automated electrostatic spray application equipment, the average air velocity into the spray booth through all openings shall be not less than 50 feet per minute (0.25 m/s).
2. Where methods are used to reduce cross drafts that can draw vapors and overspray through openings from the spray booth or spray room, the average air velocity into the spray booth or spray room shall be that necessary to capture and confine vapors and overspray to the spray booth or spray room.

❖ To help keep flammable vapors in a designated spraying space and limit the amount of overspray, the code requires that the exhaust system be adequately sized to maintain an average velocity through the openings in the booth of no less than 100 feet per minute (0.51 m/s), which is the minimum velocity to capture particulate spray material.

In electrostatic spray application, paint, in the form of either powdered particles or atomized liquid, is initially projected toward a conductive workpiece using normal spraying methods and is then accelerated toward the workpiece by a powerful electrostatic charge. This process is much more efficient than ordinary spray finishing, using 95 percent of sprayed paint, thus reducing overspray. Exception 1 recognizes this efficiency by allowing the air velocity across openings to be one-half of that required for ordinary spraying.

Competing airflows (cross drafts) in a space in which a spraying operation is located can cause a “reverse air flow” that can draw vapors or overspray out of the spray booth or spray room. Exception 2 provides a performance-oriented exhaust air velocity option where the effect of such cross drafts is reduced or eliminated.

**2404.7.4 Ventilation obstruction.** Articles being sprayed shall be positioned in a manner that does not obstruct collection of overspray.

❖ When ventilation systems for spray operations are designed and installed, the configuration and position of the object being sprayed must be considered because it might disrupt the ventilation pattern in both cross-draft and down-draft ventilation spray booths, thereby compromising the effectiveness of the ventilation system.

**2404.7.5 Independent ducts.** Each spray booth and spray room shall have an independent exhaust duct system discharging to the outside.

**Exceptions:**

1. Multiple spray booths having a combined frontal area of 18 square feet (1.67 m<sup>2</sup>) or less are allowed to have a common exhaust when identical spray finishing material is used in each booth. If more than one fan serves one booth, fans shall be interconnected such that all fans will operate simultaneously.
2. Where treatment of exhaust is necessary for air pollution control or for energy conservation, ducts shall be allowed to be manifolded if all of the following conditions are met:
  - 2.1. The sprayed materials used are compatible and will not react or cause ignition of the residue in the ducts.
  - 2.2. Nitrocellulose-based finishing material shall not be used.
  - 2.3. A filtering system shall be provided to reduce the amount of overspray carried into the duct manifold.
  - 2.4. Automatic sprinkler protection shall be provided at the junction of each booth exhaust with the manifold, in addition to the protection required by this chapter.

❖ This section requires independent duct exhaust of residue from spray-finishing operations. These ducts must be routed directly to the exterior of the building. Similar language is used in IMC Sections 502.7.3.5 and 510.4. Ducts may not penetrate fire-resistance-rated assemblies [see Commentary Figure 2404.7.5(1)].

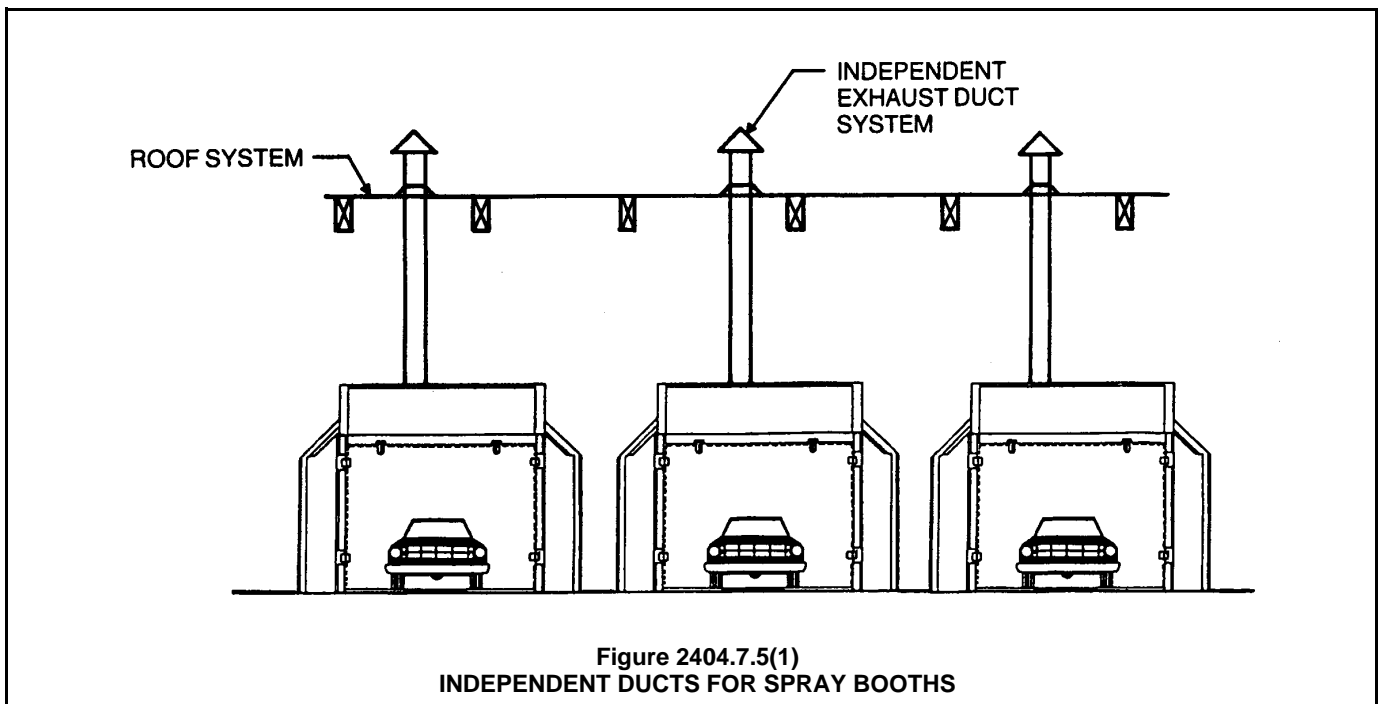
Exception 1 applies to very small spray booths where the vapor area is very small compared to the area of standard spray booths. Because these individual smaller spray booths are considered as one fire area from a ventilation standpoint, all identical materials are to be used when this exception applies. This will ensure that incompatible materials are not used in booths with a common exhaust system [see Commentary Figure 2404.7.5(2)].

Exception 2 notes that because the exhausted air is at times treated, it can be manifolded. However, special hazards must be avoided to ensure fire protection safety. Incompatible materials must be separated in case of a reaction within the ducts. A similar requirement is found in IMC Section 510.4. Nitrocellulose and nitrocellulose-based products are unstable materials that can easily be ignited, and once ignited, need large quantities of water for suppression. Additionally, nitrocellulose is incompatible with many materials (alkalis, amines, etc.). The cleaning products used in other booths may even ignite the nitrocellulose-based products in a manifolded exhaust system. Therefore, the exhaust of nitrocellulose-based products is considered an exception to this section. See the commentary to Chapter 65 for further information on the hazards of cellulose nitrate (pyroxylin) plastics.

Additional protection, such as filtering and sprinklers at the junction of spray booth exhaust, is also required.

**2404.7.6 Termination point.** The termination point for exhaust ducts discharging to the atmosphere shall be not less than the following distances:

1. Ducts conveying explosive or flammable vapors, fumes or dusts: 30 feet (9144 mm) from the lot line; 10 feet



**Figure 2404.7.5(1)**  
**INDEPENDENT DUCTS FOR SPRAY BOOTHS**

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(3048 mm) from openings into the building; 6 feet (1829 mm) from exterior walls and roofs; 30 feet (9144 mm) from combustible walls or openings into the building that are in the direction of the exhaust discharge; 10 feet (3048 mm) above adjoining grade.

2. Other product-conveying outlets: 10 feet (3048 mm) from the lot line; 3 feet (914 mm) from exterior walls and roofs; 10 feet (3048 mm) from openings into the building; 10 feet (3048 mm) above adjoining grade.

❖ This section details the requirements for safe outlets/termination points of exhaust ducts conveying spray-finish operation effluent. This section gives distances that must be maintained, depending on the type of exhaust, and is consistent with the requirement in IMC Section 501.2.1.

Item 1 details the requirements of safe outlets/termination points for exhaust ducts that convey explosive or flammable vapors, fumes or dusts like those exhaust systems that serve operations involving the application of flammable finishes. This section is intended to reduce the exposure from the dangerous vapors in the exhaust. This is done to:

1. Protect other parts of the building.
2. Protect other buildings.
3. Reduce a potential reaction from materials that may be incompatible.
4. Reduce the severity of a fire, in case of an ignition.

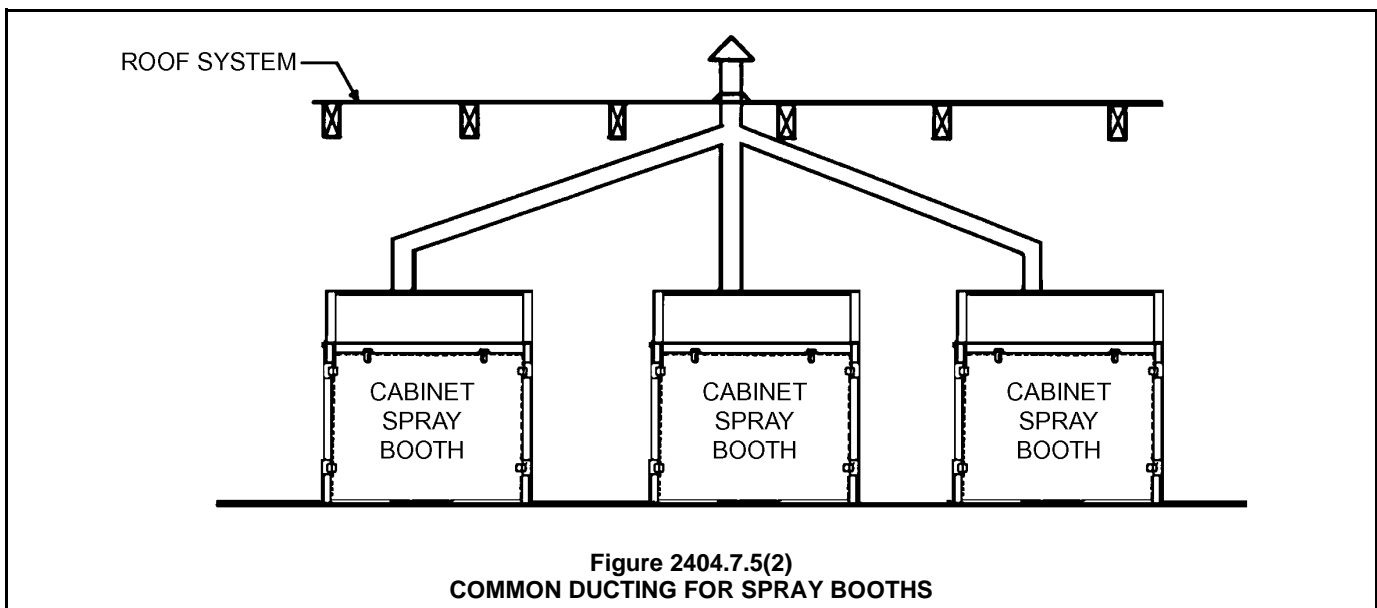
Vapors that are considered flammable and flammable finishes, including dusts, have more restrictive outlet/termination requirements than other vapors due to the potential for ignition. To avoid recirculation of flammable vapors, fumes or dusts back into the building, the duct must be designed and located to reduce such exposures. This may be achieved by physically separating the exhaust outlet

from openings in the building, walls and roof, where sources of ignition or incompatible materials may be present [see Commentary Figures 2404.7.6(1) and 2404.7.6(2)].

For health and safety reasons, hazardous exhaust cannot be directed onto adjacent property. Maintaining the required distance allows the hazardous contents of the exhaust to disperse into the atmosphere, thereby minimizing the exposure of an adjoining property to the potential ignition hazard of a burning ember or spark or the hazardous, noxious and objectionable odors emitted from such systems. Wind and wind-induced eddy currents can react with building structural surfaces to create air pressure zones that can diminish exhaust flow or redirect exhaust into nearby building openings, such as fresh air or combustion air intakes and operable windows.

Exhaust systems sometimes incorporate rotating hoods over the discharge opening to prevent high winds from restricting the flow of exhaust gases out of the system. The hoods align themselves with the direction of the wind to allow the unimpeded and sometimes induced discharge from the exhaust outlet. The termination height specified for combustible walls is more restrictive to allow the concentration of explosive or flammable constituents in the exhaust to diminish before landing or accumulating on a combustible wall. The fire code official must consider prevailing wind conditions in locating hazardous exhaust outlets with respect to other building openings.

Item 2 details provisions regarding safe outlets/termination points of other product-conveying ducts, such as those exhausting nonflammable and nonexplosive dusts and waste products. This item requires that the exhaust outlet be located well into the undisturbed wind stream and away from the cavity



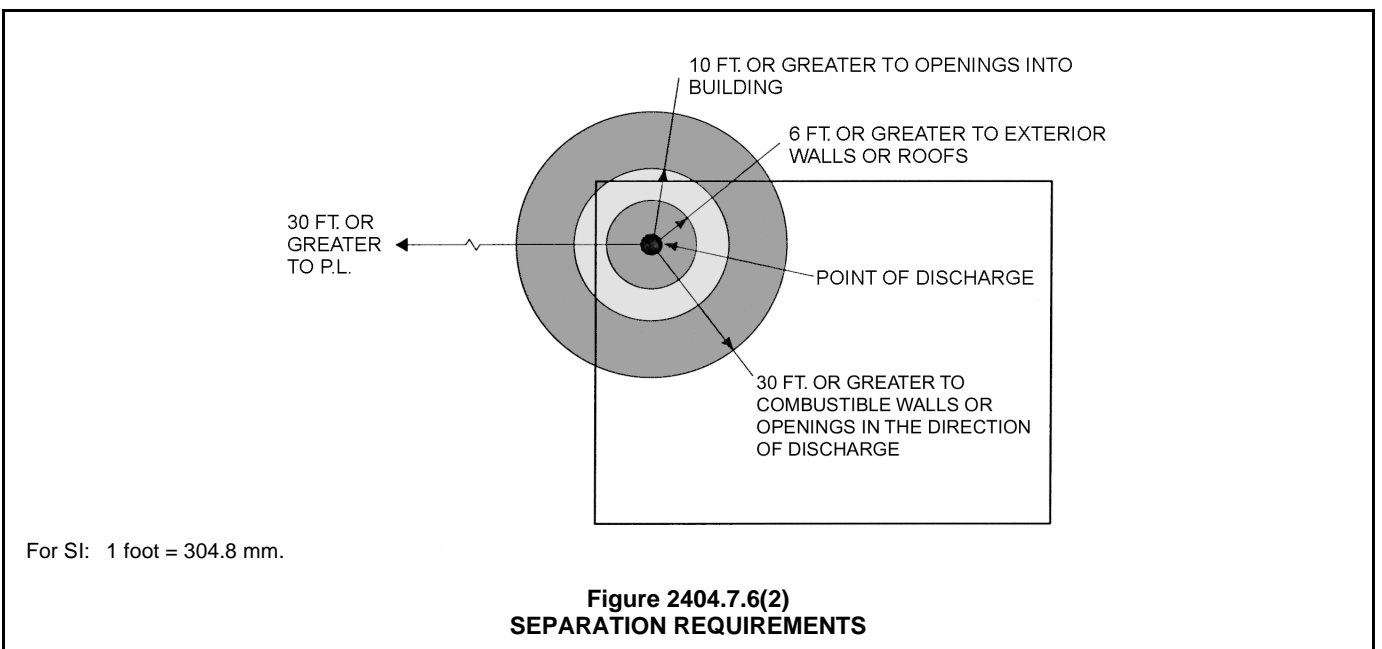
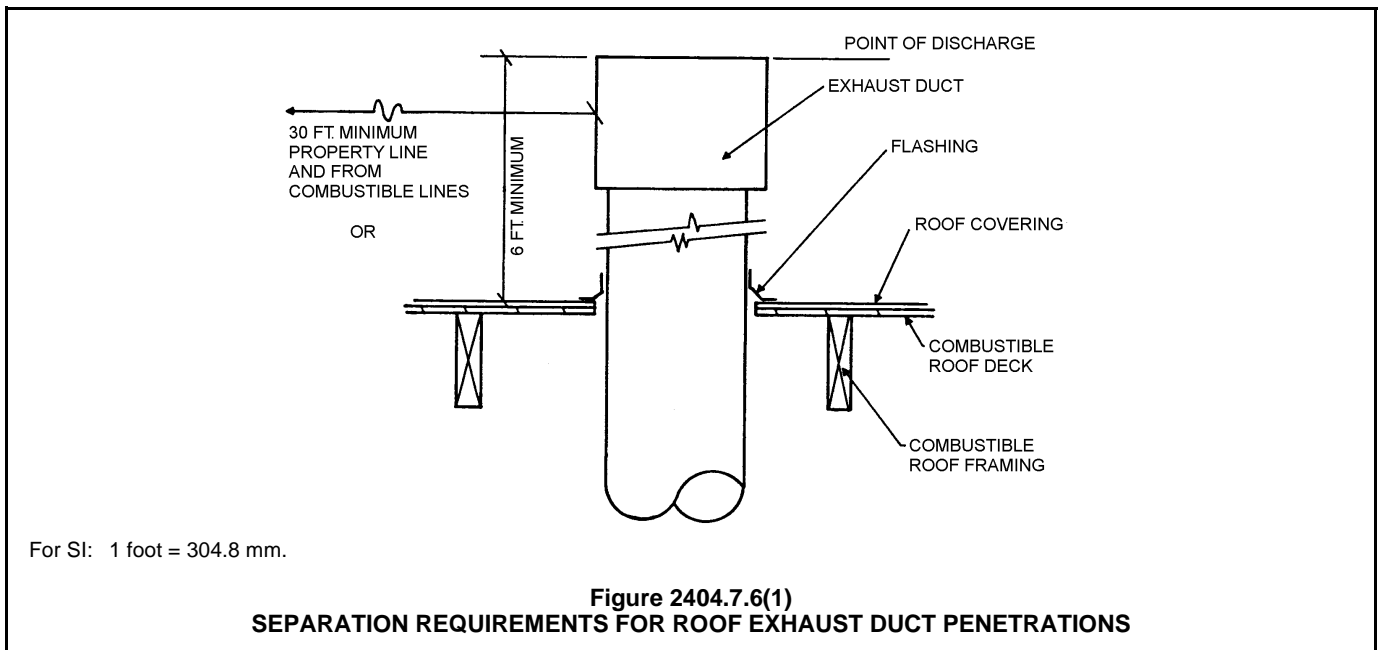
and wake (eddy) zones around the building. This counteracts the negative effects of wind-induced conditions and also prevents the reentry of exhaust products into the building through openings and fresh air intakes.

**2404.7.7 Fan motors and belts.** Electric motors driving exhaust fans shall not be placed inside booths or ducts. Fan rotating elements shall be nonferrous or nonsparking or the casing shall consist of, or be lined with, such material. Belts shall not enter the duct or booth unless the belt and pulley within the duct are tightly enclosed.

❖ This requirement in the ventilation section is intended to reduce sources of ignition from spark-producing

elements. This would increase the likelihood that overspray in the booth or duct cannot accumulate on the motor housing, which could ultimately cause the motor to overheat. Products that are subject to sparking should be avoided within spraying spaces. Belts that drive exhaust fans are not permitted in the spraying area unless the belts and pulleys are tightly enclosed to prevent solvents in exhaust air from degrading the belt materials and causing a failure of the ventilation system.

As mentioned in the commentary to Section 2403.4.1, the term “nonsparking” is somewhat inaccurate. Parts made of brass and similar “nonsparking” materials do produce sparks but with ignition



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energies too low to ignite flammable vapors. Nevertheless, such parts should be designed carefully to avoid producing sufficient frictional heat to cause an ignition.

**2404.7.8 Filters.** Air intake filters that are part of a wall or ceiling assembly shall be *listed* as Class I or II in accordance with UL 900. Exhaust filters shall be required.

❖ Spray-booth and ventilation system design should effectively enclose spray operations. To prevent exhausting contaminated vapors into the atmosphere and to prevent accumulation of overspray and residue on duct surfaces and at the duct discharge location, filters must be installed ahead of the exhaust ventilation systems from spraying spaces.

UL 900 requirements cover tests to determine combustibility and the amount of smoke generated for air filter units of both washable and throwaway types used for removal of dust and other air-borne particles from air circulated mechanically in equipment and systems. Because the combustibility and smoke generation of an air filter unit once used depends on the chemicals or materials it is impregnated with, the filter test requirements of UL 900 are for the clean condition only. See the commentary to IMC Section 605.2 for further discussion of UL 900 filters.

**2404.7.8.1 Supports.** Supports and holders for filters shall be constructed of noncombustible materials.

❖ This section is intended to minimize the combustible materials in a spray booth. The area near a filter that is used or partially used is very susceptible to ignition.

**2404.7.8.2 Attachment.** Overspray collection filters shall be readily removable and accessible for cleaning or replacement.

❖ Dry-type overspray collectors or filters of paper or fiberglass construction are more efficient than baffle plates. They are frequently used in spray booths containing moderate volumes of work. Replaceable flat or cartridge filters are intended to be discarded once they are significantly loaded with finish residue.

**2404.7.8.3 Maintaining air velocity.** Visible gauges, audible alarms or pressure-activated devices shall be installed to indicate or ensure that the required air velocity is maintained.

❖ Maintaining air velocities is critical in maintaining a safe environment outside the spraying space, as well as proper collection of flammable vapors and dusts within the spraying space. If air velocities that the exhaust system is designed for are not maintained, the spray booth operator must be made aware of this malfunction. To reduce the possibility of a fire or injury caused by human error, an automatic shut-down of the system is recommended when the designed air velocities are not maintained.

**2404.7.8.4 Filter rolls.** Spray booths equipped with a filter roll that is automatically advanced when the air velocity is reduced to less than 100 feet per minute (0.51 m/s) shall be

arranged to shut down the spraying operation if the filter roll fails to advance automatically.

❖ In the case of roll-type filters, fresh filter material is advanced into the air stream when the air velocity is reduced to less than 100 feet per minute (0.51 m/s). The impregnated filter is wound on a take-up reel. When the entire filter roll is consumed, it is discarded and replaced with a fresh roll of filter material. Shutting down the spray booth when the filter cannot automatically advance (either because of system failure or the need for cartridge replacement) ensures that the operator of the spray booth does not fail in his or her task of replacing the filter.

**2404.7.8.5 Filter disposal.** Discarded filter pads shall be immediately removed to a safe, detached location or placed in a noncombustible container with a tight-fitting lid and disposed of properly.

❖ To reduce the possibility of ignition, filters should be disposed of in approved metal containers with tight-fitting, self-closing lids. Waste containers should be removed from the building when full and at the end of each work shift. See also the commentary to Section 2403.4.3 for further discussion of waste disposal.

**2404.7.8.6 Spontaneous ignition.** Spray booths using dry filters shall not be used for spraying materials that are highly susceptible to spontaneous heating and ignition. Filters shall be changed prior to spraying materials that could react with other materials previously collected. An example of a potentially reactive combination includes lacquer when combined with varnishes, stains or primers.

❖ Ventilation system filters must be noncombustible. Once fouled with paint or coating residue, the filters become highly combustible. Moreover, they are more susceptible to spontaneous heating. Dry-type overspray collectors or filters of paper or fiberglass construction are more efficient than baffle plates and are frequently used in spray booths containing moderate volumes of work. Replaceable flat or cartridge filters are intended to be discarded once they are significantly loaded with finish residue. See also the commentary to Section 2404.5.1 for further discussion of spontaneous ignition.

**2404.7.8.7 Waterwash spray booths.** Waterwash spray booths shall be of an *approved* design so as to prevent excessive accumulation of deposits in ducts and residue at duct outlets. Such booths shall be arranged so that air and overspray are drawn through a continuously flowing water curtain before entering an exhaust duct to the building exterior.

❖ Waterwash booths are typically used for high-volume paint and lacquer usage. Many paints and lacquers are susceptible to spontaneous heating and combustion when left in a poorly ventilated or enclosed area. Materials containing linseed oil are especially prone to this type of reaction. Spray-finishing operations involving these materials should be confined to waterwash booths when possible because water is used as the filtration medium instead of dry filters.

**2404.8 Interlocks.** Interlocks for spray application finishes shall be in accordance with Sections 2404.8.1 through 2404.8.2.

- ❖ This section establishes the applicability of the requirements of Sections 2404.8.1 and 2404.8.2 for controlling hazards of spraying operations through the installation of system interlocks.

**2404.8.1 Automated spray application operations.** Where protecting automated spray application operations, automatic fire-extinguishing systems shall be equipped with an *approved* interlock feature that will, upon discharge of the system, automatically stop the spraying operations and workpiece conveyors into and out of the flammable vapor areas. Where the building is equipped with a fire alarm system, discharge of the automatic fire-extinguishing system shall also activate the building alarm notification appliances.

- ❖ An interlock is a practical solution to avoid a fire situation in which the automated system would allow for a “moving fire” as the pieces within the automated assembly move through the spraying space. The interlock would stop the spray application, which would further contribute to the flammable fuel/vapors, and prevent a moving fire from spreading faster and farther than expected. This is especially significant in larger conveyor and multiple spraying-space/spray-booth systems, where fire could spread quickly beyond the designed sprinkler area. The interlock between the suppression system and the alarm system would notify the occupants of a building to evacuate.

**2404.8.1.1 Alarm station.** A manual fire alarm and emergency system shutdown station shall be installed to serve each flammable vapor area. When activated, the station shall accomplish the functions indicated in Section 2404.8.1.

- ❖ In case the operator of a spraying area becomes aware of a fire prior to the actuation of the extinguishing system, or in case there is an emergency not related to a fire where there is a risk to the occupants of the building, a manual fire alarm station is needed. The manual station is to provide the same functions as the automated interlock in Section 2404.8.1, such as stopping the spread of fire and activating occupant notification. Because areas near the spraying space are dangerous, to reduce the risk of injury to an operator who may be attempting to activate the manual alarm, an additional alarm is required adjacent to an exit for the operator to activate while exiting from a hazardous situation.

**2404.8.1.2 Alarm station location.** Not less than one manual fire alarm and emergency system shutdown station shall be readily accessible to operating personnel. Where access to this station is likely to involve exposure to danger, an additional station shall be located adjacent to an *exit* from the area.

- ❖ Manual fire alarm and emergency system shutdown stations, in order to be effective, must be located

within easy reach of spray operation personnel who might be working in the area. The term “readily accessible” can be described as the capability of being quickly reached or approached for the purpose of operation. Ready access means that there are no physical obstructions and that there is no change in elevation to reach the required object or location.

When access to required manual fire alarm and emergency system shutdown stations could be compromised by a flash fire or equipment malfunction, an additional station must be installed near [within 5 feet (1524 mm)] an exit door from the area so that at least one station is available in the path of egress to transmit an alarm in a timely manner. This location also encourages the actuation of the manual fire alarm and emergency system on the fire floor prior to entering the stairway or exiting the building, resulting in the alarm being received from the actual fire floor and not another floor along the path of egress. The installation criteria contained in Section 907.4 for manual fire alarm boxes are applicable to such stations since part of their function is as a fire alarm pull station.

**2404.8.2 Ventilation interlock prohibited.** Air makeup and flammable vapor area exhaust systems shall not be interlocked with the fire alarm system and shall remain in operation during a fire alarm condition.

**Exception:** Where the type of fire-extinguishing system used requires such ventilation to be discontinued, air makeup and exhaust systems shall shut down and dampers shall close.

- ❖ Exhaust ventilation of flammable vapors and smoke during a fire may help reduce the fire severity and increase visibility. Therefore, an interlock system to shut down the spray operations during a fire should not include the safety systems, such as ventilation. In an emergency, the success of the fire-extinguishing system takes precedence over the function of the ventilation system. Therefore, if the ventilation system in any way compromises the fire-extinguishing system, the exception allows these systems to be interlocked to shut down in the event of a fire. Examples of systems that may be compromised if the ventilation system is on are many of the extinguishing systems that are not water based, such as carbon dioxide, halogenated agent, clean agent, etc.

**2404.9 Limited spraying spaces.** Limited spraying spaces shall comply with Sections 2404.9.1 through 2404.9.4.

- ❖ Limited spraying spaces are to accommodate uses that are limited in their frequency and amounts of hazardous materials used. As mentioned previously, this operation is intended more for small touch-up work found in a maintenance shop.

**2404.9.1 Job size.** The aggregate surface area to be sprayed shall not exceed 9 square feet (0.84 m<sup>2</sup>).

- ❖ Limiting the workpiece size limits the amount of flammable vapors that are produced in such an area. This

is again to accommodate small incidental-type spraying processes found in typical manufacturing or mercantile occupancies.

**2404.9.2 Frequency.** Spraying operations shall not be of a continuous nature.

❖ As mentioned previously, the limited spraying setup is to accommodate small incidental-type processes. If the processes are continuous, a spray booth, spray room or spraying space must be used whose requirements are more stringent and are better regulated from a fire prevention and fire protection standpoint.

**2404.9.3 Ventilation.** Positive mechanical ventilation providing a minimum of six complete air changes per hour shall be installed. Such system shall meet the requirements of this code for handling flammable vapor areas. Explosion venting is not required.

❖ Six air changes per hour is the requirement for limited spraying areas; however, if the quantity of hazardous material in the room or control area in which the limited spraying space is located exceeds the MAQ for hazardous materials given in Chapter 50 or 57, both exhaust ventilation requirements in those chapters for flammable vapors and the requirement in this section have to be met. A typical example would be a plating shop where allowable quantities of corrosives and toxics are exceeded (Group H-4) and where the exhaust ventilation at a rate of 1 cfm per square foot [0.00508 m<sup>3</sup>/(s • m<sup>2</sup>)] of floor area is required. If a limited spraying space is located in such a room, the most restrictive requirement has to be met; that is, the greater of 1 cfm per square foot [0.00508 m<sup>3</sup>/(s • m<sup>2</sup>)] or six air changes per hour. The vapor density of the material should be taken into account (whether vapors are heavier or lighter than air) when considering the location of exhaust inlets. Additionally, because IMC Section 502.7.2 is identical to this section, conformance to the general requirements of IMC Section 502, especially Section 502.1.1 (the inlet to an exhaust system shall be located in the area of heaviest concentration of contaminants), is recommended.

**2404.9.4 Electrical wiring.** Electrical wiring within 10 feet (3048 mm) of the floor and 20 feet (6096 mm) horizontally of the limited spraying space shall be designed for Class I, Division 2 locations in accordance with NFPA 70.

❖ Processes in limited spraying spaces may still result in some vapor generation. Because they are generally heavier than air, vapors in spray processes typically accumulate near the floor. These vapors may travel long distances undetected before causing a flash fire. To limit the ignition sources, wiring must be installed to meet Class I, Division 2 requirements within 10 feet (3048 mm) of the floor and 20 feet (6096 mm) horizontally.

## SECTION 2405 DIPPING OPERATIONS

**2405.1 General.** Dip-tank operations shall comply with the requirements of Section 2403 and Sections 2405.2 through 2405.11.

❖ This section establishes the applicability of the requirements of Sections 2403 and 2405 for controlling hazards associated with dip tanks and dipping operations.

**2405.2 Location of dip-tank operations.** Dip-tank operations conducted in buildings used for Group A, I or R occupancies shall be located in a room designed for that purpose, equipped with an *approved automatic sprinkler system* and separated vertically and horizontally from other areas in accordance with the *International Building Code*.

❖ Separation and protection from hazards of other portions of a building housing the occupancy groups listed in this section are critical for several reasons. Dipping and coating processes are too hazardous to be conducted in occupancies with a high life or property exposure. The number of occupants in such buildings and their physical conditions vary. People exposed to the danger of a fire involving dip-tank operations must be able to evacuate or protect themselves promptly and effectively to avoid the risk of serious injury or death. Also, the behavior psychology of people in a Group A, I or R occupancy is very different from those in a Group F manufacturing occupancy. A person walking in a manufacturing facility where dipping operations/processes take place in a large area where the dip tanks and signs are in plain view is more aware of the physical dangers associated with these processes than someone in a Group R occupancy, who would more likely be relaxing and thinking of things other than physical hazards.

The protection designed into these occupancies is, in many cases, less than would be found in manufacturing occupancies. Separation and protection in the form of fire-resistance-rated construction and automatic fire suppression must be provided where dipping operations must be conducted in the same building. Fire barriers, horizontal assemblies or both having a fire-resistance rating of 3 hours are required between Group F-1 and A, or I and R occupancies. Except for Group I-2, this requirement can be reduced in a sprinklered building by 1 hour. If the amounts of hazardous materials exceed the MAQ listed in Chapter 50, the occupancy separation between Group H and A, or I and R occupancies varies depending on what material(s) is involved (see IBC Section 508).

**2405.3 Construction of dip tanks.** Dip tanks shall be constructed in accordance with Sections 2405.3.1 through 2405.3.4.3 and NFPA 34. Dip tanks, including drain boards, shall be constructed of noncombustible material and their

supports shall be of heavy metal, reinforced concrete or masonry.

- ❖ The selection of materials and design of dipping and coating processes must consider the physical properties of the liquid and the processing environment. The corrosivity, density, viscosity, vapor pressure and flash point of the liquid influences the selection of materials and arrangement of processing equipment. Additionally, mechanical hazards, such as impacts and collisions involving conveyor equipment, should be considered. Protected steel or concrete tank supports reduce the likelihood of a collapse in the event of a fire caused by a spill or release. The figure accompanying the definition of “Dip tank” in Chapter 2 shows the arrangement of a typical dip tank, including overflow and emergency release drains.

**2405.3.1 Overflow.** Dip tanks greater than 150 gallons (568 L) in capacity or 10 square feet (0.93 m<sup>2</sup>) in liquid surface area shall be equipped with a trapped overflow pipe leading to an *approved* location outside the building. The bottom of the overflow connection shall be not less than 6 inches (152 mm) below the top of the tank.

- ❖ An overflow drain is required for tanks with capacities greater than 150 gallons (568 L) or having a surface area greater than 10 square feet (0.93 m<sup>2</sup>) to confine spills or uncontrolled releases caused by overflowing or overflowing when parts are immersed. The capacity of overflow drains should exceed the capacity of the tank and discharge through an approved trap and separator or to an approved salvage tank.

**2405.3.2 Bottom drains.** Dip tanks greater than 500 gallons (1893 L) in liquid capacity shall be equipped with bottom drains that are arranged to automatically and manually drain the tank quickly in the event of a fire unless the viscosity of the liquid at normal atmospheric temperature makes this impractical. Manual operation shall be from a safe, accessible location. Where gravity flow is not practicable, automatic pumps shall be provided. Such drains shall be trapped and discharged to a closed, vented salvage tank or to an *approved* outside location.

**Exception:** Dip tanks containing Class IIIB *combustible liquids* where the liquids are not heated above room temperature and the process area is protected by automatic sprinklers.

- ❖ Emergency release drains permit flammable liquids in dip tanks to be safely discharged if a fire occurs. A trap between the drain opening and the separator or salvage tank reduces the likelihood that the fire will flash back into the tank. The arrangement of emergency release drains must permit both automatic and manual operation. Moreover, viscous liquids are exempt from these requirements. These liquids, however, generally have higher flash points and are more difficult to ignite than other, less viscous materials. If a highly viscous combustible liquid is heated for use as a coating material, having a drain remains a good practice. If installed, the drain should be sized for the volume and viscosity of the liquid under normal usage

conditions. When practical, tanks should be arranged to drain by gravity. Pumps must be used if gravity discharge is not practical. When a tank is equipped with a pump, the pump should be installed on the discharge side of the trap. When a pump is installed to aid in emergency release, flammable and combustible liquid piping must comply with Chapter 57. The exception covers Class IIIB combustible liquids, which have a flashpoint above 200°F (93°C). These liquids are not viewed by the code as extremely hazardous, especially when they are not heated above room temperature. For example, Table 5003.1.1(1), Note f allows for unlimited quantities of Class IIIB liquids in storage and use in a sprinklered building.

**2405.3.3 Dipping liquid temperature control.** Protection against the accumulation of vapors, self-ignition and excessively high temperatures shall be provided for dipping liquids that are heated directly or heated by the surfaces of the object being dipped.

- ❖ The evaporation rate of a liquid increases as the liquid temperature increases. By controlling the maximum liquid temperature, in case of a malfunction or unplanned event, the temperature of the liquid will not increase to a point where the exhaust ventilation cannot accommodate the exhaust of the vapors. Moreover, controlling the maximum liquid temperature would prevent the liquid from reaching its self-ignition (or auto-ignition) temperature. The temperature control for the liquid must be specifically designed for the liquid. Self-ignition temperatures of liquids can be found in many references. The *SFPE* (Society of Fire Protection Engineers) *Handbook of Fire Protection Engineering* includes tables listing auto-ignition temperatures for a variety of products. Although it is a more general application, similar temperature control requirements apply when exempt use and storage amounts of heated hazardous materials are exceeded (see Section 5004.8.1).

**2405.3.4 Dip-tank covers.** Dip-tank covers allowed by Section 2405.4.1 shall be capable of manual operation and shall be automatic closing by *approved* automatic-closing devices designed to operate in the event of a fire.

- ❖ Dip-tank covers installed as a method of automatic suppression conforming to Section 2405.4.1 must be capable of manual actuation. Automatic closure must be initiated by a fusible link or another approved heat-sensitive device. Covers that cannot close under the force of gravity must be assisted by hydraulic activators, springs, counterweights or other methods.

**2405.3.4.1 Construction.** Covers shall be constructed of noncombustible material or be of a tin-clad type with enclosing metal applied with locked joints.

- ❖ Dip-tank covers must be constructed of noncombustible material to avoid adding to the fire load, as well as to maintain the integrity of the system as a passive containment fire protection system. Tin-clad covers should be designed the same as metal-clad or tin-clad fire doors (see NFPA 80). Materials used for

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automatic-closing mechanisms, such as hydraulic actuators, springs, etc., should also be constructed of noncombustible materials.

**2405.3.4.2 Supports.** Chain or wire rope shall be utilized for cover supports or operating mechanisms.

❖ Devices for holding the cover open must be designed to permit it to close freely and seal tightly. If noncombustible materials are used, a fusible link or another heat-sensitive device must be used to initiate closure.

**2405.3.4.3 Closed covers.** Covers shall be kept closed when tanks are not in use.

❖ Keeping the cover closed when the tank is not in use reduces the release of flammable vapors or the accidental introduction of an ignition source into the vapor area located below the rim of the dip tank.

**2405.4 Fire protection.** Dip-tank operations shall be protected in accordance with Sections 2405.4.1 through 2405.4.2.

❖ This section establishes the applicability of the requirements of Section 2405.4 for controlling and extinguishing fires in dipping operations.

**2405.4.1 Fixed fire-extinguishing equipment.** An approved automatic fire-extinguishing system or dip-tank cover in accordance with Section 2405.3.4 shall be provided for the following dip tanks:

1. Dip tanks less than 150 gallons (568 L) in capacity or 10 square feet (0.93 m<sup>2</sup>) in liquid surface area.
2. Dip tanks containing a liquid with a *flash point* below 110°F (43°C) used in such manner that the liquid temperature could equal or be greater than its *flash point* from artificial or natural causes, and having both a capacity of more than 10 gallons (37.9 L) and a liquid surface area of more than 4 square feet (0.37 m<sup>2</sup>).

❖ This section applies to fire-extinguishing equipment for certain smaller sizes of dip tanks. It offers the option of dip-tank covers instead of a fixed fire-extinguishing system. Tanks equipped with noncombustible automatic-closing covers conforming to Section 2405.3.4 need not be protected by a fire suppression system on the basis that the cover can be closed, thus containing a dip tank fire and further restricting oxygen supply to the fire. Additionally, the suppression system will not be effective in controlling a fire when the cover is in the sloped position because the sprinkler water would simply run off the cover and away from the fire. Automatic sprinkler protection is recommended for plant areas located around dip tanks and other similar equipment. However, the primary protection for the dip tank should be one of the following types of systems listed in order of desirability and effectiveness:

1. Water-spray fixed system (NFPA 15 or 16).
2. Foam-extinguishing system (NFPA 11, 11A or 16).
3. Carbon dioxide system (NFPA 12).

4. Halogenated system (NFPA 12A).

5. Dry-chemical system (NFPA 17).

Water-spray fixed systems are more effective at controlling flammable liquid pool fires, such as those involving dip tanks, because they produce finer water droplets that are more effective at absorbing heat from these rapidly burning, intense fires. Most water droplets are quickly vaporized by the fire and rarely pose a significant danger of boil-over, froth-over or slop-over from penetrating the surface of the flammable or combustible liquid (see NFPA 30 for further information on these phenomena unique to flammable and combustible liquids in tanks). Unless dip-tank covers are installed, fixed fire-extinguishing equipment is required for dip tanks less than 150 gallons (568 L) or 10 square feet (0.93 m<sup>2</sup>). Unless dip-tank covers are installed, dip tanks containing Class I flammable liquids and Class II combustible liquids with flash points below 110°F (43°C) used at ambient temperatures above their flash points; and having capacities greater than 10 gallons (38 L) and exposed surface areas greater than 4 square feet (0.37 m<sup>2</sup>) must be protected in accordance with Section 2405.4.1.1 because of their ease of ignition.

**2405.4.1.1 Fire-extinguishing system.** An approved automatic fire-extinguishing system shall be provided for dip tanks with a 150-gallon (568 L) or more capacity or 10 square feet (0.93 m<sup>2</sup>) or larger in a liquid surface area. Fire-extinguishing system design shall be in accordance with NFPA 34.

❖ Automatic fire suppression must be installed at dip tanks with a capacity greater than 150 gallons (568 L) or larger than 10 square feet (0.93 m<sup>2</sup>) in surface area. See the commentary to Section 2405.4.1 for the preferred type of extinguishing system.

**2405.4.2 Portable fire extinguishers.** Areas in the vicinity of dip tanks shall be provided with portable fire extinguishers complying with Section 906 and suitable for flammable and combustible liquid fires as specified for extra (high) hazard occupancies.

❖ Readily accessible portable fire extinguishers for incipient fire fighting must be installed for use by employees working around dipping and coating processing equipment. Both the size and distribution of portable fire extinguishers must conform to this section, Section 906.1 and the applicable sections of NFPA 10 for extra (high) hazards. Two units of Class B extinguishing capabilities are required for each square foot (m<sup>2</sup>) of dip-tank area if either dry-chemical or carbon dioxide portable extinguishers are installed. Only one unit of Class B rating is required per square foot (m<sup>2</sup>) if aqueous film-forming foam (AFFF) portable extinguishers are provided. For example, a 40-square-foot (4 m<sup>2</sup>) dip tank would require an 80-B-rated dry-chemical or carbon dioxide extinguisher, or a 40-B AFFF extinguisher. The maximum travel distance to the nearest required portable fire extinguisher is 30 feet (9144 mm). Employees who are expected to fight incipient fires should

receive instructions in the operation of installed fire protection equipment. Fire protection systems, equipment and devices must be maintained in accordance with Section 901.6.

**2405.5 Housekeeping, maintenance and storage of hazardous materials.** Housekeeping, maintenance, storage and use of hazardous materials shall be in accordance with Sections 2403.3 and 2403.4.

❖ This section establishes the applicability of the requirements of Sections 2403.3 and 2403.4 for controlling hazards associated with housekeeping, maintenance and the storage of hazardous materials.

**2405.6 Sources of ignition.** Control of sources of ignition shall be in accordance with Section 2403.2.

❖ See the commentary to Section 2403.2.

**2405.7 Ventilation of flammable vapor areas.** Flammable vapor areas shall be provided with mechanical ventilation adequate to prevent the dangerous accumulation of vapors. Required ventilation systems shall be arranged such that the failure of any ventilating fan shall automatically stop the dipping conveyor system.

❖ This section includes performance-based language that requires ventilation to prevent the dangerous accumulation of vapors. Additionally, conveyor systems used with dipping operations need to be interlocked with the ventilation system to avoid continuation of operations in the event of a ventilation system failure. The IMC contains requirements for hazardous exhaust systems and requires independent duct exhaust of vapor releases from dipping and coating processing tanks, reservoirs, trench drains, drain boards, conveyor tunnels and any other space where flammable vapors may be liberated. Ducts are not to penetrate fire-resistance-rated assemblies. The plenum and ductwork must be protected by automatic sprinklers or other approved fire suppression systems installed in accordance with Chapter 9. Only fans and mechanical equipment approved for use in Class I, Division 1 hazardous locations are to be installed in the exhaust air stream, and ductwork must be of materials, thicknesses and construction methods specified in the IMC.

**2405.8 Conveyor interlock.** Dip tanks utilizing a conveyor system shall be arranged such that in the event of a fire, the conveyor system shall automatically cease motion and the required tank bottom drains shall open.

❖ Mechanical or electrical interlocks must interrupt conveyor motion and cause required emergency release drains to open in the event of a fire. Stopping the conveyor prevents newly coated parts from transporting a fire beyond the immediate vicinity of the dipping or coating processing area and its protection systems.

**2405.9 Hardening and tempering tanks.** Hardening and tempering tanks shall comply with Sections 2405.3 through 2405.3.3, 2405.4.2 and 2405.8, but shall be exempt from other provisions of Section 2405.

❖ Requirements of Sections 2405.9.1 through 2405.9.5 apply to oil-quenching tanks used in hardening and tempering processes. Individually, hardening and tempering are usually accomplished by immersing parts in tanks containing certain metal salts heated to temperatures between 1,400°F and 2,350°F (760°C and 1287°C). This process often requires several steps, with parts cooled by oil quenching between steps. Such oil-quenching baths are the subject of these requirements. Animal, vegetable and mineral oils, and various mixtures of each, are used for oil quenching, but mineral oils are most commonly used. Recently, polymers have replaced oils on a small scale in some oil-quenching processes. For most oil-quenching processes, oils have flash points above 300°F (149°C) (Class III-B) and many have flash points exceeding 500°F (260°C). Oil-quenching baths are usually maintained 100°F to 200°F (38°C to 93°C) below their flash points. The same design, construction, operation, maintenance and fire protection requirements applying to dip tanks pertain to hardening and tempering tanks, as do the requirements of Sections 2405.9.1 through 2405.9.5.

**2405.9.1 Location.** Tanks shall be located as far as practical from furnaces and shall not be located on or near combustible floors.

❖ High temperatures produced by hardening and tempering processes require the maintenance of separation between tanks, ignition sources and combustible materials (see Commentary Figure 2405.9.1).

**2405.9.2 Hoods.** Tanks shall be provided with a noncombustible hood and vent or other *approved* venting means, terminating outside of the structure to serve as a vent in case of a fire. Such vent ducts shall be treated as flues and proper clearances shall be maintained from combustible materials.

❖ Though the materials in hardening and tempering baths are usually not considered flammable, the elevated temperatures may represent an ignition source to other combustibles. The contents of oil-quenching tanks used for high flash-point liquids may be difficult to ignite, but once ignited, the rate of heat release is comparable to other flammable and combustible liquids. Hoods over hardening, tempering and oil-quenching tanks will help maintain tenable conditions near the tanks and help control a fire, should it occur, by providing a controlled avenue of vertical spread. Therefore, exhaust hood materials must be noncombustible and separated from combustible structural components.

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**2405.9.3 Alarms.** Tanks shall be equipped with a high-temperature limit switch arranged to sound an alarm when the temperature of the quenching medium reaches 50°F (10°C) below the *flash point*.

- ❖ Thermostats may be used to limit the heat input to the oil bath for temperature maintenance. However, many systems require cooling systems to maintain oil baths within specified temperature limitations. Water leaking from these cooling systems can pose a special hazard from boil-over as the water is converted to steam (see Commentary Figure 2405.9.3).

**2405.9.4 Fire protection.** Hardening and tempering tanks greater than 500 gallons (1893 L) in capacity or 25 square feet (2.3 m<sup>2</sup>) in liquid surface area shall be protected by an *approved* automatic fire-extinguishing system complying with Chapter 9.

- ❖ Tanks larger than 500 gallons (1893 L) in capacity or 25 square feet (2.3 m<sup>2</sup>) in surface area present a sig-

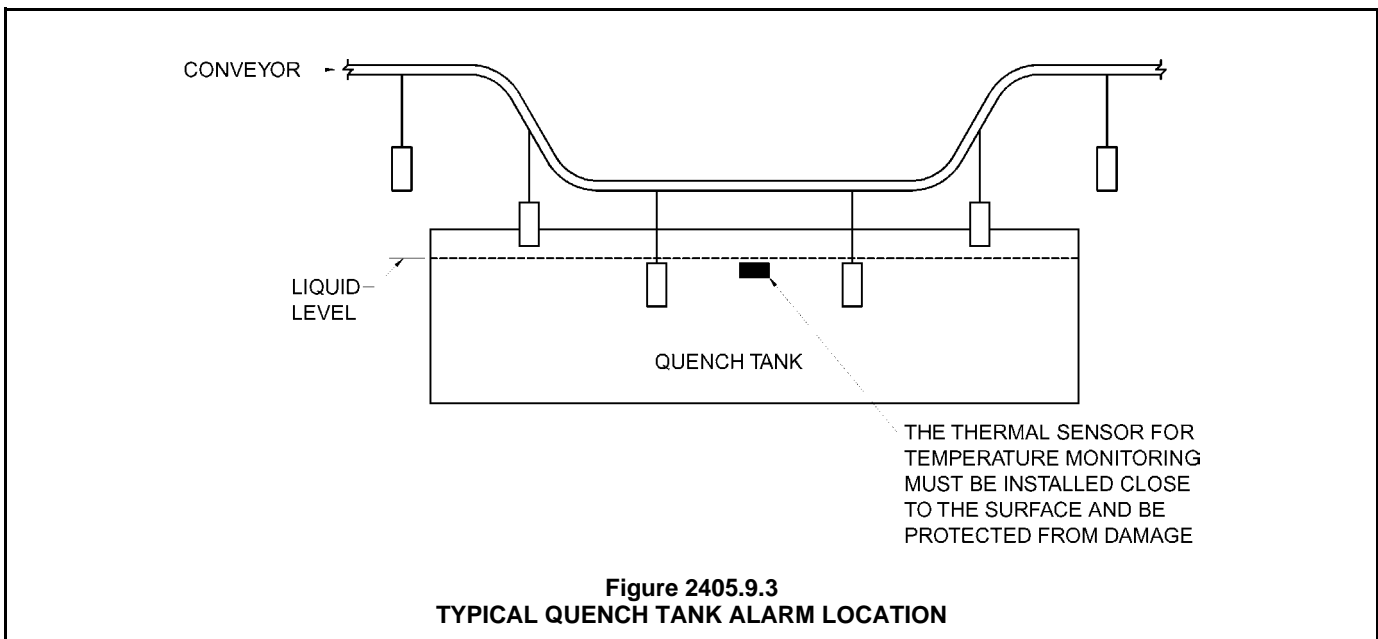
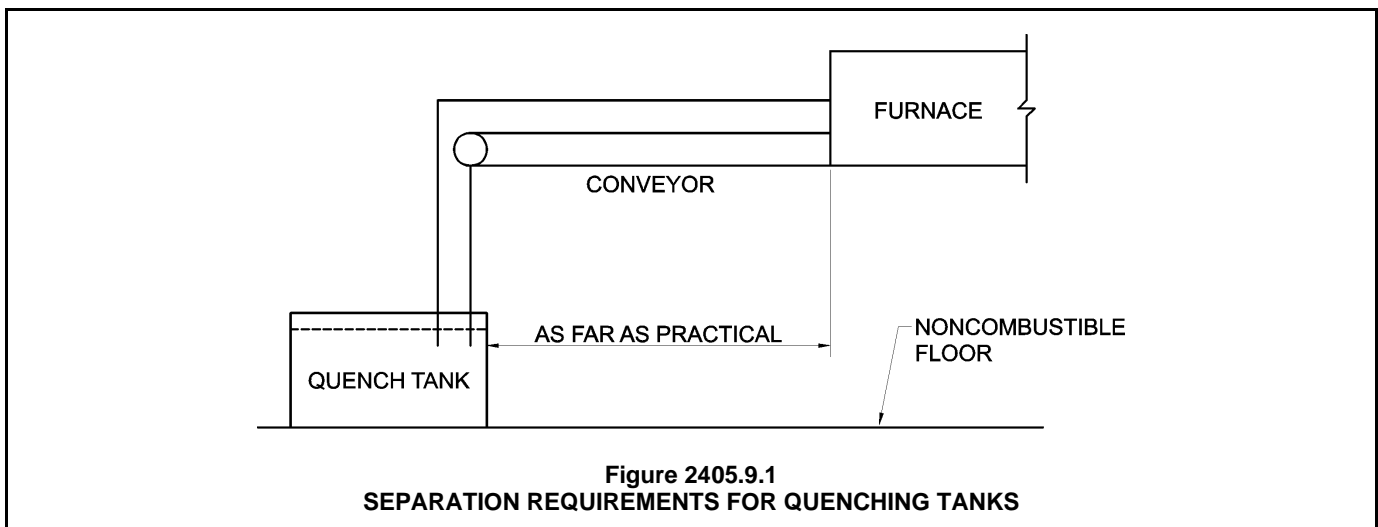
nificant enough hazard as to be required to be protected by an automatic fire-suppression system.

**2405.9.5 Use of air pressure.** Air under pressure shall not be used to fill or agitate oil in tanks.

- ❖ Heated oil can cause air injected below the oil surface to expand, allowing oil to spill from the tank. Air containing moisture can contaminate the oil bath, leading to boil-over.

**2405.10 Flow-coating operations.** Flow-coating operations shall comply with the requirements for dip tanks. The area of the sump and any areas on which paint flows shall be considered to be the area of a dip tank.

- ❖ In flow-coat operations, a liquid coating is applied to the workpiece in a nonatomized stream through fixed or oscillating nozzles. Excess liquid is collected in a trough or sump below the workpiece and recirculated through a reservoir. The principal hazard from flow



coating is the liberation of flammable liquid vapor from the surface of excess liquid. The area of the trough or sump for collecting overspray defines the scope of the hazard. Protection of flow-coat operations must be based on the combined area of the trough or sump and any surfaces in which paint or coating material flows en route to the trough or sump (see Commentary Figure 2405.10). In large operations, drain tunnels extend outside the enclosure. Moving the object through the drain tunnels reduces solvent evaporation. Using the tunnels also improves the film coating on the object. Curtain coating operates on a similar principle, except a trough is filled above the workpiece and allowed to overflow in a thin flat stream. This process is often used to coat flat or slightly curved workpieces.

**2405.10.1 Paint supply.** Paint shall be supplied by a gravity tank not exceeding 10 gallons (38 L) in capacity or by direct low-pressure pumps arranged to shut down automatically in case of a fire by means of *approved* heat-actuated devices.

- ❖ Positive displacement pumps are most commonly used to recirculate paint and coating material from the reservoir to the nozzles. Gravity tanks not exceeding 10 gallons (38 L) in capacity are also permitted. When a pump is used, the pump power supply must be interlocked with heat detectors to shut down if a fire occurs.

**2405.11 Roll-coating operations.** Roll-coating operations shall comply with Section 2405.10. In roll-coating operations utilizing flammable or *combustible liquids*, sparks from static electricity shall be prevented by electrically bonding and grounding all metallic rotating and other parts of machinery and equipment and by the installation of static collectors, or by maintaining a conductive atmosphere such as a high relative humidity.

- ❖ Roll-coating methods apply material to flat work pieces, usually paper, cardboard, cloth or thin metals, using liq-

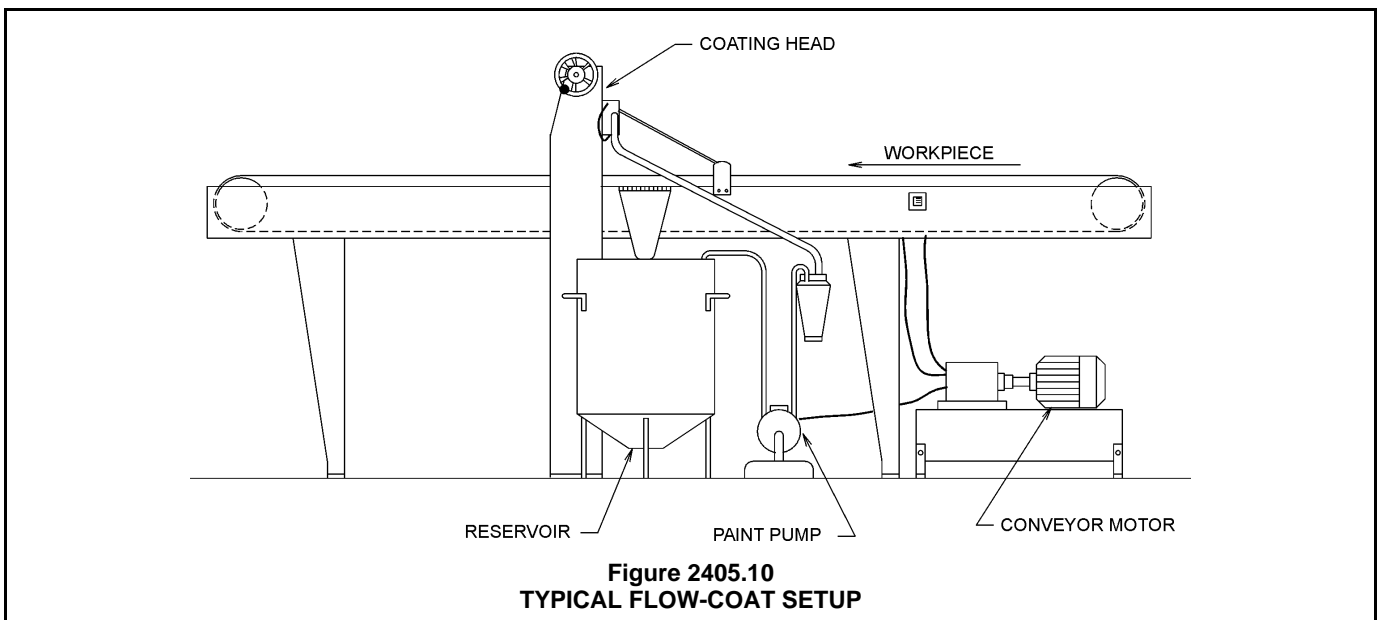
uid-coated cylinders or rollers. Coating material may be applied to the rollers by rotating them in an open trough or pan or applying liquid to the space between two rollers (see Commentary Figure 2405.11).

**SECTION 2406  
POWDER COATING**

**2406.1 General.** Operations using finely ground particles of protective finishing material applied in dry powder form by a fluidized bed, an electrostatic fluidized bed, powder spray guns or electrostatic powder spray guns shall comply with Sections 2406.2 through 2406.7. In addition, Section 2407 shall apply to fixed electrostatic equipment used in powder coating operations.

- ❖ This section applies to powder-coating operations, which involve the application of finely ground particles of protective finishing material. The finish from powder coating is very strong and more durable than conventional finishes. This is a benefit, from an environmental and fire protection standpoint, because there are no liquid finishes or solvents to produce flammable vapors or VOCs. Additionally, less solid waste is created with this method of finishing. The foremost hazard associated with such application(s) is fire or explosion as a result of the airborne dust. The hazard associated with powder-coating operations is considered less than that of a similar operation using flammable or combustible liquids. The energy required to ignite a cloud of air-suspended coating powder is from 100 to 1,000 times higher than that required to ignite flammable vapors associated with fluid-coating processes. Nevertheless, these operations pose a significant explosion hazard when organic powder is suspended in air, forming dust clouds.

**2406.2 Location.** Powder coating operations shall be conducted in enclosed powder coating rooms, enclosed powder



**Figure 2405.10  
TYPICAL FLOW-COAT SETUP**

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coating facilities that are ventilated or ventilated spray booths.

- ❖ This section simply states that powder coating must be conducted within enclosed rooms, spaces or apparatus that are designed for the purpose and constructed in accordance with the applicable provisions of Sections 2406.3 through 2406.7.

**2406.3 Construction of powder coating rooms and booths.** Powder coating rooms shall be constructed of noncombustible materials. Spray booths shall be constructed in accordance with Section 2404.3.2.

**Exception:** *Listed* spray-booth assemblies that are constructed of other materials shall be allowed.

- ❖ The majority of powder-coating operations are conducted in rooms or spray booths designed specifically to accommodate the air-borne dust. Listed spray-booth assemblies should be specifically listed for powder-coating operations to ensure that the differences in medium between flammable spray finish and powder coating are addressed in the protection systems. An example of such differences is the type of electrical classification between powder-coating operations and flammable-finish operations.

The exception allows powder-coating operations to be conducted in spray booths constructed of any

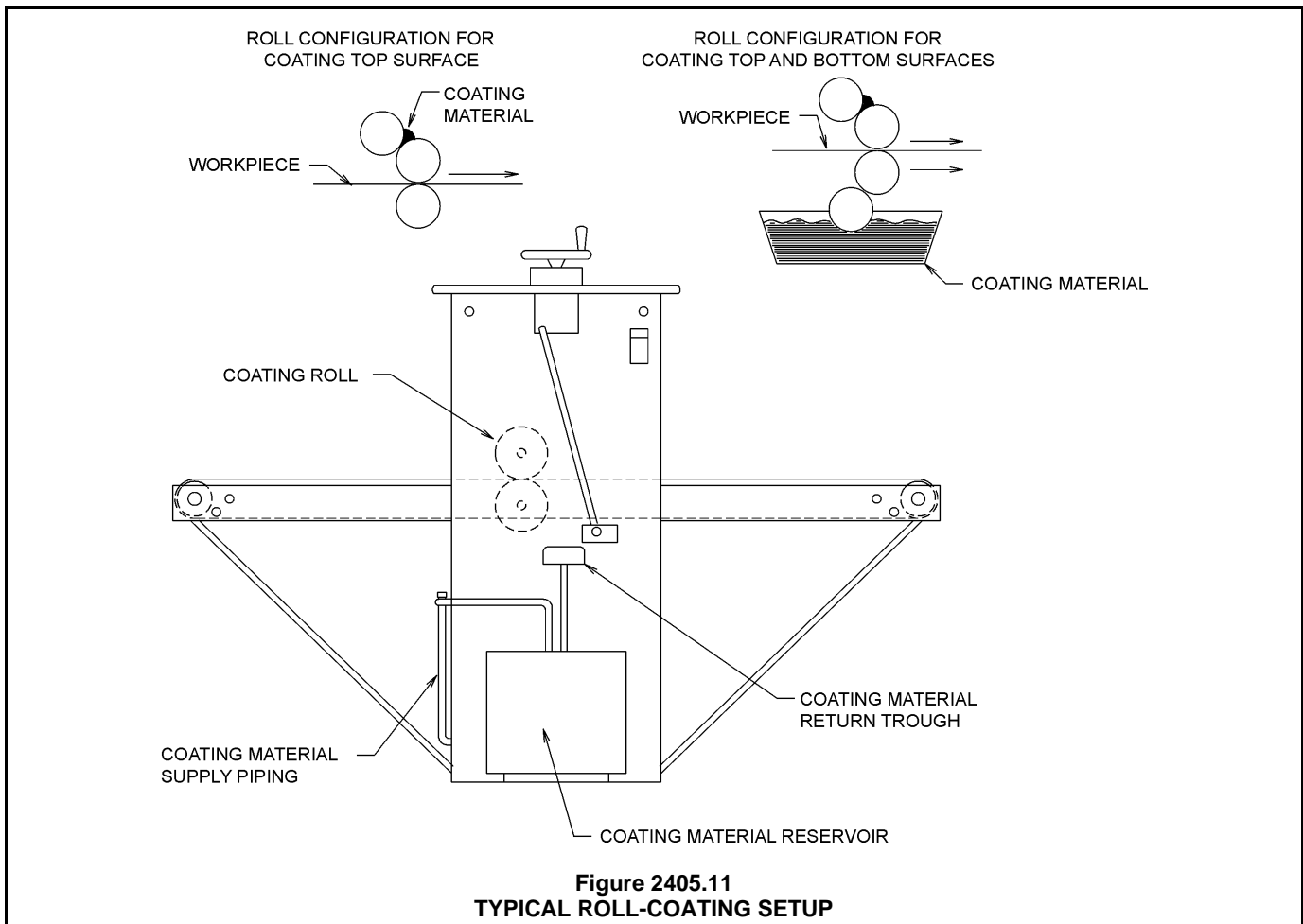
material, provided that the spray booths are listed (see the commentary to Section 202 for the definition of "Listed").

**2406.4 Fire protection.** Areas used for powder coating shall be protected by an *approved* automatic fire-extinguishing system complying with Chapter 9.

- ❖ Although automatic sprinkler protection is the most common method of protection in facilities, other approved automatic fire suppression systems may be installed where approved by the fire code official. Fire protection systems, equipment and devices must be installed in accordance with Chapter 9 and maintained.

**2406.4.1 Additional protection for fixed systems.** Automated powder application equipment shall be protected by the installation of an *approved*, supervised flame detection apparatus that shall react to the presence of flame within 0.5 second and shall accomplish all of the following:

1. Shutting down of energy supplies (electrical and compressed air) to conveyor, ventilation, application, transfer and powder collection equipment.
2. Closing of segregation dampers in associated ductwork to interrupt airflow from application equipment to powder collectors.



**Figure 2405.11**  
**TYPICAL ROLL-COATING SETUP**

3. Activation of an alarm that is audible throughout the powder coating room or booth.

- ❖ Automated powder application may or may not have operators who would take steps to reduce the severity of the fire by shutting down the supply of powder, turning off energy supplies, warning occupants for evacuation, etc. The flame detection system and its associated interlocks are part of the protection system, in case ignition has already occurred. To reduce the severity of a fire or dust cloud explosion, the powder-coating application must be shut down immediately upon fire detection. Because automated powder application equipment may at times be unsupervised, flame detection that automatically can shut down the system is required. Shutting down systems such as conveyors, which can further spread the fire, or an application that further augments the existing fuel load/air-borne dust is critical to reducing the severity of a fire. Further, an audible alarm throughout the powder-coating room or area must notify the occupants to evacuate immediately to avoid injury. For example, injury to occupants of the booth may be avoided or reduced if they evacuate when a small incipient fire is detected before it reaches areas within the booth where dust-cloud explosions are sustainable.

**2406.4.2 Fire extinguishers.** Portable fire extinguishers complying with Section 906 shall be provided for areas used for powder coating in accordance with the requirements for an extra-hazard occupancy.

- ❖ Section 906 gives the requirements for portable fire extinguishers. Areas may be classified as an extra-hazard occupancy in accordance with NFPA 10 because of the higher hazard of powder-coating operations.

**2406.5 Operation and maintenance.** Powder coating areas shall be kept free from the accumulation of powder coating dusts, including horizontal surfaces such as ledges, beams, pipes, hoods, booths and floors.

- ❖ Regularly scheduled cleaning of accumulation of powder on surfaces is an important and often ignored good housekeeping practice. This is especially critical when pieces are bonded to the conveyor. If too much residue is accumulated on the conveyor, the pieces may no longer be bonded. When pieces are preheated, the additional dust accumulation may contribute to air-borne dust and escalate a small fire to a much larger and more severe fire.

**2406.5.1 Cleaning.** Surfaces shall be cleaned in such a manner so as to avoid scattering dusts to other places or creating dust clouds. Vacuum sweeping equipment shall be of a type *approved* for use in hazardous locations.

- ❖ Additional air-borne dust must be avoided during cleaning operations. Any type of dust-agitating process can create a potential for flash fires or dust explosions. Removal of dusts from any horizontal surfaces, such as ledges, beams, pipes, hoods, booths and floors, is important in reducing the excess

dust concentrations within powder-coating areas.

Cleaning should minimize the scattering of dust or creation of a dust cloud that can easily cause a fire or explosion. Vacuum sweeping equipment must be approved for the type of use and be electrically classified in accordance with NFPA 70 (see commentary, Section 2403.2.1).

**2406.6 Sources of ignition.** Control of sources of ignition shall be in accordance with Section 2403.2 and Sections 2406.6.1 through 2406.6.4.

- ❖ This section establishes the applicability of the listed sections to the control of ignition sources in powder-coating operations.

**2406.6.1 Drying, curing and fusion equipment.** Drying, curing and fusion equipment shall comply with Chapter 30.

- ❖ Chapter 30 details the construction, operation, maintenance and fire protection of, as well as the equipment and piping associated with, industrial ovens (see commentary, Chapter 30).

**2406.6.2 Spark-producing metals.** Iron or spark-producing metals shall be prevented from being introduced into the powders being applied by magnetic separators, filter-type separators or by other *approved* means.

- ❖ Iron or spark-producing metals, such as small workpieces or tools, have caused ignitions or explosions of the air-borne combustible dusts in powder-coating operations. Although magnetic or filter-type separators are the simplest and most commonly used systems for reducing such a hazard, other approved means of removing metals are acceptable.

**2406.6.3 Preheated parts.** When parts are heated prior to coating, the temperature of the parts shall not exceed the ignition temperature of the powder to be used.

- ❖ During the heating process and prior to coating, safety controls must be implemented to prevent the ignition of the powder on an overheated piece as a result of a system malfunction (temperature control failures, when a piece is overheated on a conveyor that has stopped, etc.).

**2406.6.4 Grounding and bonding.** Precautions shall be taken to minimize the possibility of ignition by static electrical sparks through static bonding and grounding, where possible, of powder transport, application and recovery equipment.

- ❖ See the commentary to Section 2403.2.5.

**2406.7 Ventilation.** Exhaust ventilation shall be sufficient to maintain the atmosphere below one-half the minimum *explosive* concentration for the material being applied. Nondeposited, air-suspended powders shall be removed through exhaust ducts to the powder recovery system.

- ❖ Powder coating creates explosive atmospheres because of the large surface areas of the particles when dispersed in the air. The explosive limit or concentration, just as with flammable vapors, will depend on the type of material being used. For example, Factory Mutual tested several powder-coating materials and

found a range of lower explosive limit (LEL) of 0.026 to 0.097 ounces per square foot and auto-ignition temperatures between 790°F to 1,039°F (412°C to 559°C). Therefore, ventilation system requirements may vary from one type of coating to another. Also, a collection system is required to collect any unused powder. This requirement is similar to ventilation requirements for flammable vapors in its intent to limit the amount of vapors or dusts to a concentration that would not support ignition. Therefore “one-half the minimum explosive concentration” for powder coating is similar in intent to the “25 percent of the lower flammable limit (LFL).” The safety factor in the combustible dust is 2, while the safety factor for the LFL is 4. This is partly the result of the lower ignitability of a dust compared to a vapor (see commentary, Section 2407.1).

## SECTION 2407 ELECTROSTATIC APPARATUS

**2407.1 General.** Electrostatic apparatus and devices used in connection with paint-spraying and paint-deteating operations shall be of an *approved* type.

- ❖ Electrostatic spraying and paint deteating equipment, as well as electrostatic devices, such as generators, motors, transformers and electrodes, must be acceptable to the fire code official and should bear the label of an independent testing laboratory. Evidence of satisfactory performance is indicated by use or display of the appropriate label or seal of the laboratory. Testing laboratories generally publish directories or lists containing important information about labeled products.

**2407.2 Location and clear space.** A space of not less than twice the sparking distance shall be maintained between goods being painted or deteated and electrodes, electrostatic atomizing heads or conductors. A sign stating the sparking distance shall be conspicuously posted near the assembly.

**Exception:** Portable electrostatic paint-spraying apparatus *listed* for use in Class I, Division I, locations.

- ❖ The equipment manufacturer’s instructions must be consulted to determine the sparking distance of the equipment involved. Once the sparking distance is determined, it must be posted conspicuously in the work area. The sign must be clear, concise and of durable construction.

Maintaining the required separation distance prevents sparks generated by the properly maintained equipment from igniting vapors near the surface of the newly coated workpiece before it dries.

The exception recognizes that portable electrostatic spray guns have been listed by recognized testing laboratories for many years and are in use in commercial/industrial applications throughout the United States. These units are listed for use in Class I, Division I, Group D environments and they do not create an ignition source from potential sparking. Such units are designed to preclude sparking when

the spray gun is moved directly against the object being sprayed. The requirements to install barriers, provide signs or require general isolation of equipment do not improve the safety of this category of equipment and hamper its use by industry.

**2407.3 Construction of equipment.** Electrodes and electrostatic atomizing heads shall be of *approved* construction, rigidly supported in permanent locations and effectively insulated from ground. Insulators shall be nonporous and noncombustible.

**Exception:** Portable electrostatic paint-spraying apparatus *listed* for use in Class I, Division I, locations.

- ❖ Electrostatic atomizing heads are connected to both an air source and flammable coating products. Additionally, this particular piece of equipment is connected to high-voltage electricity. Oxygen, fuel and sources of ignition are readily available. Therefore, special care and consideration must be given in the construction and installation of such equipment. To avoid any sparking of the equipment, electrostatic atomizing heads must be insulated from grounded objects or parts.

The exception recognizes that portable electrostatic spray guns have been listed by recognized testing laboratories for many years and are in use in commercial/industrial applications throughout the United States. These units are listed for use in Class I, Division I, Group D environments and they do not create an ignition source from potential sparking. Such units are designed to preclude sparking when the spray gun is moved directly against the object being sprayed. The requirements to install barriers, provide signs or require general isolation of equipment do not improve the safety of this category of equipment and hamper its use by industry.

**2407.3.1 Barriers.** Booths, fencing, railings or guards shall be placed about the equipment such that either by their location or character, or both, isolation of the process is maintained from plant storage and personnel. Railings, fencing and guards shall be of conductive material, adequately grounded, and not less than 5 feet (1524 mm) from processing equipment.

**Exception:** Portable electrostatic paint-spraying apparatus *listed* for use in Class I, Division I, locations.

- ❖ The required guards prevent materials with an opposite charge from being placed within the range of the electrostatic spraying apparatus. Guards or railings are grounded so that any charge accumulation or deficit on people or materials will be safely neutralized. The separation distance requirement allows the charge dissipation to occur at a safe distance from ignitable vapors.

The exception recognizes that portable, electrostatic spray guns have been listed by recognized testing laboratories for many years and are in use in commercial/industrial applications throughout the United States. These units are listed for use in Class I, Division I, Group D environments and they do not

create an ignition source from potential sparking. Such units are designed to preclude sparking when the spray gun is moved directly against the object being sprayed. The requirements to install barriers, provide signs or require general isolation of equipment do not improve the safety of this category of equipment and hamper its use by industry.

**2407.4 Fire protection.** Areas used for electrostatic spray finishing with fixed equipment shall be protected with an *approved* automatic fire-extinguishing system complying with Chapter 9 and Section 2407.4.1.

❖ Although automatic sprinkler protection is the most common method of protection in facilities, other approved automatic fire suppression systems may be installed if approved by the fire code official. Fire protection systems, equipment and devices must be installed in accordance with Chapter 9 and maintained.

**2407.4.1 Protection for automated liquid electrostatic spray application equipment.** Automated liquid electrostatic spray application equipment shall be protected by the installation of an *approved*, supervised flame detection apparatus that shall, in the event of ignition, react to the presence of flame within 0.5 second and shall accomplish all of the following:

1. Activation of a local alarm in the vicinity of the spraying operation and activation of the building alarm system, if such a system is provided.
2. Shutting down of the coating material delivery system.
3. Termination of all spray application operations.
4. Stopping of conveyors into and out of the flammable vapor areas.
5. Disconnection of power to the high-voltage elements in the flammable vapor areas and disconnection of power to the system.

❖ Automated liquid electrostatic spray application may or may not have operators who would take steps to reduce the severity of the fire, such as shutting down the supply of coating material, warning occupants for evacuation purposes, etc. The flame detection system and its associated interlocks are part of the protection system, in case ignition has already occurred. Systems that are designed to reduce the severity of the accident in the event of a fire need to be initiated automatically. Supervised flame detection systems are required by this section to stop the flow of additional fuel into the system, stop the spread of fire by shutting down the conveyor, activate an alarm for evacuation, terminate spray application operations that would further add to the fuel and disconnect power to the system. The power disconnection referred to in this section is for the spray booth equipment, but does not include power to emergency systems.

**2407.5 Housekeeping, maintenance and storage of hazardous materials.** Housekeeping, maintenance, storage and

use of hazardous materials shall be in accordance with Sections 2403.3, 2403.4 and Sections 2407.5.1 and 2407.5.2.

❖ This section establishes the applicability of the listed sections to hazardous materials in and around electrostatic apparatus and its operations.

**2407.5.1 Maintenance.** Insulators shall be kept clean and dry. Drip plates and screens subject to paint deposits shall be removable and taken to a safe place for cleaning. Grounds and bonding means for the paint-spraying apparatus and all associated equipment shall be periodically cleaned and maintained free of overspray.

❖ Accumulation of dirt, oil, moisture or debris may compromise the effectiveness of insulators. Overspray accumulations are less severe with electrostatic processes but still require attention. Electrostatic spray equipment requires that grounding and bonding means be properly maintained free of overspray so as to preclude the potential injury to employees or the creation of potential fire hazards caused by the stored electric charge of objects.

**2407.5.2 Signs.** Signs shall be posted to provide the following information:

1. Designate the process zone as dangerous with respect to fire and accident.
2. Identify the grounding requirements for all electrically conductive objects in the flammable vapor area, including persons.
3. Restrict access to qualified personnel only.

❖ Signs should warn of the smoking, open-flame, grounding areas and high-voltage equipment hazards. Additionally, signs should warn against entrance of unqualified personnel into these areas to avoid accidents caused by people or employees who are not trained for the surrounding hazards.

**2407.6 Sources of ignition.** Transformers, power packs, control apparatus and all other electrical portions of the equipment, except high-voltage grids and electrostatic atomizing heads and connections, shall be located outside of the flammable vapor areas or shall comply with Section 2403.2.

❖ Devices that are not classified must be located outside the vapor area to prevent ignition of flammable vapors and overspray residue. The vapor area is defined as "that area where flammable vapors exceed 25 percent of the materials LFL." Equipment must be tested and labeled for use in Class I, Division 1, hazardous locations, as defined by Article 516 of NFPA 70, when locating equipment outside the spraying or vapor area is impractical.

**2407.7 Ventilation.** The flammable vapor area shall be ventilated in accordance with Section 2404.7.

❖ See the commentary to Section 2404.2.

**2407.8 Emergency shutdown.** Electrostatic apparatus shall be equipped with automatic controls operating without time delay to disconnect the power supply to the high-voltage

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transformer and signal the operator under any of the following conditions:

1. Stoppage of ventilating fans or failure of ventilating equipment from any cause.
  2. Stoppage of the conveyor carrying articles past the high-voltage grid.
  3. Occurrence of a ground or an imminent ground at any point of the high-voltage system.
  4. Reduction of clearance below that required in Section 2407.2.
- ❖ The required interlocks reduce the likelihood of the apparatus igniting flammable vapors in the event of any of the specified conditions. Conditions 1 and 2 may lead to an increase in the concentration of flammable vapors in the atmosphere. Condition 3 may lead to the release of a spark or arc capable of igniting flammable vapors. Additionally, occurrence of Condition 4 could bring those parts of the system capable of producing an ignition into an area containing an ignitable vapor concentration.

**2407.9 Ventilation interlock.** Hand electrostatic equipment shall be interlocked with the ventilation system for the spraying area so that the equipment cannot be operated unless the ventilating system is in operation.

- ❖ The required interlock is intended to prevent the use of hand sprayers without ventilation equipment in operation. Failure to operate exhaust ventilation may lead to the creation of ignitable vapor concentration in the spraying space.

### SECTION 2408 ORGANIC PEROXIDES AND DUAL-COMPONENT COATINGS

**2408.1 General.** Spraying operations involving the use of organic peroxides and other dual-component coatings shall be in accordance with the requirements of Section 2403 and Sections 2408.2 through 2408.5.

- ❖ This section establishes the applicability of Sections 2408.2 through 2408.5, as well as Section 2403 for the regulation of organic peroxides and other dual-component coatings.

**2408.2 Use of organic peroxide coatings.** Spraying operations involving the use of organic peroxides and other dual-component coatings shall be conducted in *approved* sprinklered spray booths complying with Section 2404.3.2.

- ❖ Because of the reactivity of the material, the use of organic peroxide and other dual-component coating systems is limited to spray booths only. For example, organic peroxide coatings cannot be applied in the limited spraying spaces described in Section 2404.1.4. This section is more specific and, therefore, supersedes the more general requirements. Storage of organic peroxides shall comply with Chapter 62.

**2408.3 Equipment.** Spray guns and related handling equipment used with organic peroxides shall be of a type manufactured for such use.

- ❖ This process involves the discharging of two different components through the same spray gun. The sensitivity of the materials used results in a system that is extremely sensitive to shock, friction, temperature, contaminants, etc. The design and installation of the system cannot be taken lightly.

**2408.3.1 Pressure tanks.** Separate pressure vessels and inserts specifically for the application shall be used for the resin and for the organic peroxide, and shall not be interchanged. Organic peroxide pressure tank inserts shall be constructed of stainless steel or polyethylene.

- ❖ Special consideration must be given to the materials used in organic peroxide systems. Materials that do not react with organic peroxides, such as stainless steel or polyethylene, ensure system component integrity.

**2408.4 Housekeeping, maintenance, storage and use of hazardous materials.** Housekeeping, maintenance, storage and use of hazardous materials shall be in accordance with Sections 2403.3 and 2403.4 and Sections 2408.4.1 through 2408.4.7.

- ❖ This section establishes the applicability of the listed sections to hazardous materials in conjunction with organic peroxides and dual-component coatings.

**2408.4.1 Contamination prevention.** Organic peroxide initiators shall not be contaminated with foreign substances.

- ❖ See the commentary to Section 2409.4.3.

**2408.4.2 Spilled material.** Spilled organic peroxides shall be promptly removed so there are no residues. Spilled material absorbed by using a noncombustible absorbent shall be promptly disposed of in accordance with the manufacturer's recommendation.

- ❖ In order to avoid contact with materials and conditions that would cause a reaction, it is good housekeeping practice to promptly clean the spilled organic peroxide. Additionally, to reduce the possibility of a reaction, prompt disposal is recommended. Because the organic peroxides vary in nature and volatility, the manufacturer's recommendations or Material Safety Data Sheets (MSDS) must be followed for disposal.

**2408.4.3 Residue control.** Materials shall not be contaminated by dusts and overspray residues resulting from the sanding or spraying of finishing materials containing organic peroxides.

- ❖ Because of the hazards associated with organic peroxides and the chemical reactions within the system, issues such as contamination control are very important. To avoid a violent reaction with contaminants that may be introduced accidentally to the organic peroxide initiators, careful consideration must be given to the overall system design.

**2408.4.4 Handling.** Handling of organic peroxides shall be conducted in a manner that avoids shock and friction that produces decomposition and violent reaction hazards.

❖ Many organic peroxides are unstable reactive materials that are decomposed by heat, shock or friction. The rate of decomposition varies depending on the material and the condition it is exposed to. Organic peroxides vary in reactions from plain decomposition (without a fire or explosion hazard) to deflagration or detonation. Special handling care must be given to these materials. The manufacturer's information on handling and care (typically, the "Special Precautions" and "Reactivity" sections of the MSDS) should be referred to for proper storage of the product.

**2408.4.5 Mixing.** Organic peroxides shall not be mixed directly with accelerators or promoters.

❖ In order to avoid any unexpected reaction, organic peroxides should not be mixed directly. Dual-coating systems specifically designed and approved for such use must be used.

**2408.4.6 Personnel qualifications.** Personnel working with organic peroxides and dual-component coatings shall be specifically trained to work with these materials.

❖ Because of the sensitive nature of organic peroxides, only trained personnel should work with them. Qualified personnel should be trained in material handling to avoid accidents, as well as procedures (such as system shutdown, notification, evacuation, etc.) in case of an accident. Qualified personnel should also be familiar with the MSDS of the flammable finishes.

**2408.4.7 Storage.** The storage of organic peroxides shall comply with Chapter 62.

❖ Chapter 62 is specific to the storage and use of organic peroxides (see commentary, Chapter 62). The manufacturer's information on handling and care (typically "Special Precautions" and "Reactivity" sections of the MSDS) should be referred to for proper storage of the product.

**2408.5 Sources of ignition.** Only nonsparking tools shall be used in areas where organic peroxides are stored, mixed or applied.

❖ Many organic peroxides are sensitive to heat, shock and friction. Additionally, many of these materials are dissolved in flammable or combustible solvents. Because of the volatility of the material, sources of ignition must be avoided completely. As mentioned in other sections of this chapter, the term "nonsparking" is somewhat inaccurate. Tools made of brass and similar nonsparking materials produce sparks with ignition energies too low to ignite flammable vapors. Nonetheless, such tools should be used carefully to avoid producing sufficient frictional heat to cause an ignition. Smoking is prohibited in organic peroxide coating areas. "No Smoking" signs should be conspicuously located throughout the work area. Desig-

nated smoking areas should be located well outside the organic peroxide and dual-coating areas and storage rooms, preferably in a separate room (see also commentary, Section 310).

## SECTION 2409 INDOOR MANUFACTURING OF REINFORCED PLASTICS

**2409.1 General.** Indoor manufacturing processes involving spray or hand application of reinforced plastics and using more than 5 gallons (19 L) of resin in a 24-hour period shall be in accordance with Sections 2409.2 through 2409.6.1.

❖ The applicability of this section is limited to operations involving the use of more than 5 gallons (19 L) of resin in a 24-hour period. It is intended to allow very limited amounts of resin to be removed from storage containers and applied in the manufacturing process during that period without further regulation other than those applicable to any hazardous material.

**2409.2 Resin application equipment.** Equipment used for spray application of resin shall be installed and used in accordance with Section 2408 and Sections 2409.3 through 2409.6.1.

❖ The equipment used for resin application should be manufactured for that use. Listed equipment is recommended.

**2409.3 Fire protection.** Resin application areas shall be protected by an *automatic sprinkler system*. The sprinkler system design shall be not less than that required for Ordinary Hazard, Group 2, with a minimum design area of 3,000 square feet (279 m<sup>2</sup>). Where the materials or storage arrangements are required by other regulations to be provided with a higher level of sprinkler system protection, the higher level of sprinkler system protection shall be provided.

❖ Similar language and requirements can be found in Sections 5005.1.8 and 5004.5 when storage and use or dispensing of hazardous materials exceed the allowable quantities per control area given in Section 5003. If design density required by other sections results in a higher sprinkler demand, the more stringent requirement applies.

**2409.4 Housekeeping, maintenance, storage and use of hazardous materials.** Housekeeping, maintenance, storage and use of hazardous materials shall be in accordance with Sections 2403.3 and 2403.4 and Sections 2409.4.1 through 2409.4.3.

❖ This section establishes the applicability of the listed sections to hazardous materials in and around the indoor manufacturing of reinforced plastics.

**2409.4.1 Handling of excess catalyzed resin.** A noncombustible, open-top container shall be provided for disposal of excess catalyzed resin. Excess catalyzed resin shall be drained into the container while still in the liquid state. Enough water shall be provided in the container to maintain a

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minimum 2-inch (51 mm) water layer over the contained resin.

- ❖ Some catalyzed resin products produce heat as they cure (exothermic reaction). This may be a fire hazard if the container is not open-top. In a confined container, enough heat may be generated to ignite the resin. Additionally, the required water in the container would help cool down the material and the container until the product is cured or safely disposed of.

**2409.4.2 Control of overchop.** In areas where chopper guns are used, exposed wall and floor surfaces shall be covered with paper, polyethylene film or other *approved* material to allow for removal of overchop. Overchop shall be allowed to cure for not less than 4 hours prior to removal.

- ❖ To ease removal of excess materials, coverings are required in the areas where chopper guns are used. Again, the materials are best left until they are cured to reduce the likelihood of any reactions or ignition from the heat produced during curing (exothermic reaction).

**2409.4.2.1 Disposal.** Following removal, used wall and floor covering materials required by Section 2409.4.2 shall be placed in a noncombustible container and removed from the facility.

- ❖ Once the material is cured for 4 hours, immediate disposal is important to reduce further chances of reaction. Additional heat may be produced if the materials are not fully cured. Regular disposal of hazardous materials is an important part of housekeeping in fire prevention.

**2409.4.3 Storage and use of hazardous materials.** Storage and use of organic peroxides shall be in accordance with Section 2408 and Chapter 62. Storage and use of flammable and *combustible liquids* shall be in accordance with Chapter 57. Storage and use of unstable (reactive) materials shall be in accordance with Chapter 66.

- ❖ Because a variety of materials are used in the GFRP process, chapters specific to the materials are referenced. In addition to the referenced chapters, the MSDS, as well as the manufacturer's recommendation for safe practices, should be considered. Although the codes contain information for the general hazardous materials category, the MSDS are specific to the material being used. For example, the reactivity section of an MSDS is specific in the types of materials that may be incompatible with the resin used.

**2409.5 Sources of ignition in resin application areas.** Sources of ignition in resin application areas shall comply with Section 2403.2.

- ❖ As with other flammable finishes, the sources of ignition must be controlled to a manageable level in hazardous environments.

**2409.6 Ventilation.** Mechanical ventilation shall be provided throughout resin application areas in accordance with Section 2404.7. The ventilation rate shall be adequate to maintain the

concentration of flammable vapors in the resin application area at or below 25 percent of the LFL.

**Exception:** Mechanical ventilation is not required for buildings that have 75 percent of the perimeter unenclosed.

- ❖ In many cases, acetone is used for cleanup of resin accumulations. Therefore, the LFL for both resin and the cleaning solvent must be considered when designing the ventilation for the resin application areas. The exception recognizes that natural ventilation is considered adequate if the perimeter of the building is 75 percent open.

**2409.6.1 Local ventilation.** Local ventilation shall be provided inside of workpieces where personnel will be under or inside of the workpiece.

- ❖ Ventilation in areas where personnel are present is required for fire prevention as well as for reduction of health risks.

## SECTION 2410

### FLOOR SURFACING AND FINISHING OPERATIONS

**2410.1 Scope.** Floor surfacing and finishing operations exceeding 350 square feet (33 m<sup>2</sup>) and using Class I or II liquids shall comply with Sections 2410.2 through 2410.5.

- ❖ Floor surfacing and finishing using Class I or II liquids in facilities such as bowling alleys or gymnasiums pose a high risk because of the spread of liquid over large surface areas. The intent of this section is to provide additional protection and hazard reduction for large surface fires resulting from floor surfacing and finishing.

**2410.2 Mechanical system operation.** Heating, ventilation and air-conditioning systems shall not be operated during resurfacing or refinishing operations or within 4 hours of the application of flammable or *combustible liquids*.

- ❖ In order to avoid circulation of potentially flammable vapors into other parts of the building, mechanical systems that are not part of the exhaust system required in Section 2410.3 must be shut down during the application of flammable or combustible liquids and for 4 hours after the last of the flammable or combustible liquids is applied. For example, if a flammable surface is applied and the entire area application takes 2 hours, the number of hours that the mechanical systems must be shut down is 6 (4 hours after the application).

**2410.3 Business operation.** Floor surfacing and finishing operations shall not be conducted while an establishment is open to the public.

- ❖ In case of a fire, the types and numbers of injuries are reduced by allowing surfacing and finishing operations only when the business is not open to the public. This would limit the exposure to fewer people (nighttime employees, etc.).

**2410.4 Ignition sources.** The power shall be shut down to all electrical sources of ignition within the flammable vapor area, unless those devices are classified for use in Class I, Division 1 hazardous locations.

❖ Because floor surfacing and finishing is a temporary process, the protection system is also temporary. Therefore, unlike processes such as spray booths, the building or area is not required to meet electrical requirements for hazardous areas. These systems that cannot meet the hazard conditions at the time of surfacing and finishing must be shut down to reduce the potential for unrated electrical sources to cause ignition of vapors.

**2410.5 Ventilation.** To prevent the accumulation of flammable vapors, mechanical ventilation at a minimum rate of 1 cubic foot per minute per square foot [ $0.00508 \text{ m}^3 / (\text{s} \cdot \text{m}^2)$ ] of area being finished shall be provided. Such exhaust shall be by *approved* temporary or portable means. Vapors shall be exhausted to the exterior of the building.

❖ The air exhausted over the entire surface must be at minimum 1 cfm per square foot [ $0.00508 \text{ m}^3 / (\text{s} \cdot \text{m}^2)$ ], even in the most remote areas or corners where finishing and surfacing take place. Please note that floor surfacing and finishing do not occur often in a building. Because outside companies are typically hired to do such surfacing, protection systems, such as exhaust, are temporary and can, therefore, be portable. To prevent recirculation of exhaust air that may contain flammable vapors, the exhausted air must be discharged to the exterior of the building.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

Burklin, Ralph W. and Robert G. Purington. *Fire Terms: A Guide to Their Meaning and Use*. Quincy, MA: National Fire Protection Association, 1980.

*Code Changes Resource Collection—2015 International Fire Code*. Washington, DC: International Code Council, 2014.

*Flammable Finishes Application Guide: 2009 International Fire Code*. Washington, DC: International Code Council, 2009.

Scarborough, D.R. "Spray Finishing and Powder Coating," Section 6, Chapter 16, *Fire Protection Handbook*, 19th ed. Quincy, MA: National Fire Protection Association, 2003.

*SFPE Handbook of Fire Protection Engineering*, 3rd Edition. Quincy, MA: National Fire Protection Association, 2002.



# Chapter 25: Fruit and Crop Ripening

## General Comments

American consumers have become accustomed to having a wide variety of the ripest and most attractive fruits and vegetables available all year. To supply this demand, horticulturists, growers and distributors have devised a means of growing and transporting these commodities to minimize damage and spoilage. Two fruits in greatest demand, tomatoes and bananas, are now shipped hard and green off the vine or tree, minimizing bruising but contributing to poor sales. To make the fruit attractive and edible, it must be ripened. Ethylene, a naturally occurring hormone in many fruit-bearing plants, is used to complete the ripening process after the fruit arrives at the distributor. This material has a wide explosive range and, when inhaled, is a medical anesthetic. Though only small concentrations of the gas are required in the ripening process, explosions have occurred. These incidents are usually attributed to the use of excessive concentrations of gas well above the

lower flammable limit (LFL). Placed in a relatively vapor-tight room filled with ethylene gas at small concentrations—100 to 150 parts per million (ppm) (100 to 500 mg/L)—for varying durations, quantities of fruit are ripened slowly, bringing them to just the right point before transporting them to the local retail market.

## Purpose

Chapter 25 provides guidance that is intended to reduce the likelihood of explosions resulting from improper use or handling of ethylene gas used for crop-ripening and coloring processes. This is accomplished by regulating ethylene gas generation; storage and distribution systems and controlling ignition sources. Design and construction of facilities for this use are regulated by the *International Building Code*® (IBC®) to reduce the impact of potential accidents on people and buildings.

## SECTION 2501 GENERAL

**2501.1 Scope.** Ripening processes where ethylene gas is introduced into a room to promote the ripening of fruits, vegetables and other crops shall comply with this chapter.

**Exception:** Mixtures of ethylene and one or more inert gases in concentrations that prevent the gas from reaching greater than 25 percent of the lower explosive limit (LEL) when released to the atmosphere.

❖ This section establishes that this chapter is applicable to fruit- and crop-ripening processes that use ethylene gas as a ripening agent. While still green, many fruits and vegetables are picked and shipped to their point of distribution. Prior to shipping or upon arrival at the distribution warehouse near the retail market, fruits and vegetables are transferred to containers (trailers) or rooms filled with low concentrations of ethylene gas to facilitate ripening. As they ripen, some fruits and vegetables, including bananas, tomatoes, pears, apples and honeydew melons, produce ethylene gas. If kept in tightly enclosed rooms or containers, gas accumulates, expediting the ripening process as concentrations increase.

This process would be relatively safe, simple and effective except for one problem—ethylene is a highly flammable gas (see Commentary Figure 2501.1). A constituent of liquefied petroleum gas (LP-gas), eth-

ylene is colorless with a sweet odor and taste. It is explosive in sunlight when mixed with chlorine. Moderate concentrations of ethylene in air are a medical anesthetic; thus, care must be taken to prevent inhalation. Atmospheres containing ethylene are classi-

Ignition Temperature <sup>a</sup>	842°F to 914°F
Vapor Density	1.0
Flammable Range	
Lower	2.7 percent
Upper	36 percent
NFPA 704 Hazard Classification	
Health	1
Flammability	4
Reactivity	2
Other	—

For SI: °C = (°F - 32)/1.8.

a. In the *NFPA Fire Protection Guide on Hazardous Materials*, 13th edition, NFPA 325 reports the lower value, while NFPA 49 reports the higher value.

**Figure 2501.1  
FLAMMABILITY CHARACTERISTICS  
AND ETHYLENE HAZARDS**

fied as Class I, Division 1, Group C hazardous locations by NFPA 70. Additionally, ethylene (R-1150) is sometimes used as a refrigerant gas and classified among Group 3 (highly flammable) refrigerants. Explosions involving trucks and warehouses where ethylene gas is used as a fruit-ripening agent are usually attributed to the use of excessive concentrations of gas well above the lower explosive limit (LEL). The exception recognizes the reduced hazard of ethylene-inert gas mixtures when the mixtures keep the ethylene concentration at or below 25 percent of its LEL.

**2501.2 Permits.** Permits shall be required as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. Because of the extremely flammable nature of ethylene gas, an operational permit is required by Section 105.6.20 for ethylene-based ripening processes.

**2501.3 Ethylene generators.** *Approved* ethylene generators shall be operated and maintained in accordance with Section 2506.

❖ Chapter 25 recognizes the use of listed ethylene generators as a means of safely producing ethylene concentrations needed to ripen crops. This section requires that those devices be properly operated and maintained (see commentary, Section 2506.1).

## SECTION 2502 DEFINITIONS

**2502.1 Terms defined in Chapter 2.** Words and terms used in this chapter and defined in Chapter 2 shall have the meanings ascribed to them as defined therein.

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

## SECTION 2503 ETHYLENE GAS

**2503.1 Location.** Ethylene gas shall be discharged only into *approved* rooms or enclosures designed and constructed for this purpose.

❖ Rooms or spaces occupied for the ripening of fruits and crops using ethylene gas must be constructed to

accommodate the process without exposing the rest of the building to process hazards. The design and construction of facilities for this use are regulated by the applicable provisions of the IBC to reduce the impact of potential accidents on people and buildings. In particular, buildings and portions of buildings used for crop-ripening or coloring processes must conform to the requirements of IBC Section 414.

Because ethylene is a flammable gas, the occupancy group classification of the building depends on the quantities of gas present and the use of the control area concept (see IBC Section 414.2). If the amount of gas exceeds the maximum allowable quantity per control area (MAQ) [see IBC Table 307.1(1)], the applicable provisions of IBC Section 415 would also apply. Additionally, Chapter 53 regulates the physical hazards of compressed gases and Chapter 58 regulates the material hazards of flammable gases. Both would apply to ethylene used in fruit-ripening processes as would the general hazardous materials provisions of Chapter 50.

**2503.2 Dispensing.** Valves controlling discharge of ethylene shall provide positive and fail-closed control of flow and shall be set to limit the concentration of gas in air below 1,000 parts per million (ppm).

❖ Although the hazards of using ethylene should be of considerable concern, technological innovation has produced a safe alternative to the old method of distributing ethylene to the ripening rooms. In the past, compressed ethylene gas in cylinders was piped through regulating equipment into rooms. Regulating equipment was calibrated to restrict gas quantity to a volume that would produce concentrations below the lower explosive gas limit; however, excessive concentrations occasionally escaped and uncontrolled ignition sources produced serious explosions.

Ideally, gas sensors should be used to stop gas flow as it approaches the desired level. Manual overrides must be provided to interrupt the gas flow if a danger exists. A 1:1,000 concentration is only 0.1 percent in air. The LFL of ethylene is 2.6 percent. When used properly, this gas poses little hazard.

## SECTION 2504 SOURCES OF IGNITION

**2504.1 Ignition prevention.** Sources of ignition shall be controlled or protected in accordance with this section and Chapter 3.

❖ Lighted smoking materials and other open-flame sources are prohibited in crop-ripening and color-processing rooms. This prohibition should also be extended to the immediate vicinity of the entrance to such rooms. “No Smoking” signs are to be conspicuously posted and stringently enforced (see also commentary, Sections 305, 308 and 310).

**2504.2 Electrical wiring and equipment.** Electrical wiring and equipment, including luminaires, shall be *approved* for

use in Class I, Division 2, Group C hazardous (classified) locations.

- ❖ Atmospheres containing ethylene are classified as Class 1, Division 1, Group C hazardous locations by NFPA 70. All electrical wiring and equipment must be suitably listed and labeled for use in such atmospheres.

**2504.3 Static electricity.** Containers, piping and equipment used to dispense ethylene shall be bonded and grounded to prevent the discharge of static sparks or arcs.

- ❖ Suitable grounds must be provided on all ethylene-handling systems and equipment to permit the dissipation of static electricity, thus preventing the generation of static sparks. Electrically isolated sections of systems and equipment must be independently grounded. NFPA 77 provides valuable guidance on this topic. Grounding and bonding should be in accordance with NFPA 70.

**2504.4 Lighting.** Lighting shall be by *approved* electric lamps or luminaires only.

- ❖ Open-flame lighting is prohibited in crop-ripening rooms and spaces because ethylene gas is flammable. Only approved electrical lighting equipment is allowed and it must comply with the provisions of Section 2504.2 of the code (see commentary, Section 2504.2).

**2504.5 Heating.** Heating shall be by indirect means utilizing low-pressure steam, hot water or warm air.

**Exception:** Electric or fuel-fired heaters *approved* for use in hazardous (classified) locations and that are installed and operated in accordance with the applicable provisions of NFPA 70, the *International Mechanical Code* or the *International Fuel Gas Code*.

- ❖ Wherever practical, heat for crop-ripening and coloring rooms should be indirect (steam, hot water or warm air) to eliminate sparks or open-flame ignition hazards. Piped steam and hot water-heating systems operate at temperatures of 250°F to 430°F (121°C to 221°C) and are considered the most appropriate method when providing indirect heat to ripening rooms.

The exception provides that electric heaters may be used where approved by the fire code official. The type of electric heaters required must be approved and listed for use in Class I, Division 1, Group C electrically classified locations because of the presence of ethylene gas. Such heaters must also be designed to keep all exposed surfaces at temperatures of 800°F (427°C) or below because ethylene gas has an ignition temperature of 842°F (450°C). Fuel-fired heaters using gas or liquid fuel may also be used, provided they are approved and comply with the *International Mechanical Code*® (IMC®) or the *International Fuel Gas Code*® (IFGC®), as applicable. These appliances must also have a sealed combustion chamber to prevent open-flame ignition of the ethylene gas and be installed in accordance with the

manufacturer's instructions. All heaters must be protected from physical damage to prevent fuel spills or heater malfunctions.

## SECTION 2505 COMBUSTIBLE WASTE

**2505.1 Housekeeping.** Empty boxes, cartons, pallets and other combustible waste shall be removed from ripening rooms or enclosures and disposed of at regular intervals in accordance with Chapter 3.

- ❖ Waste accumulation, especially packing materials and crop debris, is to be removed regularly from the premises and disposed of in an approved manner to reduce the volume of nonessential combustible materials susceptible to ignition and contributing to the fire load. Section 304 of the code provides specific regulations for waste disposal (see commentary, Section 304).

## SECTION 2506 ETHYLENE GENERATORS

**2506.1 Ethylene generators.** Ethylene generators shall be *listed* and *labeled* by an *approved* testing laboratory, *approved* by the *fire code official* and used only in *approved* rooms in accordance with the ethylene generator manufacturer's instructions. The listing evaluation shall include documentation that the concentration of ethylene gas does not exceed 25 percent of the lower explosive limit (LEL).

- ❖ Several companies produce ethylene generators especially for fruit-ripening processes. These devices convert a liquid similar to ethanol into ethylene gas. This process produces ethylene in concentrations far below the LEL, even in very small compartments, which is an important feature since these generators are portable and could be operating in ripening rooms of different sizes. During a test conducted by an independent testing laboratory and witnessed by representatives of the Los Angeles City Fire Marshal's office, a small [4,000 cubic foot (113 m<sup>3</sup>)] fruit-ripening room was filled with 400 cases of green bananas with the generator set at the maximum setting. During the 8-hour test, the device did not produce a concentration greater than 0.1 percent by volume; the LEL for ethylene is 2.6 percent by volume. While this may not be a worst-case scenario, it certainly suggests a significant safety margin—a factor of 26. This section mandates that ethylene generators be listed and labeled by a third-party testing laboratory. The basic standard used in the investigation and listing of these devices is UL 499, which, while it covers the most significant electrical hazards of ethylene generators, does not evaluate the flammable vapor-air mixtures produced when the devices are operated in closed rooms. This section is intended to fill that gap by requiring that the listing evaluation attests to the safety of the devices by documenting in the report results that the maximum ethylene concentration capable of being generated by the device does not

## FRUIT AND CROP RIPENING

exceed 25 percent of the LEL. This section also requires adherence to the ethylene generator manufacturer's instructions, which are considered part of the listing.

**2506.2 Ethylene generator rooms.** Ethylene generators shall be used in rooms having a volume of not less than 1,000 cubic feet (28 m<sup>3</sup>). Rooms shall have air circulation to ensure even distribution of ethylene gas and shall be free from sparks, open flames or other ignition sources.

- ❖ Because ethylene generators are portable, the level of hazard associated with their use in closed rooms can change each time one is moved to a new ripening room. The intent of this section is to reduce the hazard potential by requiring that ethylene generators be used only in ripening rooms having a minimum volume of 1,000 cubic feet (28 m<sup>3</sup>) [10 feet by 10 feet by 10 feet (3048 mm by 3048 mm by 3048 mm)], that are free from ignition hazards and have air circulation to distribute the ethylene gas evenly throughout the space to avoid the potential for pockets of gas having concentrations approaching or exceeding 25 percent of the LEL.

### SECTION 2507 WARNING SIGNS

**2507.1 Where required.** *Approved* warning signs indicating the danger involved and necessary precautions shall be posted on all doors and entrances to the premises.

- ❖ Given the flammability and the anesthetic quality of ethylene gas, it poses potential dangers to personnel who might accidentally enter a ripening room, building or area unaware of the hazards. As with other hazardous materials, warning signs and placards must be posted to give appropriate notice to warn personnel of the hazards of the ripening process and discourage entry by unauthorized and unprotected people. Warning signs must comply with Sections 5003.5 and 5003.5.1 and include NFPA 704 hazard warning system markings to warn of fire- and health-related hazards of these materials (see commentary, Sections 5003.5 and 5003.5.1).

### Bibliography

The following resource material was used in the preparation of the commentary for this chapter of the code:

“Ethylene Gas Generator—Fruit Ripening.” *Field Service Bulletin F-2-81*. Long Grove, IL: Kemper Group of Insurance Companies, 1981.

# Chapter 26: Fumigation and Insecticidal Fogging

## General Comments

Fumigation is the use of toxic pesticide chemicals to kill insects, rodents and other vermin. In addition, agricultural fumigation is used to kill plant and animal parasites, weed seeds and various types of fungi that adversely affect agricultural products.

Fumigants are available as liquids that will vaporize readily at ambient temperatures, solids that can release a toxic gas on reacting with water or acid or gases. Fumigants and insecticidal fogging agents pose little hazard if properly applied; however, the inherent toxicity of all these agents and the potential flammability of some makes special precautions necessary when they are used. Requirements of this chapter are intended to protect both the public and fire fighters from hazards associated with these products.

The use of fumigants poses the following two distinct hazards to both fire fighters and the general public: some fumigants are flammable or burn under certain circumstances and all fumigants are poisonous or toxic. Compounding these hazards, the fumigation fog may easily be confused with smoke from a fire if it is not properly contained within a building or compartment. Though these concerns seem quite serious, the proper use of fumigants poses little fire hazard. With the exception of allyl alcohol, aluminum phosphide, dichloropropane-dichloropropene mixtures and formaldehyde, most fumigants are relatively difficult to ignite. However, all fumigants are intended to kill something, whether involved in a fire or not. In fact, many of these agents are quite toxic if involved in a fire.

## Special Fire Protection Problems

In particular, aluminum phosphide poses a special fire protection problem. This agent readily decomposes in water to form phosphine ( $\text{PH}_3$ ), a pyrophoric toxic gas. In 1990, M.R. Spencer noted that although the lower flammable limit (LFL) of phosphine is only 1.79 percent, this is more than 10 times the effective concentration for fumigation. However, he also noted that poorly distributed agent and storage canisters can easily produce ignitable concentrations.

The other agents—allyl alcohol, dichloropropane-dichloropropene mixtures and formaldehyde—are either flammable or combustible liquids commonly used in diluted form. However, all flammable or combustible liquids are easier to ignite when finely dispersed in air; therefore, special precautions must be taken to eliminate ignition sources during fumigation and fogging

operations. Commentary Figure 26-1 lists hazard classifications of various common fumigants.

## Information Sources

Understanding and regulating fumigants and insecticidal fogging agents requires specialized knowledge of their hazards beyond the basic classifications of health, flammability and reactivity. Several references provide additional details necessary to apply code requirements. The most helpful of these references is the product's Material Safety Data Sheet (MSDS). A copy of this document is often shipped with a product in transit (see commentary, Section 407 and Chapter 50). Anyone handling or using these products should also have access to this information in compliance with the provisions of the hazard communication requirements of the Occupational Safety and Health Act (OSH Act).

Reference books, such as the *Farm Chemicals Handbook* and the *Crop Protection Chemicals Reference*, are also comprehensive sources for handling and storage information. The former contains a list of common agricultural chemicals based on their use, a list of suppliers or distributors and a chemical dictionary containing each product listed.

Every manufacturer of a pesticide or fumigant also produces a reference known as a label book containing facsimiles of the warning labels for each of its products. This reference is often helpful because U.S. Environmental Protection Agency (EPA) regulations require that labels contain breakdowns of the contents of environmentally hazardous substances and signal words providing clues about their toxicity.

## Storage and Handling

Other code chapters should be consulted for specific storage and handling requirements for certain fumigants. Chapters 50, 57, 60 and 63 prescribe safeguards for the storage and handling of materials based on their specific hazardous properties. Requirements of this chapter apply only to the use of these products as fumigants or insecticidal fogging agents.

## Purpose

Some of these products are also flammable and their involvement in fire may result in serious health or environmental hazards. The key to the safe use of these products is knowledge of the hazards, elimination of ignition sources and isolation of the premises during application.

PRODUCT	DOT CLASSIFICATION	NFPA 704 HAZARD CLASSIFICATION			
		Health	Flammability	Reactivity	Other
Allyl alcohol	Flammable liquid, Poisonous	3	3	0	
Aluminum phosphide	Flammable solid, Poisonous, Water reactive	4	4	2	W
Calcium cyanide	Poison B	3	0	0	
Carbon tetrachloride	ORM-A	3	0	0	
Chloropicrin	Poison B	4	0	3	
Paradichlorobenzene	ORM-A	2	2	0	
Dichloropropane-dichloropropene mixtures	Flammable liquid	3	3	0	
Ethylene dibromide (EDB)	ORM-A	3	0	0	
EDB/chloropicrin mixtures		4	0	3	
Formaldehyde	Combustible liquid	2	4	0	
Furfural	Combustible liquid	2	2	0	
Methyl bromide	Poison B	3	1	0	
Methyl bromide/chloropicrin mixtures	Poison B	4	1	3	
Methyl bromide/EDB mixtures	Poison B	3	1	0	
Methylene chloride		2	1	0	
Napthalene	ORM-B	2	2	0	
Phosphine	Poison A, Flammable	4	4	4	

a. This list was compiled from chemicals listed under the heading "Fumigants" in the *Farm Chemicals Handbook*.

b. Other common fumigants include: streptomycin, dibromo-chloropropane, metam ammonium and metan sodium (consult MSDS or these products before issuing permits.)

**Figure 26-1**  
**HAZARDOUS PROPERTIES OF COMMON FUMIGANTS<sup>a, b</sup>**

**SECTION 2601**  
**GENERAL**

**2601.1 Scope.** Fumigation and insecticidal fogging operations within buildings, structures and spaces shall comply with this chapter.

❖ The requirements of this chapter govern fumigation operations using insecticidal fogging agents and other air-borne pesticides used to control insects, rodents, vermin and other similar pests inside buildings, structures and spaces.

**2601.2 Permits.** Permits shall be required as set forth in Section 105.6.

❖ Issuing an operational permit as prescribed in Section 105.6.19 gives the fire code official a method for identifying and controlling the hazards of fumigation and insecticidal fogging operations. The process of issuing permits also gives the fire code official a reason or method to advise fire fighters of the potential hazards at fumigation sites. This will allow fire fighters to take special note of the hazards present and will give them the information needed to determine whether the operation is mistaken for a fire.

This chapter states the requirements for approval and special warning signs because of the toxicity and

flammability hazards of fumigants. Upon notification of the hazardous potential, the fire code official should notify the fire department responsible for protecting the work site.

A guard or fire watch must be posted at the work site and must have a means available to report a fire or other emergency. If possible, a means should also be provided for the fire department to contact the guards or fire watches to verify the occurrence of a fire and obtain additional information en route to the scene.

**SECTION 2602**  
**DEFINITIONS**

**2602.1 Definitions.** The following terms are defined in Chapter 2:

**FUMIGANT.**

**FUMIGATION.**

**INSECTICIDAL FOGGING.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chap-

ter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3 or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

### SECTION 2603 FIRE SAFETY REQUIREMENTS

**2603.1 General.** Buildings, structures and spaces in which fumigation and insecticidal fogging operations are conducted shall comply with the fire protection and safety requirements of Sections 2603.2 through 2603.7.

❖ The provisions in Sections 2603.2 through 2603.7 apply to safe fumigation and insecticidal fogging in buildings, structures and spaces.

**2603.2 Sources of ignition.** Fires, open flames and similar sources of ignition shall be eliminated from the space under fumigation or insecticidal fogging. Heating, where needed, shall be of an *approved* type.

❖ Some insecticides and fumigants are flammable. Others that are considered nonflammable may ignite readily when suspended in air or dispersed as a vapor during fogging or fumigation operations. See the commentary to Chapters 22, 50, 57 and 60, and Section 307 of the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>), for further information on the safe storage and handling of dusts and other materials used as pesticides or fogging agents.

**2603.2.1 Electricity.** Electricity in any part of the building, structure or space where operation of switches or electrical devices, equipment or systems could serve as a source of ignition shall be shut off.

**Exception:** Circulating fans that have been specifically designed for utilization in hazardous atmospheres and installed in accordance with NFPA 70.

❖ The structure's electrical service must be disconnected at the main service disconnect during fumigation or insecticidal fogging operations. While not specifically required, a physical means for preventing the inadvertent, premature restoration of power by anyone other than the fumigation supervisor should be provided, such as by locking the service disconnect switch, if possible, or by equivalent means.

The exception allows the use of fans to assist in the distribution of fumigant throughout the building undergoing fumigation. The power supply for circulating fans must be located outside the building undergoing fumigation or the fans may be self-powered, either by battery or an integral internal combustion engine. In any case, fans exposed to the hazardous atmosphere must be appropriately classified when an insecticide or fogging agent is susceptible to ignition during application or use, so as not to become an ignition source.

Equipment and devices used in the presence of flammable liquid vapors must be classified for use in

Class I, Division 1, hazardous locations. When used where a dust explosion hazard exists, the fans must be classified for Class II hazardous locations.

**2603.2.2 Electronic devices.** Electronic devices, including portable equipment and cellular phones, shall be shut off. Telephone lines shall be disconnected from telephones.

❖ This section focuses on the ignition hazard posed to flammable vapor-rich atmospheres by popular personal electronic devices, such as cell phones, MP3 players, computers, etc., and requires that if present, they be shut off. Even though telephones are low-voltage devices, in certain atmospheres, the simple ringing of a telephone can be a source of ignition in a space undergoing fumigation. To avert potential ignition by a telephone, telephone lines must be unplugged from the phone sets.

**2603.2.3 Duration.** Sources of ignition shall be shut off during the fumigation activity and remain shut off until the ventilation required in Section 2603.6 is completed.

❖ This section provides the common-sense precaution regarding ignition sources that they must be secured as required by Sections 2603.2, 2603.2.1 and 2603.2.2 until the fumigation operation is finished and the fumigated space has been ventilated in accordance with Section 2603.6.

**2603.3 Notification.** The *fire code official* and fire chief shall be notified in writing not less than 48 hours before the building, structure or space is to be closed in connection with the utilization of any toxic or flammable fumigant. Notification shall give the location of the enclosed space to be fumigated or fogged, the occupancy, the fumigants or insecticides to be utilized, the person or persons responsible for the operation, and the date and time at which the operation will begin. Written notice of any fumigation or insecticidal fogging operation shall be given to all affected occupants of the building, structure or space in which such operations are to be conducted with sufficient advance notice to allow the occupants to evacuate the building, structure or space. Such notice shall inform the occupants as to the purposes, anticipated duration and hazards associated with the fumigation or insecticidal fogging operation.

❖ Written notice is required at least 48 hours before a structure is closed for fumigation or fogging with flammable or toxic agents. All pesticides must be considered toxic to some degree because they are intended to kill something at some concentration. Occupants of the structure must be given sufficient advance notice to permit evacuation and removal of any belongings or equipment that may be endangered by fumigation or fogging operations. The fire code official should relay the notification information and the nature of the fumigation or fogging operation to the responsible fire service personnel for this location.

Fire fighters must be aware of the nature of hazards to encourage the use of protective gear and precautions when investigating or operating at sites involving structures undergoing fumigation. Fire code

officials may consider the required written notification as a default for permit application under Section 2601.2; however, the fire code official must inspect the premises and equipment to verify compliance with the code before a permit is issued (see commentary, Sections 105.2.2 and 105.6.20).

**2603.3.1 Warning signs.** *Approved* warning signs indicating the danger, type of chemical involved and necessary precautions shall be posted on all doors and entrances to the affected building, structure or space and upon all gangplanks and ladders from the deck, pier or land to a ship. Such notices shall be printed in red ink on a white background. Letters in the headlines shall be not less than 2 inches (51 mm) in height and shall state the date and time of the operation, the name and address of the person, the name of the operator in charge, and a warning stating that the affected building, structure or space shall be vacated not less than 1 hour before the operation begins and shall not be reentered until the danger signs have been removed by the proper authorities.

- ❖ Warning signs and placards must be posted to give notice for evacuation, warn of the hazards of the fumigant or fogging agent and discourage entry by unauthorized and unprotected people. Warning signs must include the name and address of the party responsible for conducting fumigation operations. Both names and hazards associated with the chemical fumigant must appear on the warning signs.

The NFPA 704 hazard warning system is especially useful for warning of the fire-related hazards of these materials. Hazard warning signs also provide useful qualitative information about the relative toxicity of pesticides and fumigants in use at a particular site to warn and assist the fire department (see Commentary Figure 2603.3.1).

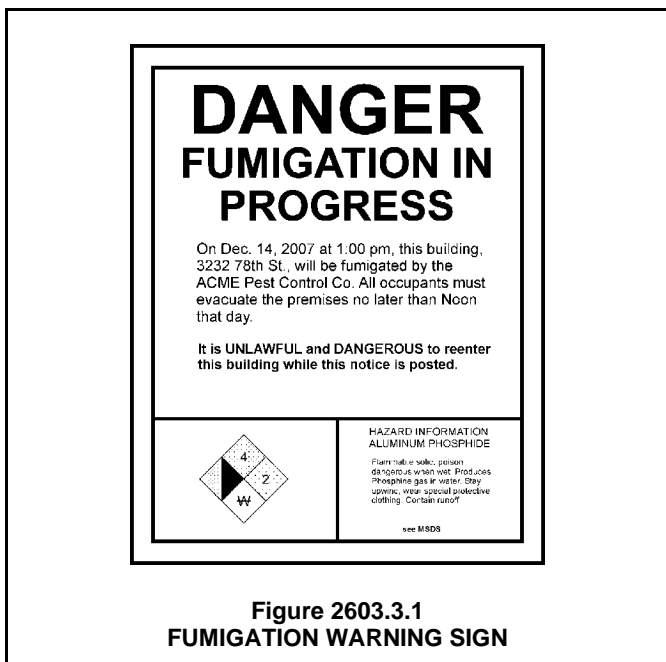


Figure 2603.3.1  
FUMIGATION WARNING SIGN

**2603.3.2 Breathing apparatus.** Persons engaged in the business of fumigation or insecticidal fogging shall maintain and have available *approved* protective breathing apparatus.

- ❖ Respiratory protective equipment must be appropriate for the hazards of the material used. Stored-air self-contained breathing apparatus (SCBA) is not necessarily the only appropriate form of respiratory protection. Canister respirators with suitable filters may provide employees greater flexibility to perform required tasks without posing a danger of exposure or contamination to the employee. Employees required to wear respiratory protective equipment should be fitted for the correct size mask and enrolled in a medical surveillance program. The required protective equipment must be available at all times during the fumigation or fogging process.

**2603.3.3 Watch personnel.** During the period fumigation is in progress, except where fumigation is conducted in a gas-tight vault or tank, a responsible watchperson shall remain on duty at the entrance or entrances to the enclosed fumigated space until after the fumigation is completed and the building, structure or space is properly ventilated and safe for occupancy. Sufficient watchers shall be provided to prevent persons from entering the enclosed space under fumigation without being observed.

- ❖ A minimum of one watch must be posted at each entrance to the structure or space being fumigated. Watch personnel must discourage or prevent entry by unauthorized and unprotected individuals until fumigation is completed; the building, structure or premises has been ventilated; and the building, structure or premises is again ready for occupancy. Watch personnel must also have a means available to report emergencies without leaving their posts unattended. If practical, a means should be provided for the fire department to contact the watch while responding to determine whether a fire exists and, if so, obtain additional information before arrival.

**2603.3.4 Evacuation during fumigation.** Occupants of the building, structure or space to be fumigated, except the personnel conducting the fumigation, shall be evacuated from such building, structure or space prior to commencing fumigation operations.

- ❖ This section reinforces the life safety focus of this chapter by requiring that occupants of areas to be fumigated must leave the area of treatment prior to the commencing of fumigation operations to avoid contact with the toxic fumigant. Obviously, the fumigator's personnel are allowed to remain since they would be protected by appropriate protective clothing and a breathing apparatus. Although it is not explicitly stated, occupants should remain outside of the fumigated area until it has been properly ventilated and cleaned up in accordance with Section 2603.6.

**2603.3.5 Evacuation during insecticidal fogging operations.** Occupants in the building, structure or space to be

fogged, except the personnel conducting the insecticidal fogging operations, shall be evacuated from such building, structure or space prior to commencing fogging operations.

- ❖ This section reinforces the life safety focus of this chapter by requiring that the occupants of the areas to be fogged must leave the area of treatment prior to the commencing of insecticidal fogging operations to avoid contact with the toxic pesticide fog. Obviously, the insecticidal fogger's personnel are allowed to remain since they would be protected by appropriate protective clothing and a breathing apparatus. Although it is not explicitly stated, occupants should remain outside of the fogged area until it has been properly ventilated and cleaned up in accordance with Section 2603.6.

**2603.4 Insecticidal fogging liquids.** Insecticidal fogging liquids with a *flash point* below 100°F (38°C) shall not be utilized.

- ❖ The use of Class I flammable liquids as fumigants is prohibited. Many fumigants that are otherwise non-flammable or only combustible may be easily ignited when dispersed or suspended in air as a vapor or fine mist. This prohibition does not apply to flammable active ingredients in nonflammable concentrations when in a solution with other ingredients.

**2603.5 Sealing of buildings, structures and spaces.** Paper and other similar materials that do not meet the flame propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701 shall not be used to wrap or cover a building, structure or space in excess of that required for the sealing of cracks, casements and similar openings.

- ❖ Fundamental to a successful fumigation operation is achieving the proper concentration of fumigant for the proper length of time to allow the treatment to permeate all portions of the structure, including interstitial spaces and even some building materials to a cellular level. To achieve this level of permeation, the building, structure or space must be made as gas tight as possible. Small holes, cracks and openings can easily be sealed with tape; heavy-weight paper secured with tape or water-soluble or peelable paste; caulking compound; foam plastic sealant; or similar, readily available materials. Larger openings can be sealed using plastic sheets held in place with tacks or staples and sealed with tape; heavy-weight paper secured with tape or water-soluble or peelable paste; or a spray-on vinyl sealant. The use of these and similar readily combustible materials should be limited to small cracks, casements and similar openings.

This section is intended to ensure that more extensive sealing procedures than the simple crack and hole sealing described above, such as wrapping the building or tenting it, be done using materials that are, at a minimum, flame resistant in accordance with one of the test methods of NFPA 701. The use of such materials reduces the susceptibility of the enclosing

membrane to easy ignition that could quickly engulf the entire structure in fire.

**2603.5.1 Maintenance of openings.** All openings to the building, structure or space to be fumigated or fogged shall be kept securely closed during such operation.

- ❖ Because of the "soak time" needed for fumigation operations to be successful, this section requires that the sealing of all openings to the fumigation area be maintained tightly sealed throughout the duration of the fumigation operation. This sealing of openings coupled with the watch person required by Section 2603.3.3 will also help prevent unauthorized personnel from inadvertently wandering into a toxic atmosphere or releasing fumigants to parts of the building not being fumigated. It will also prevent fumigant fog from escaping and being mistaken by a passerby for smoke from a fire which could result in an unwanted report of a fire.

**2603.6 Venting and cleanup.** At the end of the exposure period, fumigators shall safely and properly ventilate the premises and contents; properly dispose of fumigant containers, residues, debris and other materials used for such fumigation; and clear obstructions from gas-fired appliance vents.

- ❖ Following the desired fumigant exposure period, the structure must be completely aired by opening as many doors and windows as possible from the outside. Also at this time, any exterior wrapping and sealing materials should be removed. Complete removal of sealing materials from the gas-fired appliance vent and combustion air intake openings that were sealed during fumigation is especially important to avoid potential backups of products of combustion in the building. Approved ventilators and fans powered from a source, and with their switches accessible from outside the building, should be started as well (see commentary, Section 2603.2.1). Personnel should then withdraw from the immediate vicinity of the fumigated structure and wait a reasonable length of time before entering the building to open more doors and windows to complete the ventilation process.

Throughout the ventilation process, personnel should wear personal breathing protection equipment (respirators). Tests for the presence of gas may be conducted as soon as the fumigator determines that the structure is properly aired. Chemical tests for residual fumigant must be carried out to verify that both the structure and its contents are free of toxic concentrations of fumigant, at which time the building may be reoccupied for normal activities.

Consistent with Section 304, rubbish and debris generated by the fumigation project must be removed from the premises and properly discarded. Because fumigants are hazardous materials, fumigant containers and other materials that might contain flammable or toxic fumigant residues must be disposed of in accordance with the fumigant manufacturer's instructions.

**2603.7 Flammable fumigants restricted.** The use of carbon disulfide and hydrogen cyanide shall be restricted to agricultural fumigation.

❖ While they are very effective fumigants, carbon disulfide (Formula: CS<sub>2</sub>; CAS # 75-15-0) and hydrogen cyanide (Formula: HCN; CAS # 74-90-8) present such severe flammability and toxicity hazards that their use is restricted to agricultural fumigation applications only.

In addition to being toxic (see commentary, Chapter 60), carbon disulfide is a Class IB flammable liquid (see commentary, Chapter 57) having a flash point of -22°F (-30°C), a boiling point of 116°F (47°C) and a flammability range of 1 to 50 percent, thus making any release an extreme fire and deflagration hazard to the extent that its vapors can be ignited by contact with the heated surfaces of steam heating pipes or ordinary incandescent light bulbs. Given these dangers, carbon disulfide is typically used in mixtures with other materials, such as carbon tetrachloride as a fire suppressant, or stabilizing chemicals, such as sulfur dioxide, to mitigate the hazards of use.

The typical agricultural use of carbon disulfide is as a fumigant for treating raw cereal grains in grain bins and silos.

Hydrogen cyanide (also known as formonitrile, hydrocyanic acid or prussic acid) is colorless, possesses a characteristic almond-like aroma and is an insecticide principally used for fumigation of stored agricultural products, especially grains and flour in mills, warehouses and the holds of ships.

In fruit-growing regions of the United States, hydrogen cyanide has also been widely used for destroying scale insects on citrus trees by covering each tree with a gas tent. Hydrogen cyanide can be a Class IA flammable liquid (see commentary, Chapter 57) or a flammable gas (see commentary, Chapter 58). As a liquid, it may also be classified as a Class 2 unstable reactive material (see commentary, Chapter 66), a Class 1 water-reactive material (see commentary, Chapter 67) and a highly toxic material (see commentary, Chapter 60). Hydrogen cyanide may enter the body in toxic amounts by absorption through unbroken skin, inhalation and direct ingestion.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

*Code Changes Resource Collection—2015 International Fire Code.* Washington, DC: International Code Council, 2014.

*Crop Protection Chemical Reference.* Etobicoke, ON, Canada: John Wiley & Sons Canada, Limited, 1986.

*Farm Chemicals Handbook.* Willoughby, OH: Meister Publishing Co., 1991.

Moerer, G., L. Thompson, and M. Wood. "Pesticides." Chapter 11, Section 8, In Cote, A.E. ed. *Fire Protection Handbook*, 19th ed. Quincy, MA: National Fire Protection Association, 2003.

Spencer, M.R. "Storage and Handling of Grain Mill Products." In Cote, A.E., ed. *Fire Protection Handbook*, 17th ed. Quincy, MA: National Fire Protection Association, 1991.

# Chapter 27: Semiconductor Fabrication Facilities

## General Comments

The invention, development and exploitation of semiconductor technology has changed the world. Without integrated circuits, and the microchips (or “chips”) they are composed of, the world of high technology would not exist. With the benefits of living in a high-tech age come some unique and pressing challenges. The manufacture of microchips is a complex, hazardous and demanding operation involving state-of-the-art design and manufacturing techniques, specially designed processing centers and a highly trained work force. Despite these rigors, the dangers of the processes can neither be avoided nor ignored.

The manufacture of semiconductors and microprocessors has developed into its own industry within the last 25 years. The proliferation of computer technology has resulted in the incredible expansion of the semiconductor manufacturing industry. These sophisticated products require a special processing environment and new rules to match the new technology. Unlike many other hazardous operations, hazards of the production

materials are not manifested in the finished product. Considering the unique and often acute hazards of many materials used in semiconductor processing, this contributes to the relatively good safety record of the industry.

## Purpose

The requirements of this chapter are intended to control hazards associated with the manufacture of semiconductors. Though the finished product possesses no unusual hazards, materials commonly associated with semiconductor manufacturing are often quite hazardous and include flammable liquids; pyrophoric and flammable gases; toxic substances and corrosives. The requirements are concerned with both life safety and property protection. However, the fire code official should recognize that the risk of extraordinary property damage is far more common than the risk of personal injury from fire.

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## SECTION 2701 GENERAL

**2701.1 Scope.** Semiconductor fabrication facilities and comparable research and development areas classified as Group H-5 shall comply with this chapter and the *International Building Code*. The use, storage and handling of hazardous materials in Group H-5 shall comply with this chapter, other applicable provisions of this code and the *International Building Code*.

❖ Semiconductor facilities are unique facilities that, due to their size, complex layout and the logistics of their operations, have been provided with a unique package of requirements. In some cases these unique requirements will allow the maximum allowable quantities (MAQs) established in Tables 5003.1.1(1) and 5003.1.1(2) to be exceeded. The hazardous material MAQs are essentially replaced by more specific allowances and restrictions in this chapter. In cases where a material hazard is not addressed in this chapter, the applicable requirements found in Chapter 50 and associated material-specific chapters of the code and the *International Building Code*® (IBC®) would still apply regardless of whether the MAQs have been exceeded. Semiconductor fabrication facilities are classified in Occupancy Group H-5 and are to comply with the applicable provisions of IBC Section 415.11.

**2701.2 Application.** The requirements set forth in this chapter are requirements specific only to Group H-5 and shall be applied as exceptions or additions to applicable requirements set forth elsewhere in this code.

❖ Chapter 27 requirements are specific only to Group H-5 occupancies, with the requirements applied as exceptions or additions to requirements addressed elsewhere in the code. Where Chapter 27 contains a specific requirement for a certain condition and a general requirement for the same condition exists elsewhere in the code, the specific Chapter 27 requirements are to be applied. For example, general requirements for spill control and containment for use conditions involving hazardous materials in amounts exceeding MAQs are found in Section 5005.2, with conditions specific to Group H-5 occupancies addressed in Section 2705.2.2. For Group H-5 occupancy conditions, the specific Section 2705.2.2 requirements take precedence over the general requirements addressed in Section 5005.2.

**2701.3 Multiple hazards.** Where a material poses multiple hazards, all hazards shall be addressed in accordance with Section 5001.1.

❖ All hazard classifications of a material are to be considered. For example, glacial acetic acid is classified as both a Class II combustible liquid and a corrosive liquid. Thus, for glacial acetic acid, the requirements

for both Class II combustible liquids and corrosive liquids must be met. This section restates the conditions found in Section 5001.1.

**2701.4 Existing buildings and existing fabrication areas.** Existing buildings and existing *fabrication areas* shall comply with this chapter, except that transportation and handling of HPM in *corridors* and enclosures for stairways and ramps shall be allowed where in compliance with Section 2705.3.2 and the *International Building Code*.

❖ Although the adoption and enforcement of code requirements specifically addressing semiconductor manufacturing and similar research and development operations have been in place for over 20 years, there are still some facilities that predate the adoption of regulations specific to these operations. This section requires modifications to existing facilities to comply with certain provisions of IBC Section 415.11. Additionally, requirements found in Section 2705.3.2 of this code and Section 415.11.3 of the IBC must be met when existing conditions or modifications do not include service corridors and existing exit access corridors that are used to transport hazardous production materials (HPM) to fabrication areas.

**2701.5 Permits.** Permits shall be required as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. The process also notifies the fire department of the need for prefire planning for the hazardous property. See the commentary to Section 105.6 for a

general discussion of operations requiring an operational permit; notably Section 105.6.21 for a discussion of specific quantity-based hazardous materials operational permits; and Section 105.6.22 for HPM operational permits.

**SECTION 2702  
DEFINITIONS**

**2702.1 Definitions.** The following terms are defined in Chapter 2:

**CONTINUOUS GAS DETECTION SYSTEM.**

**EMERGENCY CONTROL STATION.**

**FABRICATION AREA.**

**HAZARDOUS PRODUCTION MATERIAL (HPM).**

**HPM ROOM.**

**PASS-THROUGH.**

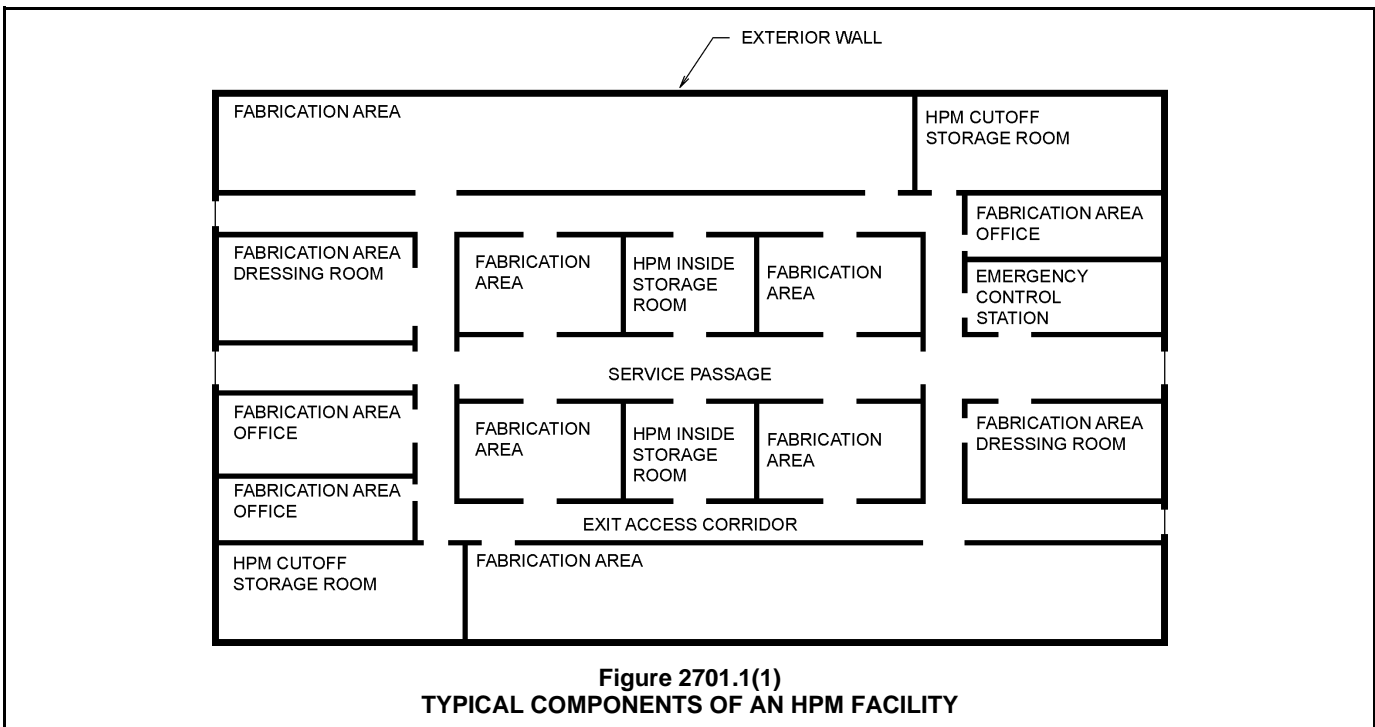
**SEMICONDUCTOR FABRICATION FACILITY.**

**SERVICE CORRIDOR.**

**TOOL.**

**WORKSTATION.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*® (I-Code®) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).



**Figure 2701.1(1)  
TYPICAL COMPONENTS OF AN HPM FACILITY**

MATERIAL	DESCRIPTION OR USE	NFPA 704 HAZARD CLASSIFICATION			
		Health	Flammability	Reactivity	Other
Acetic acid	Corrosive liquid used for wet etching (metal)	2	2	1	
Acetone	Flammable liquid used for wafer cleaning	1	3	0	
Ammonium fluoride	Corrosive for wet etching (oxide)	3	0	0	
Arsenic trichloride	Diffusion	3	0	1	W
Arsenic trioxide	Diffusion	4	0	0	
Arsine	Poison flammable gas used for epitaxial growth, diffusion and ion implantation	4	4	3	
Boron tribromide	Corrosive liquid used for diffusion	4	0	3	W
Boron trichloride	Nonflammable corrosive gas used for diffusion	4	0	1	W
Chlorine	Poison gas used for dry etching	3	0	0	OXY
Diborane	Highly reactive flammable gas used for diffusion	3	4	3	W
Dichlorosilane	Flammable liquefied gas used for epitaxial growth	4	4	4	
Gallium	Reactive metal used as a semiconductor crystal material	1	0	3	
Gallium arsenide	Reactive metal salt used as a semiconductor crystal material	3	0	0	
Gallium arsenide phosphide	Reactive metal salt used as a semiconductor crystal material	3	0	0	
Germanium	Reactive metal used as a semiconductor crystal material	0	0	3	
Hydrofluoric acid	Highly corrosive liquid or gas used for wet etching (oxide)	4	0	0	
Hydrogen peroxide <sup>a</sup>	Organic peroxide used for wafer cleaning	2	0	1	OXY
Isopropanol	Flammable liquid used for wafer cleaning	1	3	0	
Methanol	Flammable liquid used for wafer cleaning	1	3	0	
Nitric acid	Corrosive liquid used for wet etching (metal)	3	0	0	OXY
Oxygen (liquid)	Oxidizing gas used for oxidation	3	0	0	OXY
Phosphine	Flammable liquefied poison gas used for diffusion and ion implantation	4	4	4	
Phosphoric acid	Corrosive liquid used for wet etching (metal)	2	0	0	
Phosphorus oxychloride	Corrosive liquid used for diffusion	4	0	3	W
Phosphorus pentoxide	Corrosive solid sublimed for use in diffusion	4	0	3	W
Phosphorus tribromide	Corrosive liquid used for diffusion	4	0	3	W
Silane	Pyrophoric gas used for oxidation	2	4	4	
Silicon	Flammable solid (metal) used as a semiconductor crystal material	2	4	2	W
1, 1, 1-Trichloroethane	Mildly flammable solvent (difficult to ignite) used for wafer cleaning	2	1	0	
Tetrachlorosilane	Flammable liquid used for epitaxial growth	3	4	2	W

a. NFPA 704 values for 35 to 52 percent by weight (the most concentration) are listed. The reactivity hazard increases to 3 at concentrations above 52 percent.

**Figure 2701.1(2)**  
**HAZARDOUS PRODUCTION MATERIALS (HPM) USED IN THE MANUFACTURE OF SEMICONDUCTORS**

## SECTION 2703 GENERAL SAFETY PROVISIONS

**2703.1 Emergency control station.** An *emergency control station* shall be provided in accordance with Sections 2703.1.1 through 2703.1.3.

❖ This section introduces the requirements for emergency control stations in HPM facilities.

**2703.1.1 Location.** The *emergency control station* shall be located on the premises at an *approved* location outside the fabrication area.

❖ In order to enhance its operational integrity, the emergency control station must not be located in an area where hazardous materials are stored, used or transported, such as a fabrication area.

**2703.1.2 Staffing.** Trained personnel shall continuously staff the *emergency control station*.

❖ If an emergency control station is to be effective, continuous staffing must be provided. Those personnel must be conversant with the meaning of and proper response protocols for all system signals received in the station, and be able to implement prompt responsive actions.

**2703.1.3 Signals.** The *emergency control station* shall receive signals from emergency equipment and alarm and detection systems. Such emergency equipment and alarm and detection systems shall include, but not be limited to, the following where such equipment or systems are required to be provided either in this chapter or elsewhere in this code:

1. *Automatic sprinkler system* alarm and monitoring systems.
2. Manual fire alarm systems.
3. Emergency alarm systems.
4. Continuous gas detection systems.
5. Smoke detection systems.
6. Emergency power system.
7. Automatic detection and alarm systems for pyrophoric liquids and Class 3 water-reactive liquids required by Section 2705.2.3.4.
8. Exhaust ventilation flow alarm devices for pyrophoric liquids and Class 3 water-reactive liquids cabinet exhaust ventilation systems required by Section 2705.2.3.4.

❖ This section specifies the systems that are to be monitored by an emergency control station. The fire alarm system signals are received at the emergency control station, which must be located in an area approved by the fire code official. See also the commentary to the Section 202 definition of "Emergency control station."

**2703.2 Systems, equipment and processes.** Systems, equipment and processes shall be in accordance with Sections 2703.2.1 through 2703.2.3.2.

❖ This section introduces and establishes the applicability of the provisions of Section 2703.2.1 through

2703.2.3.2 to HPM systems, equipment and processes.

**2703.2.1 Application.** Systems, equipment and processes shall include, but not be limited to, containers, cylinders, tanks, piping, tubing, valves and fittings.

❖ This section clarifies the applicability of Section 2703.2 by defining what is included in the terms "systems," "equipment" and "processes" as they are used in this section.

**2703.2.2 General requirements.** In addition to the requirements in Section 2703.2, systems, equipment and processes shall also comply with Section 5003.2, other applicable provisions of this code, the *International Building Code* and the *International Mechanical Code*.

❖ This section contains a general reference to the IBC and the *International Mechanical Code*® (IMC®), as well as to Section 5003.2 and other sections of the code for regulations pertaining to hazardous materials-related systems, equipment and processes. Except as addressed in Section 2703.2.3, the requirements of the code for things such as containers, cylinders, tanks, piping, tubing, valves and fittings in Group H-5 occupancy facilities are basically the same as they are for other occupancies.

**2703.2.3 Additional requirements for HPM supply piping.** In addition to the requirements in Section 2703.2, HPM supply piping and tubing for HPM gases and liquids shall comply with this section.

❖ This section introduces the additional requirements of Sections 2703.2.3.1 and 2703.2.3.2, which are applicable to HPM supply piping due to the nature of the materials it transports.

**2703.2.3.1 General requirements.** The requirements set forth in Section 5003.2.2.2 shall apply to supply piping and tubing for HPM gases and liquids.

❖ The additional requirements for supply piping and tubing transferring HPM gases or liquids include the general requirements established in Section 5003.2.2.2, as well as more specific requirements for supply piping or tubing containing HPM gases or liquids having a health-hazard ranking of 3 or 4 found in Section 2703.2.3.2.

**2703.2.3.2 Health-hazard ranking 3 or 4 HPM.** Supply piping and tubing for HPM gases and liquids having a health-hazard ranking of 3 or 4 shall be welded throughout, except for connections located within a ventilation enclosure if the material is a gas, or an *approved* method of drainage or containment provided for connections if the material is a liquid.

❖ The primary purpose of the more specific requirements for supply piping or tubing containing a health-hazard ranking of 3 or 4 is to minimize the potential for HPM leakage. The use of mechanical compression-type fittings or other nonwelded joints for these materials is intended to be limited to areas where liquid leaks will be contained or drained, and gas leaks will be contained or exhausted.

**2703.3 Construction requirements.** Construction of semiconductor fabrication facilities shall be in accordance with Sections 2703.3.1 through 2703.3.9.

- ❖ This section contains references to the various construction requirements affecting the components of a semiconductor fabrication facility.

**2703.3.1 Fabrication areas.** Construction and location of fabrication areas shall comply with the *International Building Code*.

- ❖ Semiconductors are manufactured to specific standards. Current high-speed computers require highly sophisticated microprocessors, which rely on extremely fine electrical pathways to transmit the impulses forming the basis for their operation. A single particle of dust that is only a fraction of a micron in diameter may destroy a microprocessor by clogging one of these electronic arteries. Specially designed enclosures called “clean rooms” must be used for fabricating these products to protect the finished product during assembly. Commentary Figure 2703.3.1 illustrates various classifications used to describe the degree of cleanliness in a clean room. Environmental particulates inside the clean room are controlled by filtering all air entering the room through special high-efficiency particulate air (HEPA) filters and constantly replacing the air inside the room.

Fabrication areas are portions of an HPM area where semiconductors are actually produced. The circuit pattern is etched on the surface of the semiconductor crystal material during fabrication. Successive layers of etched semiconductor material are assembled to create integrated circuits or microchips. Fabrication is done in clean rooms, which derive their name from the ability of mechanical ventilation systems to maintain an environment nearly free of airborne particulate contamination. As a result, clean rooms are classified according to the number of particles in a cubic foot of air. For example, in a Class 10 clean room, mechanical ventilation is capable of removing all but 10 particles per cubic foot from the air in the room. The extraordinary precision required in the manufacture of semiconductors demands such cleanliness.

A fire in such an environment represents not only a life and property hazard, but also a serious contamination concern. The monetary value of semiconductors is of secondary concern when compared to the value of lost production time during recovery from a fire or other emergency. Such losses may extend into the millions of dollars from even very small fires. IBC Section 415.11 specifies requirements for the fabrication of areas to control these hazards. The requirements of this chapter are intended to complement and maintain compliance with the requirements of IBC Section 415.11.

**2703.3.2 Pass-throughs in exit access corridors.** Pass-throughs in *exit access corridors* shall be constructed in accordance with the *International Building Code*.

- ❖ Pass-throughs in exit access corridor walls must be constructed to maintain the integrity of any required fire-resistance rating of such walls in an HPM facility. Pass-through doors must also function to maintain that integrity. The IBC contains construction requirements for exit access corridor walls and their opening protectives in Chapter 10 (see also the commentary to the Section 202 definition of “Pass-through”).

**2703.3.3 Liquid storage rooms.** Liquid storage rooms shall comply with Chapter 57 and the *International Building Code*.

- ❖ Liquid storage rooms are used to store closed containers of flammable or combustible liquids used in the HPM processes. Section 5704.3.7 contains detailed requirements for these rooms (see also the commentary to the Section 202 definition of “Liquid storage room”).

**2703.3.4 HPM rooms.** HPM rooms shall comply with the *International Building Code*.

- ❖ Proper storage of hazardous materials can reduce the danger associated with those materials. Section 2704.3 establishes that adequate separation must be provided between materials and limits the quantity of materials stored in HPM rooms. This section requires that the separation of HPM storage rooms must comply with IBC Section 415.11 (see also the commentary to the Section 202 definition of “HPM room”).

Class	Measured Particle Size (Microns)				
	0.1	0.2	0.3	0.5	0.5
1	35	7.5	3	1	—
10	350	7.5	30	10	—
100	—	750	300	100	—
1,000	—	—	—	1,000	7
10,000	—	—	—	10,000	70
100,000	—	—	—	100,000	700

Source: Pearce, R.J. “Clean Rooms,” in Cote, A.E., ed., *Industrial Fire Hazards Handbook*.

**Figure 2703.3.1  
CLEAN ROOM CLASSIFICATIONS**

**2703.3.5 Gas cabinets.** Gas cabinets shall comply with Section 5003.8.6.

- ❖ To reduce the hazards presented by gases used in the fabrication of semiconductors, Section 5003.8.6 contains specific construction and ventilation requirements for enclosed gas cabinets used for the storage of HPM gases (see also the commentary to the Section 202 definition of “Gas cabinet”).

**2703.3.6 Exhausted enclosures.** Exhausted enclosures shall comply with Section 5003.8.5.

- ❖ To reduce the hazards presented by hazardous materials used in the fabrication of semiconductors, Section 5003.8.5 contains specific construction and ventilation requirements for exhausted enclosures used for the storage of HPM. Whereas gas cabinets must be fully enclosed and equipped with self-closing doors, exhausted enclosures are typically open-fronted and lend themselves to small-scale operations, such as fume hoods found in chemical laboratories (see also the commentary to the Section 202 definition of “Exhausted enclosure”).

**2703.3.7 Gas rooms.** Gas rooms shall comply with Section 5003.8.4.

- ❖ To reduce the hazards presented by hazardous gases used in the fabrication of semiconductors, Section 5003.8.4 contains specific construction and ventilation requirements for gas rooms used for the storage of HPM gases. These rooms are intended to be restricted to the storage of cylinders and tanks of highly toxic and toxic compressed gases. The storage of other hazardous materials, such as flammable and combustible liquids, is not permitted within a gas room. Similar to gas cabinets, the required exhaust ventilation for the gas room must be operated at negative pressures to prevent leakage of hazardous vapors to adjacent areas.

**2703.3.8 Service corridors.** Service corridors shall comply with Section 2705.3 and the *International Building Code*.

- ❖ The likelihood of accidental spillage or contact with HPM is increased during the transportation of such materials. Section 2705.3 regulates materials, handling and transportation in passageways used for purposes other than required means of egress.

**2703.3.9 Cabinets containing pyrophoric liquids or water-reactive Class 3 liquids.** Cabinets in *fabrication areas* containing pyrophoric liquids or Class 3 water-reactive liquids in containers or in amounts greater than  $\frac{1}{2}$  gallon (2 L) shall comply with Section 2705.2.3.4.

- ❖ See the commentary to Section 2705.2.3.4.

**2703.4 Emergency plan.** An emergency plan shall be established as set forth in Section 403.7.1.

- ❖ Thorough planning is essential to evacuate personnel effectively and to combat a fire or other emergency. Risks associated with a structure containing HPM require extraordinary efforts regarding evacuation

and fire control. Specific emergency planning procedures are outlined in Section 403.7.1.

**2703.5 Maintenance of equipment, machinery and processes.** Maintenance of equipment, machinery and processes shall comply with Section 5003.2.6.

- ❖ Fundamental to the safe operation of an HPM facility are the care and maintenance of the equipment used in the various fabrication processes. Section 5003.2.6 contains detailed maintenance requirements.

**2703.6 Security of areas.** Areas shall be secured in accordance with Section 5003.9.2.

- ❖ Public safety requires that HPM facilities be secure against unauthorized entry in accordance with Section 5003.9.2. Such security reduces the likelihood of hazardous material release or fire caused by a malicious act.

**2703.7 Electrical wiring and equipment.** Electrical wiring and equipment in HPM facilities shall comply with Sections 2703.7.1 through 2703.7.3.

- ❖ The safety and integrity of electrical wiring and equipment is a key factor in workplace safety. This section introduces the electrical safety requirements, by area, for HPM facility fabrication areas, workstations and storage rooms.

**2703.7.1 Fabrication areas.** Electrical wiring and equipment in *fabrication areas* shall comply with NFPA 70.

- ❖ NFPA 70 contains requirements for the electrical safety of HPM facilities, including fabrication areas.

**2703.7.2 Workstations.** Electrical equipment and devices within 5 feet (1524 mm) of workstations in which flammable or pyrophoric gases or flammable liquids are used shall comply with NFPA 70 for Class I, Division 2 hazardous locations. Workstations shall not be energized without adequate exhaust ventilation in accordance with Section 2703.14.

**Exception:** Class I, Division 2 hazardous electrical equipment is not required where the air removal from the workstation or dilution will prevent the accumulation of flammable vapors and fumes on a continuous basis.

- ❖ Areas located in and around workstations are considered Class I, Division 2, hazardous locations as defined by Article 500 of NFPA 70. Incidental exposures to flammable fumes or vapors must be considered horizontally possible within 5 feet (1524 mm) of each workstation where flammable liquids or gases are used. Either a mechanical or electrical interlock must be installed to engage the required exhaust ventilation system before HPM enters the workstation. This reduces the likelihood of gas or vapor exposure.

The exception in this section states that, in some cases, it is both possible and reasonable to assume that a hazardous concentration of flammable gas or vapor is unlikely to occur when ventilation is properly engaged. Class I, Division 2, electrical wiring and equipment is not required where automatic exhaust interlocks are installed.

**2703.7.3 Hazardous production material (HPM) rooms, gas rooms and liquid storage rooms.** Electrical wiring and equipment in HPM rooms, gas rooms and liquid storage rooms shall comply with NFPA 70.

❖ Electrical wiring, equipment and devices in HPM cut-off rooms used for the storage of flammable liquids or gases must be classified for hazardous locations, in accordance with NFPA 70. The hazardous location requirements in NFPA 70 contain special protection features to preclude ignition of flammable vapors, liquids, gases or dusts by sparks or electrical arcing.

**2703.8 Corridors and enclosures for stairways and ramps.** Hazardous materials shall not be used or stored in *corridors* or enclosures for stairways and ramps.

❖ Because corridors leading to enclosures for stairways and ramps are critical to the safe egress and life safety of personnel, this section prohibits the storage or use of HPM within them. This is consistent with Sections 1022.1 and 1023.1, which prohibit the use of an exit for any purpose other than the egress function.

**2703.9 Service corridors.** Hazardous materials shall not be used in an open-system use condition in service corridors.

❖ HPM dispensing, or the open use or open transfer of HPM from original shipping containers to secondary containers, must not be performed in service corridors in order to reduce the likelihood of liberating dangerous vapors or fumes that might be difficult to mitigate.

**2703.10 Automatic sprinkler system.** An *approved automatic sprinkler system* shall be provided in accordance with Sections 2703.10.1 through 2703.10.5 and Chapter 9.

❖ Sections 2703.10.1 through 2703.10.5 contain specific sprinkler protection design requirements for the various parts and components of an HPM facility. Section 903.2.5.2 requires automatic sprinkler protection throughout HPM facilities and states specific design criteria for various areas of the facility. Fabrication areas, service corridors and inside HPM storage rooms are considered Ordinary Hazard Group 2 and HPM storage rooms with dispensing are classified as Extra Hazard Group 2, in accordance with NFPA 13.

**2703.10.1 Workstations and tools.** The design of the sprinkler system in the area shall take into consideration the spray pattern and the effect on the equipment.

❖ The design of the sprinkler system must consider obstructions to water penetration of workstations and tools and the potential for collateral damage to equipment from sprinkler discharge that could delay a return to normal operations.

**2703.10.1.1 Combustible workstations.** A sprinkler head shall be installed within each branch exhaust connection or individual plenums of workstations of combustible construction. The sprinkler head in the exhaust connection or plenum shall be located not more than 2 feet (610 mm) from the point

of the duct connection or the connection to the plenum. Where necessary to prevent corrosion, the sprinkler head and connecting piping in the duct shall be coated with *approved* or *listed* corrosion-resistant materials. The sprinkler head shall be accessible for periodic inspection.

**Exceptions:**

1. *Approved* alternative automatic fire-extinguishing systems are allowed. Activation of such systems shall deactivate the related processing equipment.
2. Process equipment that operates at temperatures exceeding 932°F (500°C) and is provided with automatic shutdown capabilities for hazardous materials.
3. Exhaust ducts 10 inches (254 mm) or less in diameter from flammable gas storage cabinets that are part of a workstation.
4. Ducts *listed* or *approved* for use without internal automatic sprinkler protection.

❖ Generally, workstations are constructed of noncombustible materials. Wet benches and machines handling certain corrosives may have substantial nonmetallic components or surfaces. Notwithstanding the requirements of Sections 2703.10.4.1 and 2703.10.4.2, an automatic sprinkler must be installed within 2 feet (610 mm) of where the exhaust duct connects to a workstation of combustible construction. It is reasonable to require the installation of a corrosion-resistant sprinkler, in accordance with NFPA 13, and the application of a corrosion-resistant pipe coating because combustible (nonmetallic) parts are commonly used as a result of corrosion concerns. The duct must be accessible to permit regular periodic inspection and maintenance. (Note: corrosion-resistant sprinklers require periodic replacement despite their ability to withstand severe exposures.)

Many fire protection engineers prefer the use of listed special flow control (also called “on-off”) sprinklers or cycling (on-off) sprinkler systems to minimize the effects of water damage from automatic sprinklers. Others prefer preaction systems as a backup to an alternative fire suppression system, including clean agent or carbon dioxide systems.

Exception 1 allows the installation of an alternative, automatic fire-extinguishing system, in accordance with Section 904, instead of automatic sprinklers. The activation of the alternative system must deactivate or deenergize processing equipment in the protected room or space. Deactivation of processing equipment should not affect the operation of required exhaust ventilation.

Exception 2 states that only the HPM flow must be interrupted in processing equipment operating at temperatures greater than 932°F (500°C).

Exception 3 allows gas cabinet exhaust systems associated with and part of workstations to continue to operate after shutdown.

Exception 4 states that automatic sprinklers are not required where the risk to people or property is lim-

ited, such as when nonmetallic ducts approved for installation without sprinklers are used.

**2703.10.1.2 Combustible tools.** Where the horizontal surface of a combustible tool is obstructed from ceiling sprinkler discharge, automatic sprinkler protection that covers the horizontal surface of the tool shall be provided.

**Exceptions:**

1. An automatic gaseous fire-extinguishing local surface application system shall be allowed as an alternative to sprinklers. Gaseous-extinguishing systems shall be actuated by infrared (IR) or ultraviolet/infrared (UV/IR) optical detectors.
  2. Tools constructed of materials that are listed as Class 1 or Class 2 in accordance with UL 2360 or *approved* for use without internal fire-extinguishing system protection.
- ❖ Automatic sprinkler system discharge from ceiling sprinklers that cannot reach the fire because of obstructions below the sprinkler can allow the fire to grow beyond the capability of the system to extinguish or hold the fire's progress in check until help arrives. Where the surface of a combustible tool being used in an HPM process is thus obstructed, a fire could rapidly spread unimpeded in the workstation and overpower the ceiling sprinkler design capability. This section requires that sprinkler protection be installed to properly cover the entire surface of the tool.

Exception 1 allows surface protection to be by installation of a gaseous fire-extinguishing system, such as a clean agent system, if it is activated by the more sensitive infrared (IR) or ultraviolet/infrared (UV/IR) optical detectors (see also the commentary to the Section 202 definition of "Tool").

Exception 2 allows the use of plastics listed as being compliant with UL 2360 in the construction of combustible semiconductor tools in lieu of providing an automatic fire-extinguishing system. UL 2360 provisions are used to evaluate fire testing plastics utilized in the construction of semiconductor tools to determine their fire propagation and smoke development properties. The fire tests are implemented to evaluate two properties:

- The fire propagation index (FPI), which measures the ease of ignitibility of the plastic and its fire propagation characteristics. It is an index representing the propensity of the material to support fire propagation.
- The smoke-development index (SDI), which is a measurement of the amount of smoke generated. It is an indicator of the extent of smoke contamination of the environment during fire propagation.

In UL 2360, the FPI for a listed Class 1 plastic must not exceed  $6 (m/s^{0.5})/(kW/m)^{2/3}$  for fire propagation beyond the ignition zone. This maximum value is based on a 15-second average value of the fire test

data. The SDI of a listed Class 1 plastic must not exceed  $0.40 (m/s^{0.5})/(kW/m)^{2/3}$  as the criterion for significantly limiting smoke concentration for nonpropagating fires beyond the ignition zone. For a Class 1 plastic to be listed, the material requires an FDI of 6 or less and a SDI of 0.4 or less. Listed Class 1 plastics are considered to be nonpropagating materials in UL 2360.

A listed Class 2 plastic means it has been formulated with a resin that limits the propagation of fire and the development of smoke. Class 2 materials are evaluated using a parallel panel fire test. In this test, an 8-foot-long by 2-foot-wide by  $1/4$ -inch (2438 mm by 610 mm by 6.4 mm) sample of the plastic is placed on a load cell and subjected to a 60 kW exposure fire. For a sample to successfully pass this test and obtain a Class 2 listing, it must not have a visual flame height of 6 feet (1829 mm) or more, a thermal flux less than  $40 kW/m^2$ , a limited heat release rate calculated during the time the sample is tested with the flame source operating and 2 minutes after the flame source is discontinued, a smoke generation rate not to exceed 0.23 grams/second or less, and the total smoke generated is less than 60 grams.

Several polymers inherently resistant to fire that produce very little smoke are classified as Class 1 materials in accordance with Exception 2, including chlorinated polyvinyl chloride (CPVC), ethylene-chlorotrifluoro-ethylene (ECTFE), polyvinylidene fluoride (PVDF) and fire-resistant polypropylene (FRPP). According to Factory Mutual (FM) Global, a major insurer of semiconductor fabrication facilities, 17 manufacturers are producing about 150 different polymers that comply with its *Clean Room Materials Flammability Test Protocol* published as FM 4910, which led to the development of UL 2360.

**2703.10.2 Gas cabinets and exhausted enclosures.** An *approved automatic sprinkler system* shall be provided in gas cabinets and exhausted enclosures containing HPM *compressed gases*.

**Exception:** Gas cabinets located in an HPM room other than those cabinets containing pyrophoric gases.

- ❖ Automatic sprinkler protection is required inside HPM storage cabinets, including workstation cabinets, except those storing gases other than pyrophoric gases (silane and dichlorosilane) located inside HPM rooms.

The exception recognizes the equivalency between automatic sprinkler protection and the fire-resistance-rated separation provided by an HPM room, except in cases of extremely hazardous pyrophoric gases.

**2703.10.3 Pass-throughs in existing exit access corridors.** Pass-throughs in existing *exit access corridors* shall be protected by an *approved automatic sprinkler system*.

- ❖ Exit access corridors in new buildings are not to be used for transporting HPM to the fabrication area. In accordance with IBC Section 415.11.1.7, HPM must be transported by service corridors or piping. This

section addresses HPM facilities that existed before the adoption and enforcement of those requirements. The intent of this section is to allow a pass-through in existing exit access corridor walls for transporting HPM to a fabrication area. A pass-through, such as a storage cabinet, is used to store and receive HPM for the fabrication area. The pass-through must be separated from the exit access corridor by fire-resistance-rated construction, including rated self-closing fire doors, and be protected by internal automatic sprinklers.

**2703.10.4 Exhaust ducts for HPM.** An approved automatic sprinkler system shall be provided in exhaust ducts conveying gases, vapors, fumes, mists or dusts generated from HPM in accordance with this section and the *International Mechanical Code*.

❖ Because of the hazardous nature of the materials exhausted in HPM facilities, exhaust systems must comply with the IMC requirements for hazardous exhaust systems, including automatic sprinklers installed within the ducts. Sections 2703.10.4.1 through 2703.10.4.4.5 contain specific requirements for sprinkler installation in these systems.

**2703.10.4.1 Metallic and noncombustible nonmetallic exhaust ducts.** An approved automatic sprinkler system shall be provided in metallic and noncombustible nonmetallic exhaust ducts where all of the following conditions apply:

1. Where the largest cross-sectional diameter is equal to or greater than 10 inches (254 mm).
2. The ducts are within the building.

3. The ducts are conveying flammable gases, vapors or fumes.

❖ Sprinklers are required in each individual duct where all three of the conditions listed in this section exist.

Commentary Figure 2703.10.4.1 illustrates how to measure the cross-sectional diameter of various duct shapes. This section requires the square and rounded ducts to be protected by automatic sprinklers. The round or elliptical ducts depicted on the right side of the diagram do not require protection.

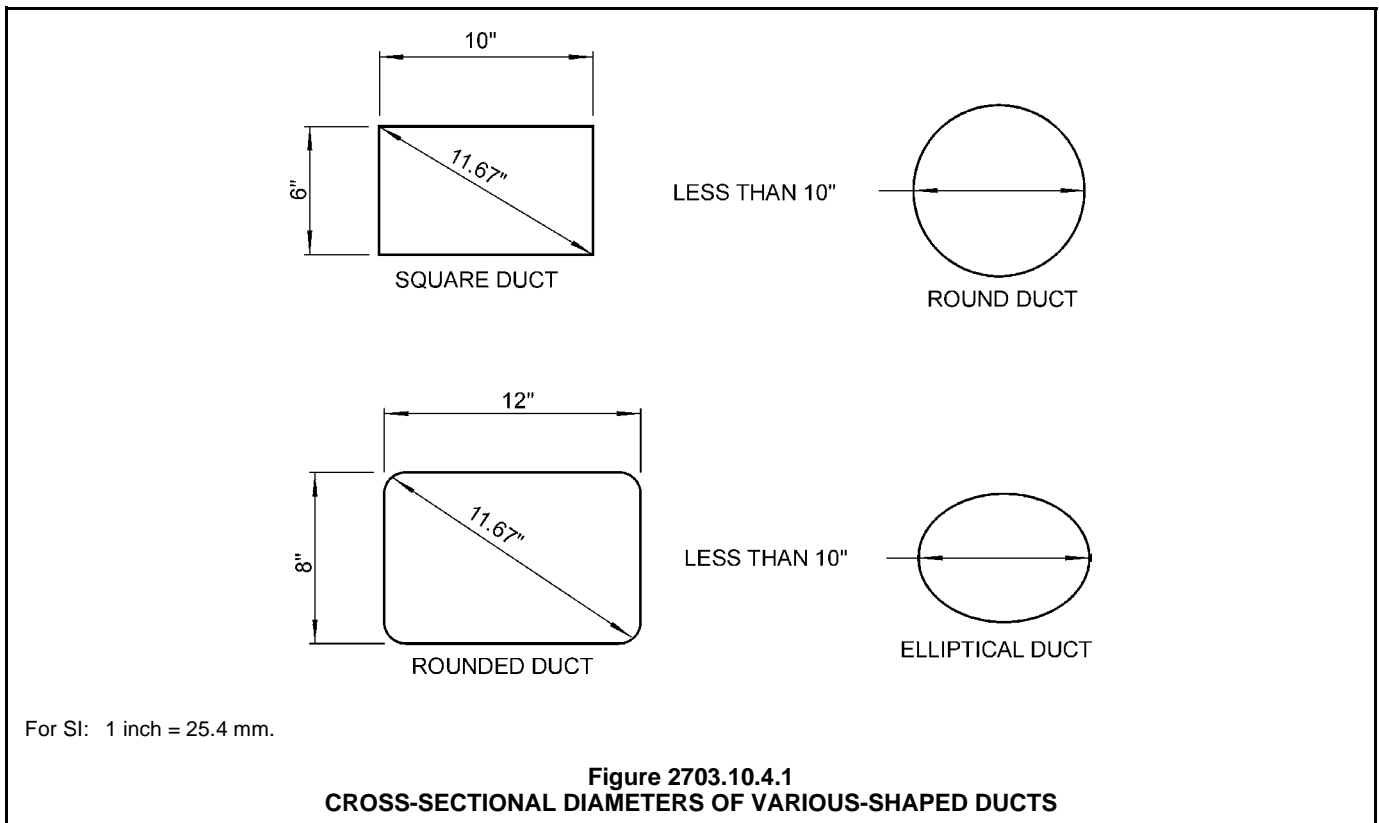
**2703.10.4.2 Combustible nonmetallic exhaust ducts.** An approved automatic sprinkler system shall be provided in combustible nonmetallic exhaust ducts where the largest cross-sectional diameter of the duct is equal to or greater than 10 inches (254 mm).

**Exceptions:**

1. Ducts listed or approved for applications without automatic sprinkler system protection.
2. Ducts not more than 12 feet (3658 mm) in length installed below ceiling level.

❖ Automatic sprinkler protection is required for all combustible nonmetallic ducts with a cross-sectional diameter equal to or greater than 10 inches (254 mm) because of their ability to add a substantial amount of fuel in case of a fire within the duct system.

Exception 1 states that automatic sprinklers are not required where the risk to people or property is limited, such as when nonmetallic ducts approved for installation without sprinklers are used.



Exception 2 states that when ducts do not exceed 12 feet (3658 mm) in length and are installed exposed below ceiling level, sprinklers may be omitted. A fire within such a system would be readily noticeable and readily accessible for fire attack because of the exposed ductwork.

**2703.10.4.3 Exhaust connections and plenums of combustible workstations.** Automatic fire-extinguishing system protection for exhaust connections and plenums of combustible workstations shall comply with Section 2703.10.1.1.

❖ Refer to Section 2703.10.1.1 for sprinkler protection for combustible workstation exhaust connections and plenums.

**2703.10.4.4 Exhaust duct sprinkler system requirements.** Automatic sprinklers installed in exhaust duct systems shall be hydraulically designed to provide 0.5 gallons per minute (gpm) (1.9 L/min) over an area derived by multiplying the distance between the sprinklers in a horizontal duct by the width of the duct. Minimum discharge shall be 20 gpm (76 L/min) per sprinkler from the five hydraulically most remote sprinklers.

❖ This section, including Sections 2703.10.4.4.1 through 2703.10.4.4.5, addresses the design, installation, maintenance and inspection requirements for sprinklers installed in exhaust duct systems. This section specifies the hydraulic design criteria and minimum flow discharged from sprinklers. Parallel provisions may also be found in Section 21.23.1.3 of NFPA 13.

**2703.10.4.4.1 Sprinkler head locations.** Automatic sprinklers shall be installed at 12-foot (3658 mm) intervals in horizontal ducts and at changes in direction. In vertical runs, automatic sprinklers shall be installed at the top and at alternate floor levels.

❖ This section specifies sprinkler spacing in both horizontal and vertical exhaust ducts. The provisions in Section 21.23.2.3 of NFPA 13 differ from these requirements in that the horizontal spacing is indicated as being 20 feet (6096 mm) and the vertical spacing as 12 feet (3658 mm). In accordance with Section 102.7, the provisions of this section would apply.

**2703.10.4.4.2 Control valve.** A separate indicating control valve shall be provided for sprinklers installed in exhaust ducts.

❖ To isolate the sprinklers installed within the exhaust ducts without depriving the building or other facility components of protection, a separate, approved indicating control valve must be installed to serve the duct system only. This valve should be supervised like any other sprinkler control valve.

**2703.10.4.4.3 Drainage.** Drainage shall be provided to remove sprinkler water discharged in exhaust ducts.

❖ To prevent contamination of process equipment by sprinkler discharge water that might flow back down the duct, this section requires that the ducts have

approved drainage facilities. Prompt drainage of sprinkler discharge water also reduces the likelihood of the duct system collapsing from the weight of retained water. Because the water will likely contain residues of the chemicals being exhausted through the ductwork, it must be disposed of in accordance with applicable environmental laws.

**2703.10.4.4.4 Corrosive atmospheres.** Where corrosive atmospheres exist, exhaust duct sprinklers and pipe fittings shall be manufactured of corrosion-resistant materials or coated with *approved* materials.

❖ Corrosion-resistant sprinklers, piping and fittings must be installed in exhaust ducts conveying corrosive vapors, fumes, mists or dusts to increase the likelihood that the sprinklers will be operable when needed. This is also critical since such sprinklers are concealed and not readily operable by building occupants.

**2703.10.4.4.5 Maintenance and inspection.** Sprinklers in exhaust ducts shall be accessible for periodic inspection and maintenance.

❖ Access panels must be installed in exhaust ducts for inspection and maintenance of sprinklers.

**2703.10.5 Sprinkler alarms and supervision.** *Automatic sprinkler systems* shall be electrically supervised and provided with alarms in accordance with Chapter 9. *Automatic sprinkler system* alarm and supervisory signals shall be transmitted to the *emergency control station*.

❖ Automatic sprinkler systems must be electrically supervised and have alarms installed, in accordance with Section 903.4. The system alarm and supervisory signals should be transmitted to the on-site emergency control station. See Section 202 for the definition of, and Section 2703.1 for the conditions and requirements applicable to, "Emergency control stations."

**2703.11 Manual fire alarm system.** A manual fire alarm system shall be installed throughout buildings containing a Group H-5 occupancy. Activation of the alarm system shall initiate a local alarm and transmit a signal to the *emergency control station*. Manual fire alarm systems shall be designed and installed in accordance with Section 907.

❖ A manual fire alarm system, designed and installed as specified in Section 907.2, must be installed throughout buildings containing a Group H-5 occupancy. System activation is to set off a local alarm, with the alarm signal transmitted to the on-site emergency control station. Note that the local alarm signal is intended only for the area of alarm origin and is not intended to be a general alarm that sounds throughout the building. Refer to the commentary to Chapter 9 for manual fire alarm system requirements. Note that this section correlates with IBC Section 415.11.8.

**2703.12 Emergency alarm system.** Emergency alarm systems shall be provided in accordance with Sections 2703.12.1 through 2703.12.3, Section 5004.9 and Section 5005.4.4. The

*maximum allowable quantity per control area* provisions of Section 5004.1 shall not apply to emergency alarm systems required for HPM.

❖ This section requires an emergency alarm system in all areas where HPM is transported or stored. It also clarifies that the requirement for an emergency alarm system in a Group H-5 facility in the locations identified in Sections 2703.12.1 through 2703.12.1.3 is not dependent on whether the MAQs of Section 5004.1 are exceeded. Emergency alarm systems must comply with Section 908.

**2703.12.1 Where required.** Emergency alarm systems shall be provided in the areas indicated in Sections 2703.12.1.1 through 2703.12.1.3.

❖ This section states that emergency alarm systems must be installed in the locations defined in Sections 2703.12.1.1 through 2703.12.1.3.

**2703.12.1.1 Service corridors.** An *approved* emergency alarm system shall be provided in service corridors, with not less than one alarm device in the service corridor.

❖ An emergency telephone system or manual alarm pull station that is readily accessible to personnel is required in service corridors. These devices must set off an alarm at the emergency control station, as well as activate a local audible signal.

**2703.12.1.2 Corridors and interior exit stairways and ramps.** Emergency alarms for corridors, interior exit stairways and ramps and exit passageways shall comply with Section 5005.4.4.

❖ Because HPM materials would not be in corridors or interior exit stairways, ramps or passageways unless they were being transported to another approved area, the emergency alarm requirements of Section 5005.4.4 for dispensing, use and handling must be complied with.

**2703.12.1.3 Liquid storage rooms, HPM rooms and gas rooms.** Emergency alarms for liquid storage rooms, HPM rooms and gas rooms shall comply with Section 5004.9.

❖ This section mandates compliance with the emergency alarm requirements of Section 5004.9 for hazardous materials in a storage condition. This section addresses storage areas that, by their designation, contain HPM in quantities greater than those listed in Table 5003.1.1(1) or 5003.1.1(2).

**2703.12.2 Alarm-initiating devices.** An *approved* emergency telephone system, local alarm manual pull stations, or other *approved* alarm-initiating devices are allowed to be used as emergency alarm-initiating devices.

❖ This section classifies what constitutes an approved alarm-initiating device, affording maximum design flexibility.

**2703.12.3 Alarm signals.** Activation of the emergency alarm system shall sound a local alarm and transmit a signal to the *emergency control station*.

❖ The alarm signal must be transmitted to the emergency control station to notify trained personnel of an emergency condition. A local alarm is required to alert the occupants of a potential hazardous condition.

**2703.13 Continuous gas detection systems.** A continuous gas detection system shall be provided for HPM gases where the physiological warning threshold level of the gas is at a higher level than the accepted permissible exposure limit (PEL) for the gas and for flammable gases in accordance with Sections 2703.13.1 through 2703.13.2.2.

❖ A gas detection system in the room or area used for the storage or use of HPM gases provides early notification of a leak before the escaping gas reaches hazardous concentration levels.

**2703.13.1 Where required.** A continuous gas detection system shall be provided in the areas identified in Sections 2703.13.1.1 through 2703.13.1.4.

❖ Sections 2703.13.1.1 through 2703.13.1.4 prescribe the locations in a Group H-5 facility where a gas detection system is required.

**2703.13.1.1 Fabrication areas.** A continuous gas detection system shall be provided in *fabrication areas* where gas is used in the fabrication area.

❖ Fabrication areas that use HPM gases must have a gas detection system. It should be noted that gas detection is often installed in workstations as a means of early detection of leaks. Such detection is generally not acceptable as an alternative to gas detection for the fabrication area because a leak may occur at locations that are remote from the workstation.

**2703.13.1.2 HPM rooms.** A continuous gas detection system shall be provided in HPM rooms where gas is used in the room.

❖ HPM rooms where gas is used, which by definition contain more than the MAQs permitted by Tables 5003.1.1(1) and 5003.1.1(2), are required to have a gas detection system.

**2703.13.1.3 Gas cabinets, exhausted enclosures and gas rooms.** A continuous gas detection system shall be provided in gas cabinets and exhausted enclosures. A continuous gas detection system shall be provided in gas rooms where gases are not located in gas cabinets or exhausted enclosures.

❖ In the potential event of a leaking cylinder of a hazardous gas, gas cabinets, exhausted enclosures and gas rooms must have a gas detection system.

**2703.13.1.4 Corridors.** Where gases are transported in piping placed within the space defined by the walls of a *corridor* and the floor or roof above the *corridor*, a continuous gas detection system shall be provided where piping is located and in the *corridor*.

**Exception:** A continuous gas detection system is not required for occasional transverse crossings of the *corridors* by supply piping that is enclosed in a ferrous pipe or tube for the width of the *corridor*.

- ❖ The installation of HPM piping in the space above an exit access corridor, as well as the cavity of the egress corridor wall, presents a potential source of hazard to the building's occupants; therefore, a gas detection system is required for early notification of a potential leak of an HPM gas.

The exception recognizes that when the piping traverses a corridor, the use of an outer-jacket containment pipe around the HPM piping is considered acceptable for the required separation and containment of a potential leak. The assumption is that the open ends of that pipe are in an HPM facility and, therefore, a leak into the outer casing can be monitored. If the adjacent areas that contain the open ends are not in an HPM facility, the "outer-jacket" method cannot be used.

**2703.13.2 Gas detection system operation.** The continuous gas detection system shall be capable of monitoring the room, area or equipment in which the gas is located at or below all the following gas concentrations:

1. Immediately dangerous to life and health (IDLH) values where the monitoring point is within an exhausted enclosure, ventilated enclosure or gas cabinet.
  2. Permissible exposure limit (PEL) levels where the monitoring point is in an area outside an exhausted enclosure, ventilated enclosure or gas cabinet.
  3. For flammable gases, the monitoring detection threshold level shall be vapor concentrations in excess of 25 percent of the lower flammable limit (LFL) where the monitoring is within or outside an exhausted enclosure, ventilated enclosure or gas cabinet.
  4. Except as noted in this section, monitoring for highly toxic and toxic gases shall also comply with Chapter 60.
- ❖ This section harmonizes the code with the widely used clean-room standard NFPA 318 provisions for gas detection, which are much more relevant to the type of monitoring performed in semiconductor manufacturing (inside exhausted enclosures, ventilated enclosures or gas cabinets). Monitoring in the semiconductor industry is designed to detect and alert employees of leaks inside exhausted enclosures, ventilated enclosures and gas cabinets, and is not intended to estimate potential employee breathing zone exposures.

This section requires gas detection based on the potential for health-threatening levels both inside

enclosures and in the employee environment as established by nationally accepted health standards, such as those used by the Occupational Safety and Health Administration (OSHA). The permissible exposure limit (PEL) of a gas is the legal limitation for long-term exposure (8 to 10 hours, normally). The American Conference of Governmental Industrial Hygienists (ACGIH) publishes threshold limit values (TLVs) based on a time-weighted average. State and local laws may also contain limits.

Additionally, flammable gas detection must be installed where dispensing that may result in vapor concentrations in excess of 25 percent of the lower explosive limit (LEL) occurs, as is consistent with IMC Section 510.2 and NFPA 318. LELs can be obtained from suppliers or other printed sources, such as the NFPA *Fire Protection Guide to Hazardous Materials*. Chapter 60 contains additional requirements for monitoring highly toxic and toxic compressed gases.

**2703.13.2.1 Alarms.** The gas detection system shall initiate a local alarm and transmit a signal to the *emergency control station* when a short-term hazard condition is detected. The alarm shall be both visible and audible and shall provide warning both inside and outside the area where the gas is detected. The audible alarm shall be distinct from all other alarms.

- ❖ The required local alarm is intended to alert occupants to a hazardous condition in the vicinity of HPM gas storage or use. The alarm is not intended to be an evacuation alarm; however, it must be monitored to hasten emergency personnel response.

**2703.13.2.2 Shut off of gas supply.** The gas detection system shall automatically close the shutoff valve at the source on gas supply piping and tubing related to the system being monitored for which gas is detected when a short-term hazard condition is detected. Automatic closure of shutoff valves shall comply with the following:

1. Where the gas-detection sampling point initiating the gas detection system alarm is within a gas cabinet or exhausted enclosure, the shutoff valve in the gas cabinet or exhausted enclosure for the specific gas detected shall automatically close.
2. Where the gas-detection sampling point initiating the gas detection system alarm is within a room and *compressed gas* containers are not in gas cabinets or exhausted enclosure, the shutoff valves on all gas lines for the specific gas detected shall automatically close.
3. Where the gas-detection sampling point initiating the gas detection system alarm is within a piping distribution manifold enclosure, the shutoff valve supplying the manifold for the *compressed gas* container of the specific gas detected shall automatically close.

**Exception:** Where the gas-detection sampling point initiating the gas detection system alarm is at the use location or within a gas valve enclosure of a branch line downstream of a piping distribution manifold,

the shutoff valve for the branch line located in the piping distribution manifold enclosure shall automatically close.

- ❖ Where gas detection systems are required, automatic emergency shutoff valves are required to stop the flow of hazardous materials from possibly deteriorating further in an emergency.

There are essentially four different protocols for shutting off valves, depending on the source of the leak. Note that one of these methods is located within the exception. It should be emphasized that the requirements are to shut off the valves only when the type of gas is detected.

**2703.14 Exhaust ventilation systems for HPM.** Exhaust ventilation systems and materials for exhaust ducts utilized for the exhaust of HPM shall comply with Sections 2703.14.1 through 2703.14.3, other applicable provisions of this code, the *International Building Code* and the *International Mechanical Code*.

- ❖ This section is a summary of the ventilation requirements for semiconductor facilities, and references the IBC and IMC for further requirements. Parallel requirements may be found in IMC Section 502.10.

**2703.14.1 Where required.** Exhaust ventilation systems shall be provided in the following locations in accordance with the requirements of this section and the *International Building Code*:

1. *Fabrication areas:* Exhaust ventilation for *fabrication areas* shall comply with the *International Building Code*. The *fire code official* is authorized to require additional manual control switches.
2. *Workstations:* A ventilation system shall be provided to capture and exhaust gases, fumes and vapors at workstations.
3. *Liquid storage rooms:* Exhaust ventilation for liquid storage rooms shall comply with Section 5004.3.1 and the *International Building Code*.
4. *HPM rooms:* Exhaust ventilation for HPM rooms shall comply with Section 5004.3.1 and the *International Building Code*.
5. *Gas cabinets:* Exhaust ventilation for gas cabinets shall comply with Section 5003.8.6.2. The gas cabinet ventilation system is allowed to connect to a workstation ventilation system. Exhaust ventilation for gas cabinets containing highly toxic or toxic gases shall also comply with Chapter 60.
6. *Exhausted enclosures:* Exhaust ventilation for exhausted enclosures shall comply with Section 5003.8.5.2. Exhaust ventilation for exhausted enclosures containing highly toxic or toxic gases shall also comply with Chapter 60.
7. *Gas rooms:* Exhaust ventilation for gas rooms shall comply with Section 5003.8.4.2. Exhaust ventilation

for gas rooms containing highly toxic or toxic gases shall also comply with Chapter 60.

8. *Cabinets containing pyrophoric liquids or Class 3 water-reactive liquids:* Exhaust ventilation for cabinets in *fabrication areas* containing pyrophoric liquids or Class 3 water-reactive liquids shall be as required in Section 2705.2.3.4.

- ❖ Items 1 through 8 list the specific ventilation requirements for semiconductor facilities based on the use of the particular area. Many of these requirements are references to other sections of the code. These are essentially the same requirements found in IMC Section 502.10 (see commentary, Section 2705.2.3.5).

Item 1 requires that fabrication areas must be ventilated as stated in the IBC. This item also gives the fire code official the authority to require additional manual control switches where facility arrangements make the additional switches necessary. Item 2 requires that workstations, typically found in each fabrication area, must have individual exhaust systems to collect any exhaust fumes and vapors. In Item 3, liquid storage rooms in semiconductor facilities are to be treated the same as other liquid storage rooms and ventilated according to the general requirements for hazardous materials found in Section 5004.3.1. Item 4 requires that HPM rooms, which are essentially a Group H-2, H-3 or H-4 occupancy, must be ventilated in the same way as any Group H-2, H-3 or H-4 occupancy would be ventilated, in accordance with Section 5004.3.1. Item 5 states that gas cabinets used in semiconductor facilities are to be treated the same as any other use of gas cabinets with hazardous materials. Gas cabinets can share the exhaust system of an individual workstation. Also, semiconductor facilities tend to make use of both toxic and highly toxic gases; therefore, additional requirements are specifically highlighted for these applications. Items 6 and 7 indicate that exhausted enclosures and gas rooms, respectively, are also regulated just as they are for other applications with hazardous materials. As with gas cabinets, semiconductor facilities tend to make use of both toxic and highly toxic gases; therefore, additional requirements are also specifically highlighted for those applications. Item 8 highlights the increased hazards of pyrophoric liquids and Class 3 water-reactive materials by requiring exhaust ventilation in fabrication area cabinets storing those materials to comply with the special requirements of Section 2705.2.3.4. See the commentary to Section 2705.2.3.4 for further discussion of pyrophoric and water-reactive materials.

**2703.14.2 Penetrations.** Exhaust ducts penetrating *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed

in accordance with Section 711 of the *International Building Code* shall be contained in a shaft of equivalent fire-resistance-rated construction. Exhaust ducts shall not penetrate *fire walls*. Fire dampers shall not be installed in exhaust ducts.

❖ Semiconductor facilities are essentially a combination of many activities involving the storage and use of hazardous materials. These facilities are large and generally complex, and exhaust systems may lead through several areas of a building before the exhaust is processed or released to the atmosphere. This section requires that the protection surrounding an exhaust system is at least equivalent to the fire-resistance rating of the surrounding fire barriers and horizontal assemblies. Ventilation should not be interrupted by a fire damper when a fire or other emergency occurs involving a workstation. This helps reduce the likelihood that hazardous combustion byproducts or hazardous concentrations of HPM will be forced back into the workstation or clean room. Continuous ventilation through a duct enclosed in a fire-resistance-rated shaft is required. Fire walls define separations between buildings. Ducts must never penetrate a barrier common to another building. This reduces the likelihood of tampering with or interrupting the duct integrity.

**2703.14.3 Treatment systems.** Treatment systems for highly toxic and toxic gases shall comply with Chapter 60.

❖ Because of their toxicity hazards, highly toxic and toxic gases should be protected by gas treatment systems. See the commentary to Section 3704 on highly toxic and toxic gases and, in particular, Section 3704.2.2.7 for further discussion of treatment systems.

**2703.15 Emergency power system.** An emergency power system shall be provided in Group H-5 occupancies in accordance with Section 604. The emergency power system shall supply power automatically to the electrical systems specified in Section 2703.15.1 when the normal supply system is interrupted.

❖ A backup emergency power source is considered essential for systems monitoring and protecting hazardous materials in a Group H-5 occupancy. Without an emergency power system, all required electrical controls or equipment monitoring hazardous materials would be rendered inoperative if a power failure or other electrical system failure were to occur. See also the commentary to Section 604.

**2703.15.1 Required electrical systems.** Emergency power shall be provided for electrically operated equipment and connected control circuits for the following systems:

1. HPM exhaust ventilation systems.
2. HPM gas cabinet ventilation systems.
3. HPM exhausted enclosure ventilation systems.
4. HPM gas room ventilation systems.
5. HPM gas detection systems.

6. Emergency alarm systems.
7. Manual fire alarm systems.
8. *Automatic sprinkler system* monitoring and alarm systems.
9. Automatic alarm and detection systems for pyrophoric liquids and Class 3 water-reactive liquids required in Section 2705.2.3.4.
10. Flow alarm switches for pyrophoric liquids and Class 3 water-reactive liquids cabinet exhaust ventilation systems required in Section 2705.2.3.4.
11. Electrically operated systems required elsewhere in this code or in the *International Building Code* applicable to the use, storage or handling of HPM.

❖ This section specifies the types of systems in a Group H-5 occupancy that must be connected to an approved emergency power system. As indicated in Section 604, emergency power systems must be installed, in accordance with the applicable requirements of NFPA 70, NFPA 110 and NFPA 111. Note that the systems included in the list are critical to personnel safety and must remain operable under all conditions of normal power system failure or impairment.

**2703.15.2 Exhaust ventilation systems.** Exhaust ventilation systems are allowed to be designed to operate at not less than one-half the normal fan speed on the emergency power system where it is demonstrated that the level of exhaust will maintain a safe atmosphere.

❖ Emergency power for exhaust ventilation is required to prevent hazardous concentrations of HPM fumes or vapors in areas such as workstations or fabrication areas. Fans for exhaust ventilation draw a considerable amount of current when operating. Running exhaust fans at a reduced speed may be desirable when it will not endanger the operator or result in a hazardous condition. However, exhaust fans must not be run at a speed less than 50 percent of their rating, even if a slower speed will not produce a serious hazard.

**2703.16 Sub-atmospheric pressure gas systems.** Sub-atmospheric pressure gas systems (SAGS) shall be in accordance with NFPA 318.

❖ This section allows the storage and use of HPM gases in subatmospheric pressure gas systems (SAGS) when the systems are installed in accordance with NFPA 318. It is the intent of this section to adopt only the provisions of NFPA 318 relating to SAGS even though the scope of the standard itself covers many more aspects of semiconductor fabrication safety. Those sections in the scope of the reference are Section 3.3.28.5 for the definition, and Section 8.6.2 addressing uses and controls (see the commentary to Section 102.7 regarding the proper application of referenced standards). Semiconductor manufacturing involves the storage, handling and use of a variety of hazardous production materials. Some

of the processes require the use of compressed gases that are classified by the code as being highly toxic, toxic, corrosive, flammable or pyrophoric. It is not uncommon for some of the gases to exhibit multiple hazard classifications. Because of the hazards associated with some of these materials, advancements to improve their safe storage and use have been developed. One improvement is SAGS for certain compressed gases, a primary goal of which is to improve safety by reducing the risk of a gas release. This is accomplished because SAGS only deliver gas when a vacuum is applied to the cylinder connection. In a SAGS, the cylinder valve can be opened, but no gas is released until the pressure downstream of the outlet connection is below atmospheric pressure. This is in contrast to a typical gas cylinder, which releases gas when the cylinder valve is opened. SAGS significantly reduce the risk associated with HPM because they mitigate the likelihood and magnitude of a gas release, and their use is becoming more common. The semiconductor industry has used SAGS successfully for a number of years.

In semiconductor manufacturing, SAGS are commonly used during ion implantation onto a silicon wafer. In ion implanting, charged metal electrons are chemically deposited or embedded onto the wafer to alter the electrical or optical properties of the substance. Known as “dopants,” they are essential in the manufacturing of semiconductors used in integrated circuits and photovoltaics. In optics, dopants are necessary in the production of certain types of lasers. As integrated circuits become more powerful microprocessors, silicon wafers must undergo greater amounts of ion implanting. Some of the common dopant gases packaged and handled using SAGS are presented in Commentary Figure 2703.16.

SAGS are designed so that the gas must be removed from the cylinder using vacuum, which is less than 14.7 pounds per square inch absolute (psia) at normal temperature and pressure (NTP) [e.g., 70°F at 1 atmosphere (21°C at 101 kPa)]. In comparison to conventional compressed gas systems where gas is released because of its stored potential

energy, SAGS either inherently remove this risk or mitigate it by using mechanical controls. In SAGS, the loss of vacuum pressure stops the gas flow.

NFPA 318 classifies SAGS into two categories: Types 1 and 2, based on the type of technology used in the gas storage and transfer system.

A Type 1 SAGS is made up of a gas cylinder filled with an adsorbent matter where the contents are stored at subatmospheric pressure at NTP. A Type 1 SAGS does not meet the code’s definition of “Compressed gas”; it has the characteristics of a low vapor pressure solid. A Type 2 SAGS uses a conventional U.S. Department of Transportation (DOT)-approved compressed gas cylinder, and incorporates an internal pressure regulator or check valve and an excess flow control. These components allow gas to be released only under a vacuum condition. A Type 2 SAGS is designed so that component or process failures, such as the loss of vacuum pressure or the failure of the pressure regulator causes an internal valve to automatically close and prevent the release of the stored gas.

**SECTION 2704  
STORAGE**

**2704.1 General.** Storage of hazardous materials shall comply with Section 2703 and this section and other applicable provisions of this code.

- ❖ This section establishes the proper storage conditions for hazardous materials in fabrication areas, storage areas and storage in equipment and cabinets.

**2704.2 Fabrication areas.** Hazardous materials storage and the maximum quantities of hazardous materials in use and storage allowed in *fabrication areas* shall be in accordance with Sections 2704.2.1 through 2704.2.2.1.

- ❖ This section establishes the applicability of Sections 2704.2.1 through 2704.2.2.1 to the proper storage conditions for hazardous materials in fabrication areas. This includes the location and amount of HPMs in fabrication areas.

Compressed Gas	Formula	IFC Hazard Classification
Arsenic Pentafluoride	AsF <sub>5</sub>	Highly Toxic; Corrosive; Class 1 Water Reactive
Arsine	AsH <sub>3</sub>	Flammable (Liquefied); Highly Toxic
Boron Trifluoride	BF <sub>3</sub>	Toxic; Corrosive; Class 1 Water Reactive
Germanium Tetrafluoride	GeF <sub>4</sub>	Toxic; Corrosive
Hydrogen Selenide	H <sub>2</sub> Se	Flammable (Liquefied); Toxic
Phosphine	PH <sub>3</sub>	Pyrophoric; Highly Toxic
Silicon Tetrafluoride	SiF <sub>4</sub>	Toxic; Corrosive; Class 1 Water Reactive

**Figure 2703.16  
COMMON DOPANT GASES AND THEIR HAZARD CLASSIFICATION**

**2704.2.1 Location of HPM storage in fabrication areas.** Storage of HPM in *fabrication areas* shall be within *approved* or *listed* storage cabinets, gas cabinets, exhausted enclosures or within a workstation as follows:

1. Flammable and *combustible liquid* storage cabinets shall comply with Section 5704.3.2.
  2. Hazardous materials storage cabinets shall comply with Section 5003.8.7.
  3. Gas cabinets shall comply with Section 5003.8.6. Gas cabinets for highly toxic or toxic gases shall also comply with Section 6004.1.2.
  4. Exhausted enclosures shall comply with Section 5003.8.5. Exhausted enclosures for highly toxic or toxic gases shall also comply with Section 6004.1.3.
  5. Workstations shall comply with Section 2705.2.3.
- ❖ Even though the amount of HPM in a fabrication area is controlled, it must be further controlled by storing it in approved cabinets, exhausted enclosures or a workstation. This requirement is intended to limit the exposure to occupants of the fabrication area to only the material in use in that area. Such separation also reduces the size of a possible hazardous material incident.

The larger amounts of HPM typically stored in separate areas present a hazard comparable to other Group H facilities. Therefore, storage rooms must meet similar code requirements. Storage rooms containing HPM in quantities greater than permitted by Tables 5003.1.1(1) and 5003.1.1(2) must comply with the applicable requirements of IBC Section 415.11.5, depending on the state of the material.

**2704.2.2 Maximum aggregate quantities in fabrication areas.** The aggregate quantities of hazardous materials stored or used in a single *fabrication area* shall be limited as specified in this section.

**Exception:** *Fabrication areas* containing quantities of hazardous materials not exceeding the maximum allowable quantities per *control area* established by Sections 5003.1.1, 5704.3.4 and 5704.3.5.

- ❖ This section regulates the total amount of hazardous materials, whether in use or in storage, in a single fabrication area based on the density/quantity of material specified in Table 2704.2.2.1. The exception permits a fabrication area to have a total quantity of HPM of either the quantity specified in Table 2704.2.2.1 or the MAQs specified in Sections 5003.1.1, 5704.3.4 and 5704.3.5, whichever is greater.

**2704.2.2.1 Storage and use in fabrication areas.** The maximum quantities of hazardous materials stored or used in a single *fabrication area* shall not exceed the quantities set forth in Table 2704.2.2.1.

- ❖ See the commentary to Table 2704.2.2.1.

**TABLE 2704.2.2.1.** See page 27-17.

- ❖ The quantity limitations identified in Table 2704.2.2.1 designate the aggregate amounts of hazardous materials allowed to be both stored and used in each fabrication area. The density basis for managing the maximum quantity of specified hazardous materials controls the hazard distribution in the occupancy. Generally, the lower the permitted density, the greater the required separation between containers.

**2704.3 Indoor storage outside of fabrication areas.** The indoor storage of hazardous materials outside of *fabrication areas* shall be in accordance with Sections 2704.3.1 through 2704.3.3.

- ❖ This section introduces the applicability of Sections 2704.3.1 through 2704.3.3 to HPM storage not contained within a fabrication area.

**2704.3.1 HPM storage.** The indoor storage of HPM in quantities greater than those *listed* in Sections 5003.1.1 and 3404.3.4 shall be in a room complying with the requirements of the *International Building Code* and this code for a liquid storage room, HPM room or gas room as appropriate for the materials stored.

- ❖ This section deals with the construction requirements for two types of storage rooms: those classified as HPM rooms or gas rooms, and those used as liquid storage rooms. The size and separation of these rooms are dependent on the type of materials stored.

**2704.3.2 Other hazardous materials storage.** The indoor storage of other hazardous materials shall comply with Sections 5001, 5003 and 5004 and other applicable provisions of this code.

- ❖ This section makes it clear that all hazardous materials, whether they are HPM or not, must comply with the basic applicable requirements of the code.

**2704.3.3 Separation of incompatible hazardous materials.** Incompatible hazardous materials in storage shall be separated from each other in accordance with Section 5003.9.8.

- ❖ This section is intended to prevent potentially incompatible materials from mixing or reacting with each other. In most instances, a noncombustible partition may suffice as the minimum required level of separation. Compliance with Section 5003.9.8 is required.

**TABLE 2704.2.2.1  
QUANTITY LIMITS FOR HAZARDOUS MATERIALS IN A SINGLE FABRICATION AREA IN GROUP H-5<sup>a</sup>**

HAZARD CATEGORY	SOLIDS (pounds/square foot)	LIQUIDS (gallons/square foot)	GAS (cubic feet @ NTP/square foot)
<b>PHYSICAL-HAZARD MATERIALS</b>			
Combustible dust	Note b	Not Applicable	Not Applicable
Combustible fiber Loose Baled	Note b Notes b and c	Not Applicable	Not Applicable
Combustible liquid Class II Class IIIA Class IIIB Combination Class I, II and IIIA	Not Applicable	0.01 0.02 Not Limited 0.04	Not Applicable
Cryogenic gas Flammable Oxidizing	Not Applicable	Not Applicable	Note d 1.25
Explosives	Note b	Note b	Note b
Flammable gas Gaseous Liquefied	Not Applicable	Not Applicable	Note d Note d
Flammable liquid Class IA Class IB Class IC Combination Class IA, IB and IC Combination Class I, II and IIIA	Not Applicable	0.0025 0.025 0.025 0.025 0.04	Not Applicable
Flammable solid	0.001	Not Applicable	Not Applicable
Organic peroxide Unclassified detonable Class I Class II Class III Class IV Class V	Note b Note b 0.025 0.1 Not Limited Not Limited	Not Applicable	Not Applicable
Oxidizing gas Gaseous Liquefied Combination of Gaseous and Liquefied	Not Applicable	Not Applicable	1.25 1.25 1.25
Oxidizer Class 4 Class 3 Class 2 Class 1 Combination oxidizer Class 1, 2, 3	Note b 0.003 0.003 0.003 0.003	Note b 0.03 0.03 0.03 0.03	Not Applicable
Pyrophoric	0.01	0.00125	Notes d and e
Unstable reactive Class 4 Class 3 Class 2 Class 1	Note b 0.025 0.1 Not Limited	Note b 0.0025 0.01 Not Limited	Note b Note b Note b Not Limited

(continued)

**TABLE 2704.2.2.1—continued**  
**QUANTITY LIMITS FOR HAZARDOUS MATERIALS IN A SINGLE FABRICATION AREA IN GROUP H-5**

HAZARD CATEGORY	SOLIDS (pounds/square foot)	LIQUIDS (gallons/square foot)	GAS (cubic feet @ NTP/square foot)
<b>PHYSICAL-HAZARD MATERIALS</b>			
Water reactive			
Class 3	Note b	0.00125	
Class 2	0.25	0.025	Not
Class 1	Not Limited	Not Limited	Applicable
<b>HEALTH-HAZARD MATERIALS</b>			
Corrosives	Not Limited	Not Limited	Not Limited
Highly toxics	Not Limited	Not Limited	Note d
Toxics	Not Limited	Not Limited	Note d

For SI: 1 pound per square foot = 4.882 kg/m<sup>2</sup>, 1 gallon per square foot = 40.7 L/m<sup>2</sup>, 1 cubic foot @ NTP/square foot = 0.305 m<sup>3</sup> @ NTP/m<sup>2</sup>,  
 1 cubic foot = 0.02832 m<sup>3</sup>.

- Hazardous materials within piping shall not be included in the calculated quantities.
- Quantity of hazardous materials in a single fabrication area shall not exceed the maximum allowable quantities per control area in Tables 5003.1.1(1) and 5003.1.1(2).
- Densely packed baled cotton that complies with the packing requirements of ISO 8115 shall not be included in this material class.
- The aggregate quantity of flammable, pyrophoric, toxic and highly toxic gases shall not exceed 9,000 cubic feet at NTP.
- The aggregate quantity of pyrophoric gases in the building shall not exceed the amounts set forth in Table 5003.8.2.

## SECTION 2705 USE AND HANDLING

**2705.1 General.** The use and handling of hazardous materials shall comply with this section, Section 2703 and other applicable provisions of this code.

❖ Section 2705 addresses the use of hazardous materials in fabrication areas, and transportation and handling of hazardous materials in buildings containing fabrication areas. Section 2703, Chapter 50 and the chapters of the code specific to hazardous materials are to be applied to the use and handling of other hazardous materials in the building.

**2705.2 Fabrication areas.** The use of hazardous materials in *fabrication areas* shall be in accordance with Sections 2705.2.1 through 2705.2.3.4.

❖ This section introduces the applicability of Sections 2705.2.1 through 2705.2.3.4 to HPM use in a fabrication area.

**2705.2.1 Location of HPM in use in fabrication areas.** Hazardous production materials in use in *fabrication areas* shall be within *approved* or *listed* gas cabinets, exhausted enclosures or a workstation.

❖ This section addresses four conditions for hazardous materials used in a fabrication area:

- Hazardous materials in use and storage must be in approved or listed gas cabinets, in exhausted enclosures or within a workstation.
- Section 2704 quantity limits for hazardous materials in use and storage apply.
- The amount of HPM per individual workstation is limited.
- Workstation construction, drainage, and containment and clearance requirements apply.

**2705.2.2 Maximum aggregate quantities in fabrication areas.** The aggregate quantities of hazardous materials in a single *fabrication area* shall comply with Section 2704.2.2, and Table 2704.2.2.1. The quantity of HPM in use at a workstation shall not exceed the quantities *listed* in Table 2705.2.2.

❖ This section establishes two quantity limitations for hazardous materials located in a fabrication area:

- Reemphasizes the Section 2704 hazardous materials quantity limitations allowed in each fabrication area by specific reference to Section 2704.2.2 and Table 2704.2.2.1.
- Limits the HPM quantity in use at each workstation. It is important to note that hazardous materials that have a hazard ranking of 1 or 2 (materials that are not HPM) are not subject to the same use limitations as HPM.

**TABLE 2705.2.2.** See page 27-19.

❖ As discussed at the beginning of this chapter, the unique engineering and operational controls inherent in semiconductor fabrication facilities justify what are, in effect, exceptions to an occupancy that would otherwise be classified as Group H-1, H-2, H-3 or H-4. Part of this justification includes limiting the maximum quantities of HPM at an individual workstation, thereby minimizing the hazard potential associated with an accident or equipment failure involving HPM. The table is intended to correlate with the HPM classifications, material conditions and quantity limitations addressed in Table 2704.2.2. It is important to understand that only HPMs are limited to the use quantities addressed in this table.

This table lists the MAQs of several types of hazardous materials that can be maintained at a workstation, either in storage or in use. It also reflects an

increase over the previous edition in the allowable gas quantities, which is intended to reduce the frequency of cylinder change-outs and, thus, the hazards associated with frequent handling of the material. The footnotes acknowledge the added safety of having approved fire-extinguishing and suppression systems in place, as well as the improved conditions with a closed system. See the commentary to Section 2705.2.3.4 for further discussion of pyrophoric and Class 3 water-reactive materials.

**2705.2.3 Workstations.** Workstations in *fabrication areas* shall be in accordance with Sections 2705.2.3.1 through 2705.2.3.4.

❖ This section introduces the applicability of Sections 2705.2.3.1 through 2705.2.3.4 to workstations located in a fabrication area.

**2705.2.3.1 Construction.** Workstations in *fabrication areas* shall be constructed of materials compatible with the materials used and stored at the workstation. The portion of the workstation that serves as a cabinet for HPM gases, Class I flammable liquids or Class II or Class IIIA combustible liquids shall be noncombustible and, if of metal, shall be not less than 0.0478-inch (18 gage) (1.2 mm) steel.

❖ This section addresses specific construction requirements for workstations and, to improve station longevity and avoid an undesirable reaction, requires that the materials of construction be compatible with the HPM used in the workstation. Likewise, HPM gases and flammable liquids must be kept in cabinets that are of substantial construction to prevent damage to HPM containers that could result in an HPM spill.

**2705.2.3.2 Protection of vessels.** Vessels containing hazardous materials located in or connected to a workstation shall be protected as follows:

1. HPM: Vessels containing HPM shall be protected from physical damage and shall not project from the workstation.
2. Hazardous *cryogenic fluids*, gases and liquids: Hazardous cryogenic fluid, gas and liquid vessels located within a workstation shall be protected from seismic forces in an *approved* manner in accordance with the *International Building Code*.
3. *Compressed gases*: Protection for *compressed gas* vessels shall also comply with Section 5303.5.
4. *Cryogenic fluids*: Protection for *cryogenic fluid* vessels shall also comply with Section 5503.5.

❖ HPM vessels located in or connected to a workstation are to be protected from physical damage and seismic forces (see Chapter 53 of the code and IBC Chapter 16). Additionally, Item 1 requires that these vessels be located in and not project from the workstation enclosure. Items 2 through 4 correlate with provisions of the code applicable to the hazards.

**TABLE 2705.2.2  
MAXIMUM QUANTITIES OF HPM AT A WORKSTATION<sup>d</sup>**

HPM CLASSIFICATION	STATE	MAXIMUM QUANTITY
Flammable, highly toxic, pyrophoric and toxic combined	Gas	Combined aggregate volume of all cylinders at a workstation shall not exceed an internal cylinder volume of 39.6 gallons or 5.29 cubic feet
Flammable	Liquid	15 gallons <sup>a, b</sup> 5 pounds <sup>a, b</sup>
	Solid	
Corrosive	Gas	Combined aggregate volume of all cylinders at a workstation shall not exceed an internal cylinder volume of 39.6 gallons or 5.29 cubic feet
	Liquid	
	Solid	
Highly toxic	Liquid	15 gallons <sup>a</sup> 5 pounds <sup>a</sup>
	Solid	
Oxidizer	Gas	Combined aggregate volume of all cylinders at a workstation shall not exceed an internal cylinder volume of 39.6 gallons or 5.29 cubic feet
	Liquid	
	Solid	
Pyrophoric	Liquid	0.5 gallon <sup>c, f</sup> 4.4 pounds <sup>c, f</sup>
	Solid	
Toxic	Liquid	Use-open system: 15 gallons <sup>b</sup> Use-closed system: 60 gallons <sup>b</sup>
	Solid	
Unstable reactive Class 3	Liquid	0.5 gallon <sup>a, b</sup> 5 pounds <sup>a, b</sup>
	Solid	
Water-reactive Class 3	Liquid	0.5 gallon <sup>c, f</sup> See Table 2704.2.2.1
	Solid	

For SI: 1 pound = 0.454 kg, 1 gallon = 3.785 L.

- a. Maximum allowable quantities shall be increased 100 percent for closed system operations. Where Note b also applies, the increase for both notes shall be allowed.
- b. Quantities shall be allowed to be increased 100 percent where workstations are internally protected with an approved automatic fire-extinguishing or suppression system complying with Chapter 9. Where Note b also applies, the increase for both notes shall be allowed. Where Note e also applies, the maximum increase allowed for both Notes b and e shall not exceed 100 percent.
- c. Allowed only in workstations that are internally protected with an approved automatic fire-extinguishing or fire protection system complying with Chapter 9 and compatible with the reactivity of materials in use at the workstation.
- d. The quantity limits apply only to materials classified as HPM.
- e. Quantities shall be allowed to be increased 100 percent for nonflammable, noncombustible corrosive liquids where the materials of construction for workstations are listed or approved for use without internal fire-extinguishing or suppression system protection. Where Note b also applies, the maximum increase allowed for both Notes b and e shall not exceed 100 percent.
- f. A maximum quantity of 5.3 gallons of liquids and 44 pounds of total liquids and solids shall be allowed at a workstation where conditions are in accordance with Section 2705.2.3.5.

**2705.2.3.3 Drainage and containment for HPM liquids.** Each workstation utilizing HPM liquids shall have all of the following:

1. Drainage piping systems connected to a compatible system for disposition of such liquids.
  2. The work surface provided with a slope or other means for directing spilled materials to the containment or drainage system.
  3. An *approved* means of containing or directing spilled or leaked liquids to the drainage system.
- ❖ Federal environmental requirements make it necessary to contain and recover HPM used in the manufacturing process. The design of the workstations must facilitate the recovery of spilled and spent HPM. The drainage system must be designed so that incompatible materials do not mix and the system is compatible with the materials handled.

**2705.2.3.4 Pyrophoric solids, liquids and Class 3 water-reactive liquids.** Pyrophoric liquids and Class 3 water-reactive liquids in containers greater than 0.5-gallon (2 L) but not exceeding 5.3-gallon (20 L) capacity and pyrophoric solids in containers greater than 4.4 pounds (2 kg) but not exceeding 44 pounds (20 kg) shall be allowed at workstations where located inside cabinets and the following conditions are met:

1. Maximum amount per cabinet: The maximum amount per cabinet shall be limited to 5.3 gallons (20 L) of liquids and 44 pounds (20 kg) of total liquids and solids.
2. Cabinet construction: Cabinets shall be constructed in accordance with the following:
  - 2.1. Cabinets shall be constructed of not less than 0.097-inch (2.5 mm) (12 gage) steel.
  - 2.2. Cabinets shall be permitted to have self-closing limited access ports or noncombustible windows that provide access to equipment controls.
  - 2.3. Cabinets shall be provided with self- or manual-closing doors. Manual-closing doors shall be equipped with a door switch that will initiate local audible and visual alarms when the door is in the open position.
3. Cabinet exhaust ventilation system: An exhaust ventilation system shall be provided for cabinets and shall comply with the following:
  - 3.1. The system shall be designed to operate at a negative pressure in relation to the surrounding area.
  - 3.2. The system shall be equipped with monitoring equipment to ensure that required exhaust flow or static pressure is provided.
  - 3.3. Low-flow or static pressure conditions shall send an alarm to the on-site emergency control station. The alarm shall be both visual and audible.
4. Cabinet spill containment: Spill containment shall be provided in each cabinet, with the spill containment

capable of holding the contents of the aggregate amount of liquids in containers in each cabinet.

5. Valves: Valves in supply piping between the product containers in the cabinet and the workstation served by the containers shall fail in the closed position upon power failure, loss of exhaust ventilation and upon actuation of the fire control system.
6. Fire detection system: Each cabinet shall be equipped with an automatic fire detection system complying with the following conditions:
  - 6.1. Automatic detection system: UV/IR, high-sensitivity smoke detection (HSSD) or other *approved* detection systems shall be provided inside each cabinet.
  - 6.2. Automatic shutoff: Activation of the detection system shall automatically close the shutoff valves at the source on the liquid supply.
  - 6.3. Alarms and signals: Activation of the detection system shall initiate a local alarm within the *fabrication area* and transmit a signal to the *emergency control station*. The alarms and signals shall be both visual and audible.

❖ As semiconductor technology progresses to smaller line widths and increased device densities, newer materials are demanded. Conducting and nonconducting structures are fabricated at atomic levels using new metal-bearing agents. A class of materials known as metalorganics is used as precursor for the fabrication of these structures. These materials may possess both pyrophoric and water-reactive properties. Some common metalorganics used are trimethylaluminum (TMA), trimethyl gallium (TMG) and dimethylaluminum hydride (DMAH).

The strict safeguards for the increased workstation quantities allowed by this section should eliminate the need for bulk distribution systems, with larger quantities centralized in a Group H-2 occupancy, that would otherwise have to be installed to meet production requirements. These systems would have to be piped to individual workstations in the fabrication area from the bulk distribution supply location. Extensive runs of piping could result in significant risks, with the potential for leaks from piping or fitting leakage, which can cause accidental damage, installation errors and deinstallation errors. In this application, the piping from the bulk distribution source servicing the workstations becomes a greater risk than the alternative of having a greater quantity localized at the workstation with no exposed piping from a Group H-2 room both to and traversing the fabrication area.

FM has indicated that it has no loss history using these materials at any site, even at the compound semiconductor companies, which use large volumes of these materials. The semiconductor industry reports no loss history with the use of water-reactive or pyrophoric liquids. In addition, semiconductor industry health and safety professionals concur that it

is much safer to reduce the handling frequency of any chemical.

**2705.3 Transportation and handling.** The transportation and handling of hazardous materials shall comply with Sections 2705.3.1 through 2705.3.4.1 and other applicable provisions of this code.

❖ Transportation and handling in this section refers to the movement of hazardous materials through means of egress elements, such as exit access corridors and exit enclosures, and through service corridors.

**2705.3.1 Corridors and enclosures for stairways and ramps.** *Corridors* and enclosures for *exit stairways* and *ramps* in new buildings or serving new fabrication areas shall not contain HPM, except as permitted in corridors by Section 415.11.6.4 of the *International Building Code* and Section 2705.3.2 of this code.

❖ This section is specific to transportation and handling of HPM in both new buildings containing Group H-5 occupancy operations and existing buildings containing new Group H-5 occupancy operations. Transportation or handling of HPM in corridors or stairway and ramp enclosures is not allowed, except for existing buildings containing existing fabrication areas, and as specifically allowed in Section 415.11.6.4 of the IBC, and Section 2705.3.2. In older semiconductor fabrication facilities (a.k.a. “fabs”), hand transportation of HPMs is common practice. However, these older facilities are reaching the end of their service life and are being replaced. In new fabs, liquids and gases are supplied directly to tools via bulk distribution systems because it is safer and less expensive because the liquids and gases are purchased in bulk quantities. As a result, the transportation of HPMs in carts or by hand is fairly infrequent. When delivered by carts or by hand (e.g., exchanging compressed gas cylinders in ion implanters), the amount of HPM is fairly small. Because of the improvements in chemical distribution, very little benefit is gained from providing service corridors in Group H-5 occupancies. Note that this section is specific to HPMs only and neither prohibits nor restricts the transportation or handling of materials having a health-hazard ranking of 1 or 2 in exit access corridors or exit enclosures. The general handling and transportation requirements addressed in Section 5003.10 apply to materials having a health-hazard ranking of 1 or 2 and to conditions not specifically addressed in this section.

**2705.3.2 Transport in corridors and enclosures for stairways and ramps.** Transport in *corridors* and enclosures for *stairways* and *ramps* shall be in accordance with Sections 2705.3.2.1 through 2705.3.3.

❖ This section identifies the requirements for HPM transport in corridors, and stairway and ramp enclosures.

**2705.3.2.1 Fabrication area alterations.** Where existing fabrication areas are altered or modified in existing buildings, HPM is allowed to be transported in existing *corridors* where

such *corridors* comply with Section 5003.10 of this code and Section 415.11.2 of the *International Building Code*.

❖ Corridors must comply with the requirements of Section 1018 and must be separated from fabrication areas in accordance with IBC Section 415.11.2. Additionally, corridors in new buildings are not to be used for transporting HPM to the fabrication area; HPM must be transported in service corridors or piping. This section addresses HPM facilities that existed before the adoption and enforcement of the IBC. It permits the transport of HPM in corridors in existing buildings under the conditions specified in IBC Section 415.11. When alterations are made to a fabrication area, those corridors must be upgraded.

**2705.3.2.2 HPM transport in corridors and enclosures for stairways and ramps.** Nonproduction HPM is allowed to be transported in *corridors* and enclosures for *stairways* and *ramps* where utilized for maintenance, lab work and testing when the transportation is in accordance with Section 5003.10.

❖ This section requires that the transportation of non-production HPMs comply with Section 5003.10, which establishes the design criteria and use parameters for carts and trucks and also includes the following requirements for on-site transportation of hazardous materials:

- Liquids packaged in containers of a volume of 5 gallons (19 L) or greater can only be transported on hand carts or hand trucks.
- Not more than four 55-gallon containers (833 L) can be handled utilizing acceptable drum trucks or on pallets.
- Compressed gas containers and cylinders require transportation using approved hand trucks.
- For HPMs transported by hand, the weight of the packaging is limited based on the contents being a solid, liquid or gas.

**2705.3.3 Service corridors.** Where a new *fabrication area* is constructed, a service corridor shall be provided where it is necessary to transport HPM from a liquid storage room, HPM room, gas room or from the outside of a building to the perimeter wall of a *fabrication area*. Service corridors shall be designed and constructed in accordance with the *International Building Code*.

❖ Under this section, in new buildings, or where a fabrication area is added in an existing building, service passageways are separate spaces dedicated to the transportation of HPM between cutoff rooms, the perimeter walls of fabrication areas and the building's exterior. Service passageways must not be used as elements of a means of egress. Requirements of Section 2705.3.4 must govern the number, capacity and type of HPM containers transported in service passageways.

## SEMICONDUCTOR FABRICATION FACILITIES

**2705.3.4 Carts and trucks.** Carts and trucks used to transport HPM in *corridors* and enclosures for *stairways* and *ramps* shall comply with Section 5003.10.3.

❖ This section identifies the requirements for carts and trucks used to transport HPM in corridors and stairway and ramp enclosures in existing buildings containing existing fabrication areas. Both Section 2705.3.2 and this section are specific to HPM, and specific only to HPM in glass containers, HPM gas cylinders and the carts and trucks allowed for the transport of HPM through corridors and stairway and ramp enclosures. The general handling and transportation requirements addressed in Section 5003.10 apply to materials having a hazard ranking of 1 or 2 and to conditions not specifically addressed in Section 2705.3.2 and this section.

**2705.3.4.1 Identification.** Carts and trucks shall be marked to indicate the contents.

❖ Cart or truck enclosures must bear placards or signs indicating the contents transported. A combination of DOTn and NFPA 704 placards is ideal for this purpose. Materials possibly posing a danger of reaction if mixed should never be transported together.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

ANSI/FM 4910—2013, *American National Standard for Clean Room Materials Flammability Test Protocol*. Norwood, MA: FM Global, 2013.

*Code Changes Resource Collection—2015 International Fire Code*. Washington, DC: International Code Council, 2014.

*Fire Protection Guide to Hazardous Materials*, 13th edition. Quincy, MA: National Fire Protection Association, 2001.

# Chapter 28: Lumber Yards and Agro-industrial, Solid Biomass and Woodworking Facilities

## General Comments

Woodworking, agro-industrial, solid biomass feedstock and forest product processing facilities tend to be located close to the source of the raw material, but facilities manufacturing finished products for the building trade industries may be found in or near most urban areas. Any facility using mechanical methods to work wood and solid biomass into a more finished form produces dust or debris. The smaller the fuel package, the more easily ignitable it will be. In fact, extremely fine wood dust or wood flour may even produce deflagrations (explosions) under the right conditions. Explosion prevention practices must be implemented to minimize the potential for such hazards. Accumulations of dust must be prevented, controlled mechanically or removed frequently. Automatic fire suppression systems are required by Section 903.2.4.1. Deflagration venting (see NFPA 69 and NFPA 495) is required where substantial amounts of dust are usually present. Areas where dust suspensions exist are considered Class II hazardous locations by NFPA 70. Manual fire-fighting equipment must be provided in the immediate vicinity of each machine because dust cannot be completely eliminated in any woodworking or wood-processing area.

Methods and procedures used to control hazards associated with wood, agro-industrial, solid biomass feedstock and forest product storage, sale and processing must recognize not only the fuel properties but the need to control and eliminate ignition sources, minimize the effect of fires and explosions, and facilitate fire control efforts by occupants at the incipient phase and fire

fighters at more advanced stages. Adherence to these requirements will help secure these objectives.

## Purpose

Most everyone is familiar with the hazards of wood as a fuel; however, the scale of wood, agro-industrial, solid biomass feedstock and forest product storage, manufacturing and processing operations stretches the limitations of their understanding. Wood has long been used as a reference fuel for understanding fire, but the sheer volume of materials present and the variety of fuel packages represented in these occupancies make this a hazard requiring special attention.

Sawdust, wood chips, shavings, bark mulch, shorts, finished planks, sheets, posts, poles, timber and raw logs represent a broad continuum of fuels. What they all bear in common is the hazard they represent once ignited; what is unique about each of these materials is the ease or difficulty with which any single fuel package may be ignited. The regulations recognize both of these concerns.

Provisions of this chapter are intended to prevent fires and explosions, facilitate fire control and reduce exposures to and from facilities storing, selling or processing wood and forest products.

This chapter requires active and passive fire protection features to reduce on- and off-site exposures, limit fire size and development, and facilitate fire fighting by employees and the fire service. Design and maintenance of these facilities must provide access to equipment and exposures to facilitate fire control.

## SECTION 2801 GENERAL

**2801.1 Scope.** The storage, manufacturing and processing of solid biomass feedstock, timber, lumber, plywood, nonmetallic pallets, veneers and agro-industrial byproducts shall be in accordance with this chapter.

❖ These provisions are intended to prevent fires and explosions in lumber yards, woodworking plants and lumber drying and other similar operations. Further, provisions are intended to facilitate fire-fighting operations in these occupancies in the event of a fire.

**2801.2 Permit.** Permits shall be required as set forth in Section 105.6.

❖ Section 105.6.26 has a permit threshold amount for lumber storage of 100,000 board feet [8,333 cubic feet (236 m<sup>3</sup>)] of lumber. The board foot is a measurement used in the lumber and building trades. One board foot (0.93 m<sup>2</sup>) is the cubic volume of a piece of lumber 1 foot square (0.93 m<sup>2</sup>) and 1 inch (25 mm) thick or approximately 0.083 cubic foot (0.002 m<sup>3</sup>). Then, 100,000 board feet [8,333 cubic feet (236 m<sup>3</sup>)] is a cubic volume of 8,333 cubic feet (236 m<sup>3</sup>) or a

solid pile of lumber approximately 20 feet, 5 inches by 20 feet, 5 inches (6223 mm by 6223 mm) by the maximum allowable height of 20 feet (6096 mm). The permit requirement is intended to facilitate the regulation of hazards presented by quantities of lumber exceeding that amount.

## SECTION 2802 DEFINITIONS

**2802.1 Definitions.** The following terms are defined in Chapter 2:

**AGRO-INDUSTRIAL.**

**BIOMASS.**

**COLD DECK.**

**FINES.**

**HOGGED MATERIALS.**

**PLYWOOD AND VENEER MILLS.**

**RAW PRODUCT.**

**SOLID BIOFUEL.**

**SOLID BIOMASS FEEDSTOCK.**

**STATIC PILES.**

**TIMBER AND LUMBER PRODUCTION FACILITIES.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

## SECTION 2803 GENERAL REQUIREMENTS

**2803.1 Open yards.** Open yards required by the *International Building Code* shall be maintained around structures.

❖ The *International Building Code*<sup>®</sup> (IBC<sup>®</sup>) requires that certain buildings face an open space on at least one side. The open spaces may be a yard required for the purpose of providing light and ventilation (see the commentary to the IBC Section 202 definition of “Yard” and IBC Section 1206) or they may be a public way provided in order to achieve an increase in building area called a “frontage increase” (see the commentary to IBC Section 202 definition of “Public way” and IBC Section 506.3), or to allow a building to be considered an “unlimited area building” (see the commentary to IBC Section 507). Regardless of the purpose of the open space, this section requires that the space be maintained and be free of obstructions associated with the outdoor storage of the materials regulated by Chapter 28, which could interfere with

the function of the open space, especially that of providing fire department access to the building.

**2803.2 Dust control.** Equipment or machinery located inside buildings that generates or emits *combustible dust* shall be provided with an *approved* dust collection and exhaust system installed in accordance with Chapter 22 and the *International Mechanical Code*. Equipment or systems that are used to collect, process or convey *combustible dusts* shall be provided with an *approved* explosion control system.

❖ The basic wood-processing activities related to lumber yards and woodworking facilities generate large volumes of wood particles suspended in the air, creating a potentially explosive form of dust. Where such activities are located inside of buildings, this section requires that combustible dust be controlled by an approved dust-collection and exhaust system designed and installed in accordance with Chapter 22, and Sections 510 and 511 of the *International Mechanical Code*<sup>®</sup> (IMC<sup>®</sup>). There are two basic designs of dust collection systems. One is a single-stage system that consists of a single dust collector in the form of a cyclone separator or a combination cyclone/baghouse unit. The other is a two-stage system that consists of a cyclone separator followed by a bag-type filter house.

An approved explosion control system is also required for the equipment and systems that collect and convey the combustible dust. Such systems should be installed in accordance with Section 911.

**2803.2.1 Explosion venting.** Where a dust explosion hazard exists in equipment rooms, buildings or other enclosures, such areas shall be provided with explosion (*deflagration*) venting or an *approved* explosion suppression system complying with Section 911.

❖ When wood dust is ignited while suspended in air in concentrations above the minimum combustible concentration (MCC), it burns violently, producing a deflagration. This likelihood depends on the concentration of fuel per unit volume. Most of the time, dust-collection systems remove the larger dust particles, allowing the finer particles to pass through the system and reenter the production area. The finer dust can create an explosion and fire hazard unless an approved suppression system is used.

**2803.3 Waste removal.** Sawmills, planning mills and other woodworking plants shall be equipped with a waste removal system that will collect and remove sawdust and shavings. Such systems shall be installed in accordance with Chapter 22 and the *International Mechanical Code*.

**Exception:** Manual waste removal where *approved*.

❖ Like many other organic materials, sawdust, wood chips and other similar waste materials are susceptible to spontaneous heat. Pileings and debris must be turned over or consumed regularly to minimize the potential for spontaneous combustion. Some waste material is used as fuel and some might go to pulp or particleboard manufacturers. Finer material is

removed by air-moving equipment, cyclones or air bags. Chapter 22 and the IMC give the installation requirements for waste removal systems.

**2803.3.1 Housekeeping.** Provisions shall be made for a systematic and thorough cleaning of the entire plant at sufficient intervals to prevent the accumulations of *combustible dust* and spilled combustible or flammable liquids.

- ❖ Good housekeeping should be maintained at all times, including regular and frequent cleaning of material-handling equipment. Combustible waste materials, such as bark, chips and other debris, should not be allowed to accumulate in amounts that will constitute a fire hazard. Air-moving systems should be designed to remove or dilute transient flammable vapors.

**2803.3.2 Metal scrap.** Provision shall be made for separately collecting and disposing of any metal scrap so that such scrap will not enter the wood handling or processing equipment.

- ❖ Waste material from rough milling is carried by a belt conveyor to the wood hog, which cuts the waste into small pieces. The conveyor should have a magnetic separator to keep metal from causing fires in the hog, pneumatic conveyors and waste-storage silos. Waste material that is swept up and carried to the hog is hazardous because the trash often contains metal objects.

**2803.4 Electrical equipment.** Electrical wiring and equipment shall comply with NFPA 70.

- ❖ Arcs, sparks and loose connections often supply the ignition source that a vapor or combustible material needs for fire. Electrical equipment must be listed for the use it is installed for and comply with the requirements of NFPA 70.

**2803.5 Control of ignition sources.** Protection from ignition sources shall be provided in accordance with Sections 2803.5.1 through 2803.5.3.

- ❖ The two key points that will reduce fire losses in storage areas of forest products are reduction in the sources of ignition and a positive program for detecting incipient fires. The following subsections address sources of ignition. Section 2804 addresses programs and systems for early detection of fires.

**2803.5.1 Cutting and welding.** Cutting and welding shall comply with Chapter 35.

- ❖ No cutting, welding or other use of open flames and spark-producing equipment are allowed in the storage area without a permit.

**2803.5.2 Static electricity.** Static electricity shall be prevented from accumulating on machines and equipment subject to static electricity buildup by permanent grounding and bonding wires or other *approved* means.

- ❖ Static electricity builds up on operating machines because of the movement of product and machine. Proper grounding and bonding of equipment prevents static electricity from producing an ignition source and igniting a fire.

**2803.5.3 Smoking.** Where smoking constitutes a fire hazard, the *fire code official* is authorized to order the *owner* or occupant to post *approved* “No Smoking” signs complying with Section 310. The *fire code official* is authorized to designate specific locations where smoking is allowed.

- ❖ Smoking must not be allowed in a woodworking facility. Considering the abundance of existing fuel, with much of it in an easily ignitable form, smoking controls are an absolute necessity in lumber yards and forest products facilities. Smoking materials being discarded improperly are an ignition threat in woodworking facilities.

**2803.6 Fire apparatus access roads.** Fire apparatus access roads shall be provided for buildings and facilities in accordance with Section 503.

- ❖ Required driveways provide access for fire apparatus and create fire breaks between piles. Access roads must be sized to allow fire emergency equipment to enter and perform emergency operations. Section 503 gives required dimensions for access roads.

**2803.7 Access plan.** Where storage pile configurations could change because of changes in product operations and processing, the access plan shall be submitted for approval when required by the *fire code official*.

- ❖ A site plan showing access to the facilities with consideration given to pile location, access roads, hydrant locations and building locations must be presented to the fire code official for approval prior to construction.

## SECTION 2804 FIRE PROTECTION

**2804.1 General.** Fire protection in timber and lumber production mills, plywood and veneer mills and agro-industrial facilities shall comply with Sections 2804.2 through 2804.4.

- ❖ This section introduces and establishes the applicability of Sections 2804.2 through 2804.4.

**2804.2 Fire alarms.** An *approved* means for transmitting alarms to the fire department shall be provided in timber and lumber production mills and plywood and veneer mills.

- ❖ The fire department must be notified if a fire occurs in the facility. How the fire department is notified must be approved by the local fire code official. This may be by a manual fire alarm system with pull stations, monitored phone lines or another approved system.

**2804.2.1 Manual fire alarms.** A manual fire alarm system complying with Section 907.2 shall be installed in areas of timber and lumber production mills and for plywood and veneer mills that contain product dryers.

**Exception:** Where dryers or other sources of ignition are protected by a supervised *automatic sprinkler system* complying with Section 903.

- ❖ Manual fire alarm systems usually have means for local notification, but according to Section 2804.2,

alarm systems must have the means to transmit the alarm to fire departments.

#### 2804.3 Portable fire extinguishers or standpipes and hose.

Portable fire extinguishers or standpipes and hose supplied from an *approved* water system shall be provided within a 50-foot (15 240 mm) distance of travel from any machine producing shavings or sawdust. Portable fire extinguishers shall be provided in accordance with Section 906 for extra-high hazards.

❖ The degree of protection will vary from facility to facility, but the basic recommendation is for a water system of mains and hydrants capable of supplying at least 1,000 gallons per minute (gpm) (60 L/s). Standpipes will provide a hose within 50 feet (15 240 mm) of shaving and sanding machines. Portable fire extinguishers are good initial fire knockdown equipment. Section 906 gives these requirements.

**2804.4 Automatic sprinkler systems.** *Automatic sprinkler systems* shall be installed in accordance with Section 903.3.1.1.

❖ This section does not require the installation of a sprinkler system. Rather, where a sprinkler system is provided as required by the occupancy group classification, this section mandates it be installed in accordance with Section 903.3.1.1, which references NFPA 13.

### SECTION 2805 PLYWOOD, VENEER AND COMPOSITE BOARD MILLS

**2805.1 General.** Plant operations of plywood, veneer and composite board mills shall comply with Sections 2805.2 and 2805.3.

❖ This section addresses protection of dryers and installation requirements for thermal oil-heating systems.

**2805.2 Dryer protection.** Dryers shall be protected throughout by an *approved*, automatic deluge water-spray suppression system complying with Chapter 9. Deluge heads shall be inspected quarterly for pitch buildup. Deluge heads shall be flushed during regular maintenance for functional operation. Manual activation valves shall be located within 75 feet (22 860 mm) of the drying equipment.

❖ A deluge system is a good protective measure for the interior of dryers. This kind of protection is especially important in veneer mills where the temperature of the dryer may approach 392°F (200°C), which is the nominal ignition temperature of wood. Smoke sensors should activate the deluge system and automatically shut down fans, burners and drive machinery. Manual trips should also be installed at each end of the dryer.

**2805.3 Thermal oil-heating systems.** Facilities that use heat transfer fluids to provide process equipment heat through piped, indirect heating systems shall comply with this code and NFPA 664.

❖ The transfer of heated fluids for process equipment presents a fire hazard. A ruptured pipe line could expose fine particles of wood products to the heated fluid, thus creating the potential for a fire. The code and Chapter 9 of NFPA 664 address the requirements for installation of this equipment.

### SECTION 2806 LOG STORAGE AREAS

**2806.1 General.** Log storage areas shall comply with Sections 2806.2 through 2806.3.

❖ The intent of this section is to provide fire protection advice for minimizing fire hazards in log-yard storage areas that contain saw, plywood or pulpwood logs stored in ranked piles, usually referred to as “cold decks”. Stacked piles of cordwood are not addressed unless they are stored in ranked piles.

**2806.2 Cold decks.** Cold decks shall not exceed 500 feet (152.4 m) in length, 300 feet (91 440 mm) in width and 20 feet (6096 mm) in height. Cold decks shall be separated from adjacent cold decks or other exposures by not less than 100 feet (30 480 mm).

**Exception:** The size of cold decks shall be determined by the *fire code official* where the decks are protected by special fire protection including, but not limited to, additional fire flow, portable turrets and deluge sets, and hydrant hose houses equipped with *approved* fire-fighting equipment capable of reaching the entire storage area in accordance with Chapter 9.

❖ Because of the fire load that they present, cold decks (see commentary to the Section 202 definition of “Cold deck”) must be limited in size and isolated from one another as prescribed in this section. All sides of the cold deck should be accessible to fire apparatus over hard-surface fire apparatus access roads. The suggested width of a cold deck fire apparatus access road is one and one-half times the height of the pile but a minimum of 20 feet (6096 mm) between alternate rows of two pile groups separated by a clear space of 100 feet (30 480 mm). See the commentary to Section 503 for further discussion of fire apparatus access roads.

**2806.3 Pile stability.** Log and pole piles shall be stabilized by *approved* means.

❖ Stabilizing the log and pole piles minimizes hazards in two ways. In a fire, the piles become weak and can fall on the fire fighters, but the stabilizing method will

assist in their protection. The method also minimizes the risk of logs falling on people and causing death or injury when no fire emergency exists.

### SECTION 2807 STORAGE OF WOOD CHIPS AND HOGGED MATERIAL ASSOCIATED WITH TIMBER AND LUMBER PRODUCTION FACILITIES

**2807.1 General.** The storage of wood chips and hogged materials associated with timber and lumber production facilities shall comply with Sections 2807.2 through 2807.5.

❖ This section gives fire protection guidance for minimizing fire hazards in yard storage areas containing wood chips and hogged materials. Each individual facility will have its own special conditions for yard use, handling procedures and topography. Fire safety is also affected by climate conditions, wood species and the age of the piles.

**2807.2 Size of piles.** Piles shall not exceed 60 feet (18 288 mm) in height, 300 feet (91 440 mm) in width and 500 feet (152 m) in length. Piles shall be separated from adjacent piles or other exposures by *approved* fire apparatus access roads.

**Exception:** The *fire code official* is authorized to allow the pile size to be increased where additional fire protection is provided in accordance with Chapter 9. The increase shall be based on the capabilities of the system installed.

❖ Restrictions on pile size are established for practical reasons. When the piles are made low and narrow, fire extinguishment is enhanced. When the piles are extremely high and wide, fire extinguishment is hampered and arrangements must be made for fire-fighting service. Piles should also be constructed with an access roadway to the top of the pile to make all parts of the pile accessible to fire fighters.

**2807.3 Pile fire protection.** Automatic sprinkler protection shall be provided in conveyor tunnels and combustible enclosures that pass under a pile. Combustible or enclosed conveyor systems shall be equipped with an *approved automatic sprinkler system*.

❖ Automatic sprinklers are needed because of the difficulty of manual fire suppression operations in concealed, enclosed and elevated areas.

**2807.4 Material-handling equipment.** *Approved* material-handling equipment shall be readily available for moving wood chips and hogged material.

❖ Bulldozers and power-operated shovel and scoop vehicles are examples of the material-handling equipment needed to move stored material and, thus, make fire fighting easier.

**2807.5 Emergency plan.** The *owner* or operator shall develop a plan for monitoring, controlling and extinguishing

spot fires. The plan shall be submitted to the *fire code official* for review and approval.

❖ As in all potential hazards, an emergency plan should be designed for monitoring and fighting spot fires. The plan must be submitted to the fire code official for review and approval.

### SECTION 2808 STORAGE AND PROCESSING OF WOOD CHIPS, HOGGED MATERIAL, FINES, COMPOST, SOLID BIOMASS FEEDSTOCK AND RAW PRODUCT ASSOCIATED WITH YARD WASTE, AGRO- INDUSTRIAL AND RECYCLING FACILITIES

**2808.1 General.** The storage and processing of wood chips, hogged materials, fines, compost, solid biomass feedstock and raw product produced from yard waste, debris and agro-industrial and recycling facilities shall comply with Sections 2808.2 through 2808.10.

❖ This section contains fire protection guidance for minimizing fire hazards in yard storage areas containing wood chips and hogged materials, fines, compost, raw materials and solid biomass feedstock.

**2808.2 Storage site.** Storage sites shall be level and on solid ground, elevated soil lifts or other all-weather surface. Sites shall be thoroughly cleaned before transferring wood products to the site.

❖ The storage site should be reasonably level, solid ground or paved with blacktop, concrete or other hard surface material. The surface must be thoroughly cleaned of scrap and debris before beginning a new pile.

**2808.3 Size of piles.** Piles shall not exceed 25 feet (7620 mm) in height, 150 feet (45 720 mm) in width and 250 feet (76 200 mm) in length.

**Exception:** The *fire code official* is authorized to allow the pile size to be increased where a fire protection plan is provided for approval that includes, but is not limited to, the following:

1. Storage yard areas and materials-handling equipment selection, design and arrangement shall be based upon sound fire prevention and protection principles.
2. Factors that lead to spontaneous heating shall be identified in the plan, and control of the various factors shall be identified and implemented, including provisions for monitoring the internal condition of the pile.
3. The plan shall include means for early fire detection and reporting to the public fire department; and facilities needed by the fire department for fire extinguishment including a water supply and fire hydrants.

4. Fire apparatus access roads around the piles and access roads to the top of the piles shall be established, identified and maintained.
5. Regular yard inspections by trained personnel shall be included as part of an effective fire prevention maintenance program.

Additional fire protection called for in the plan shall be provided and shall be installed in accordance with this code. The increase of the pile size shall be based upon the capabilities of the installed fire protection systems and features.

- ❖ Restrictions on pile sizes are established for good and practical reasons. When the piles are made low and narrow, fire extinguishment is enhanced. When the piles are extremely high and wide, fire extinguishment is hampered and arrangements must be made for fire-fighting service. This section provides tools and guidance for fire code officials when proposals to increase pile size are submitted. The protection needed for increased pile size includes fire flows through a hydrant system, fire apparatus access roads, means for monitoring pile temperatures, a means of notifying the fire department and a sound fire prevention maintenance program. The exception provides for these features to be addressed in a fire protection plan submittal to the fire code official for approval. The systems installed are covered by various portions of the code, such as fire apparatus access roads covered in Chapter 5. The exception also replaces and codifies criteria that were formerly contained in referenced standards (NFPA 46 and NFPA 230) but have been withdrawn by NFPA.

**2808.4 Pile separation.** Piles shall be separated from adjacent piles by *approved* fire apparatus access roads.

- ❖ In order to slow the spread of fire from pile to pile, as well as to provide the fire department with tactical access to all parts of the pile storage area, piles must be subdivided by fire apparatus access roads at least 20 feet (6096 mm) in clear width at the base of the piles, in accordance with Section 503.2.1 (see also commentary, Section 2809.3).

**2808.5 Combustible waste.** The storage, accumulation and handling of combustible materials and control of vegetation shall comply with Chapter 3.

- ❖ Section 304 addresses vegetation and combustible waste requirements for minimizing hazards.

**2808.6 Static pile protection.** Static piles shall be monitored by an *approved* means to measure temperatures within the static piles. Internal pile temperatures shall be monitored and recorded weekly. Such records shall be maintained. An operational plan indicating procedures and schedules for the inspection, monitoring and restricting of excessive internal temperatures in static piles shall be submitted to the *fire code official* for review and approval.

- ❖ Inherent to long-term bulk storage of chips, fines, compost and hogged materials is internal heating, which can progress to spontaneous combustion

under certain conditions. Unless procedures are established for measuring internal temperatures, fires could burn undetected for long periods before smoke is seen or produced at the surface. These piles must be monitored on a fixed schedule and records kept of the results of these inspections.

**2808.7 Pile fire protection.** Automatic sprinkler protection shall be provided in conveyor tunnels and combustible enclosures that pass under a pile. Combustible conveyor systems and enclosed conveyor systems shall be equipped with an *approved automatic sprinkler system*.

- ❖ Automatic sprinklers are needed because of the difficulty of manual fire suppression operations in concealed, enclosed and elevated areas (see commentary, Section 2807.3).

**2808.8 Fire extinguishers.** Portable fire extinguishers complying with Section 906 and with a minimum rating of 4-A:60-B:C shall be provided on all vehicles and equipment operating on piles and at all processing equipment.

- ❖ Each vehicle operating in the area must be equipped with a portable fire extinguisher that provides the fire extinguishing equivalent of 5 gallons (19 L) of water for use on a substantial Class A fire and is effective for flammable liquids and energized electrical components.

**2808.9 Material-handling equipment.** *Approved* material-handling equipment shall be available for moving wood chips, hogged material, wood fines and raw product during fire-fighting operations.

- ❖ Bulldozers and power-operated shovel and scoop vehicles are examples of the material-handling equipment needed to move stored material and, thus, make fire fighting easier. Pile surfaces can usually be removed with this type of equipment.

**2808.10 Emergency plan.** The *owner* or operator shall develop a plan for monitoring, controlling and extinguishing spot fires and submit the plan to the *fire code official* for review and approval.

- ❖ As in all potential hazards, an emergency plan should be designed for monitoring and fighting spot fires. The plan must be submitted to the fire code official for review and approval.

## SECTION 2809 EXTERIOR STORAGE OF FINISHED LUMBER AND SOLID BIOFUEL PRODUCTS

**2809.1 General.** Exterior storage of finished lumber and solid biofuel products shall comply with Sections 2809.1 through 2809.5.

- ❖ The following sections address the size and height of piles, access roads and fire protection requirements for exterior lumber and solid biofuel storage.

**2809.2 Size of piles.** Exterior storage shall be arranged to form stable piles with a maximum height of 20 feet (6096

mm). Piles shall not exceed 150,000 cubic feet (4248 m<sup>3</sup>) in volume.

❖ Bulk dimension lumber and solid biofuel represent fuel packages of considerable volume in occupancies such as wholesale and retail yards and distribution warehouses. Complicating matters, these facilities are often located in urban areas and close to the consumer. Forest products processing plants and sawmills, on the other hand, are usually closer to the raw material. Though dimension lumber may be harder to ignite than sawdust, scrap or waste, once ignited, it may expose more people and property to danger. To manage this hazard, the code places limitations on pile heights and sizes, requires fire apparatus access roadways (see Section 2809.3) and prescribes fire protection features (see Section 2809.5).

For example, pile limitations provide a means of controlling the size of potential fires and facilitate the fire-fighting process. Lumber in open piles is often stacked on dunnage to prevent damage. Spaces formed by this material create a flue space that may not only contribute to fire spread, but also may result in structural collapse of the pile.

**2809.3 Fire apparatus access roads.** Fire apparatus access roads in accordance with Section 503 shall be located so that a maximum grid system unit of 50 feet by 150 feet (15 240 mm by 45 720 mm) is established.

❖ Fire apparatus access roads must be spaced on a maximum grid system as required by this section to

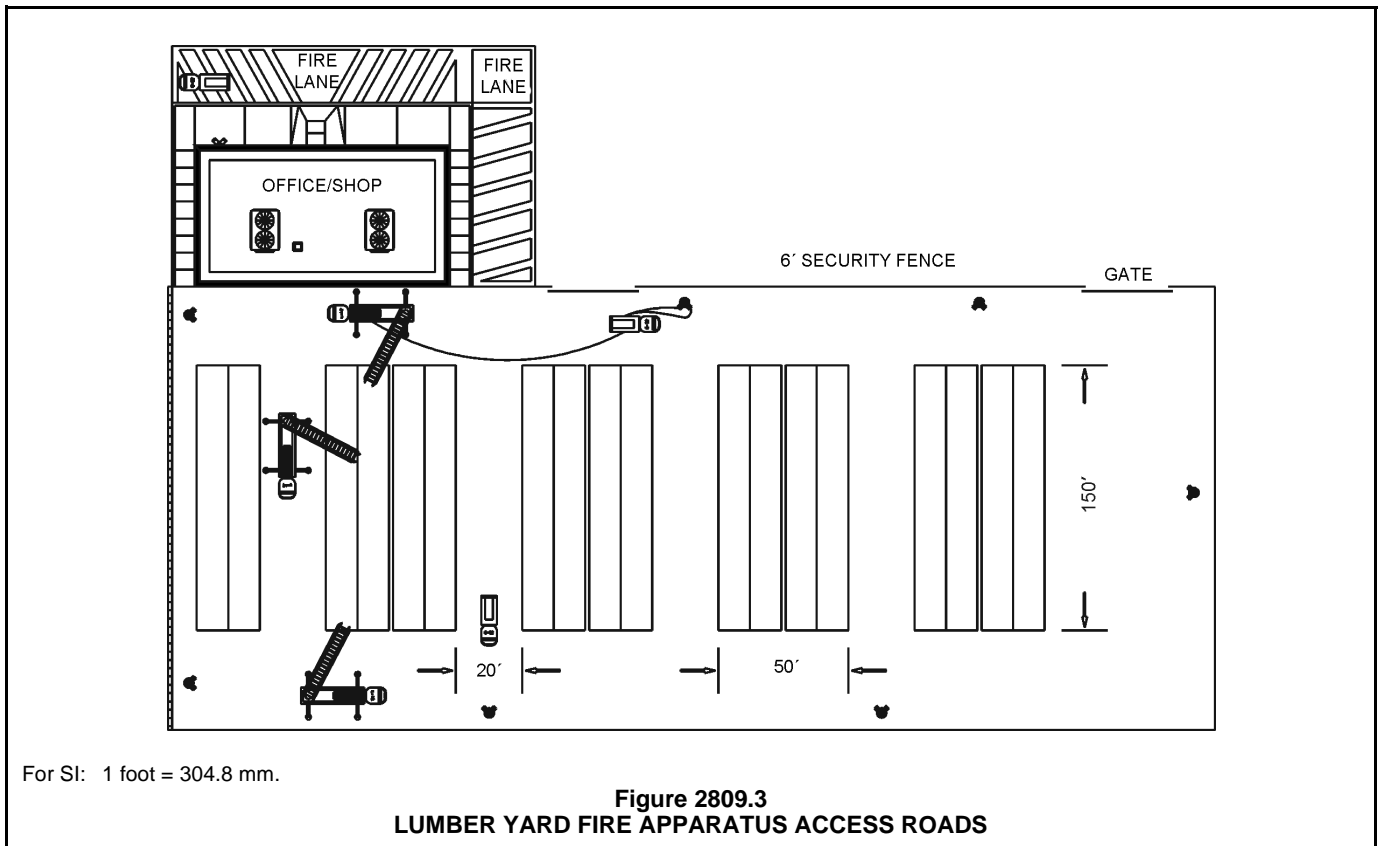
provide not only fire department access to all parts of the pile array, but also fire breaks between piles. This section correlates with Section 2809.2 by effectively limiting lumber piles to 150,000 cubic feet each (150 feet by 50 feet by 20 feet high or 1,800,000 board feet) (4248 m<sup>3</sup>) between fire apparatus access roads. The fire apparatus access roads must be arranged to provide clear, unobstructed access to required yard hydrants (see Section 2809.5), be a minimum of 20 feet (6096 mm) wide in accordance with Section 503.2.1, have an all-weather driving surface in accordance with Section 503.2.3, and provide adequate turning radii in accordance with Section 503.2.4 (see Commentary Figure 2809.3). Where Appendix D is also adopted, approved turnarounds must be provided so that the fire apparatus can maneuver to protect exposures, as well as fire fighters.

**2809.4 Security.** Permanent storage areas shall be surrounded with an *approved* fence. Fences shall be not less than 6 feet (1829 mm) in height.

**Exceptions:**

1. Lumber piles inside of buildings and production mills for lumber, plywood and veneer.
2. Solid biofuel piles inside of buildings and agro-industrial processing facilities for solid biomass feedstock.

❖ Fences for site security must be installed around the perimeter of the storage yard to limit access to stored materials and deter theft, vandalism and arson. This



section assumes that equivalent security is provided where storage is confined to a building. Open structures or weather shelters over stored materials do not qualify for the exception.

*Pumping Apparatus Driver/Operator Handbook*. Stillwater, OK: International Fire service Training Association, 2015.

**2809.5 Fire protection.** An *approved* hydrant and hose system or portable fire-extinguishing equipment suitable for the fire hazard involved shall be provided for open storage yards. Hydrant and hose systems shall be installed in accordance with NFPA 24. Portable fire extinguishers complying with Section 906 shall be located so that the distance of travel from the nearest unit does not exceed 75 feet (22 860 mm).

❖ Open storage yards can involve significant land areas and are often situated a substantial distance from public rights-of-way and public fire mains. Yard hydrant and private fire service main systems facilitate ready access to water for fire fighting by public or private fire-fighting forces. The yard hydrant system must be fed by a water supply of sufficient volume and duration to provide adequate protection where the public water supply provides inadequate volume or pressure to protect the facility. The fire flows required will, of necessity, be substantial because of the large land areas that can be included within the boundaries of a lumber yard. Water may need to be delivered to the scene by fire department tankers in rural areas where there is no public water supply. Further information and guidance on water supplies may be obtained from NFPA 1142 and the International Fire Service Training Association (IFSTA) *Pumping Apparatus Driver/Operator Handbook*. Installation of private fire protection systems must conform to the appropriate NFPA standards, including: yard hydrants and private fire mains (NFPA 24); water tanks for private fire protection (NFPA 22) and stationary fire pumps (NFPA 20).

Portable fire extinguishers must be provided for incipient fire fighting and be protected from freezing. Additionally, approved hose houses, properly equipped as described in NFPA 24, may be connected to the yard hydrant system. Travel distance to an extinguisher is limited to 75 feet (22 860 mm) so that manual efforts can be undertaken while the fire is still small enough to respond to first-aid fire-fighting efforts.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

*Code Changes Resource Collection—2015 International Fire Code*. Washington, DC: International Code Council, 2014.

NFPA 1142—*Standard on Water Supplies for Suburban and Rural Fire Fighting 2012 Edition*. Quincy MA: National Fire Protection Association, 2012.

# Chapter 29: Manufacture of Organic Coatings

## General Comments

The term “organic coatings” is used to describe diverse compounds formulated to protect buildings, machines and objects from the effects of weather, corrosion and hostile environmental exposures. Paint for architectural and industrial uses comprises the bulk of organic coating production. Most paints remain solvent-based, though the use of water-based products is becoming more widespread. The most common solvents include: mineral spirits, naphtha (VM&P), xylene, toluene, methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), acetone, ethyl acetate, butyl acetate, butanol, isopropanol, ethylene glycol and propylene glycol, most of which are Class I flammable liquids with flash points less than 100°F (38°C). Other coatings are asphaltic and bituminous (for example, roofing tar). Most products in this category are Class II combustible liquids with flash points between 100°F and 140°F (38°C and 60°C).

The manufacture of organic coatings encompasses operations that produce decorative and protective coatings for architectural uses, industrial products and other specialized purposes. Requirements of this chapter address the hazards associated with the manufacture of solvent-based organic coatings. Water-based materials are exempt from these requirements.

In 1990, Harris and Swartz explained that the manufacture of organic coatings consists of the following six steps:

- Pigment dispersion.
- Mixing of raw materials and intermediates.
- Thinning and tinting.
- Quality-control testing and adjustment.
- Filtering.
- Filling into shipping containers.

Of these six steps, those involving mixing, thinning and container filling are of the most concern. Organic solvents are producers of static electricity, especially when agitated. If dissipation of static electricity is not controlled, agitation of these fluids can release enough energy to ignite flammable vapors. Static sparks are the most common source of ignition in organic coating fires.

By far, the most hazardous organic coating to manufacture is nitrocellulose lacquer because of the release of Class I flammable liquid vapors. Nitrocellulose is commonly shipped and stored alcohol-wet. This material becomes increasingly unstable as temperatures increase, thus making it capable of breaking down and burning in the absence of oxygen. Flammable vapors nearly always exist where organic coatings are manu-

factured. Consequently, the risk of ignition is usually present. Special precautions must be used to protect electrical and mechanical ignition sources.

Requirements of this chapter focus on the separation and control of ignition and fuel sources. Housekeeping is also emphasized to limit the quantity of ignitable material. Storage of flammable and combustible liquids must conform to Chapter 57. Application of organic coatings and other flammable finishes must conform to Chapter 24. Aerosol-charging operations and storage should conform to both Chapter 51 and NFPA 30B. Organic peroxide storage must conform to Chapter 62. Cellulose nitrate storage and handling are regulated by Chapter 65.

*Hazards.* In declining order, the most hazardous organic coating processes are nitrocellulose lacquer manufacturing and aerosol-charging operations, followed by those involving Class I flammable liquids, Class II combustible liquids and resin manufacturing. Manufacture of water-based products poses little hazard, although many water-based coatings exhibit a flash point when tested in a closed-cup apparatus. Research conducted by the National Paint and Coatings Association (NPCA) in 1977, however, indicates that these products pose little fire hazard. Ignition of solvent vapors released from products during the manufacturing process and flammable liquid spills are considered the most serious hazards encountered in daily operations. Concern about both of these scenarios is compounded by the fact that the mixing, pumping, agitation and filtering of organic chemicals generate large amounts of static electricity, which is the most common ignition source in paint and coating fires.

*Nitrocellulose.* Hazards associated with nitrocellulose deserve special attention. Nitrocellulose is a generic term used to describe a group of highly flammable organic fibers and other solid materials, usually cotton or wood, in fibrous or finely divided form with nitrogen contents between 10.5 and 12.6 percent. The most dangerous characteristic of these materials is their ability to support combustion in the absence of oxygen. This quality makes fire extinguishment extremely difficult. These materials are usually shipped and stored in 55-gallon (208 L) drums; however, dry product may be found in either fiber or cardboard drums.

Nitrocellulose is usually stored in one of four raw forms: solvent-wet, water-wet, plasticized or dry. Of these four forms, solvent-wet nitrocellulose (with alcohol as the usual solvent) is most common, while dry is most hazardous. Dry nitrocellulose must be avoided in all operations. Solvent-wet nitrocellulose possesses the same relative hazard as the solvent. Though relatively stable at room temperature, alcohol-wet nitrocellulose

decomposes rapidly as temperatures increase; therefore, maintaining room temperature and adequate ventilation is extremely important. Metal drums of the material must be carefully handled to prevent ignition. Drums should never be pushed across the floor or any other surface. Relatively small amounts of frictional heat may ignite the material inside the drum. Burning nitrocellulose produces harmful oxides of nitrogen and carbon monoxide (see commentary, Chapter 65).

*Spills.* Good housekeeping and prompt responses to spills are extremely important fire protection practices. Though not always successful in preventing a disaster, the prompt response of the occupants can often keep the hazard contained and under control until help arrives. Such was the case at a Sherwin-Williams paint warehouse in Dayton, Ohio, in May 1987, where the quick response of employees to a small spill [8 gallons to 10 gallons (30 L to 38 L)] saved a worker whose clothing caught on fire. It is very likely that the employees' training and experience prevented their coworker's death.

After their spill control efforts failed, the employees promptly evacuated the building and activated the fire alarm system, resulting in the notification of other employees working in different areas of the building, as well as the local fire department through the central station. Sherwin-Williams employees at the Dayton facility were well trained and well drilled in spill and emergency response procedures. After the incident, employee interviews conducted by the fire department, National Fire Protection Association (NFPA) and Building Officials and Code Administrators (BOCA) investigators suggested that this program had successfully averted disasters in the past.

*Mechanical Ignition Sources.* During the Sherwin-Williams warehouse incident, a Type E lift truck was operated in an area that should have been restricted to Type EE or EX lift trucks (see NFPA 505). Many fire investigators believe the Type E lift truck was the ignition source; however, other possible causes, including static electricity, could not be eliminated. The estimated total loss in damages resulting from this fire topped \$49 million, thus requiring an extensive environmental cleanup effort.

*Static Electricity.* Arcs and sparks from static discharge are the most common ignition sources in organic coating manufacturing plants. As stated earlier, organic chemicals produce a great deal of static electricity. Special measures are required to successfully dissipate this energy without causing ignition. NFPA 77 describes recommended practices for controlling this ignition source.

*Ignition Source Control.* In this case, fire prevention means preventing ignition. Because the fuel sources (flammable liquids and vapors) usually exist, as do ignition sources (static electricity, electric motors and fix-

tures), keeping the two apart is nearly impossible. Safeguards must, therefore, be placed to minimize the likelihood that a flammable mixture will be ignited. Some of the most fundamental practices for controlling ignition sources are:

- Installing grounds.
- Observing bonding practices.
- Installing and maintaining electrical equipment classified for hazardous locations.
- Using nonsparking tools.

Purging and inerting systems are often employed where static electricity cannot be adequately dissipated (for example, pebble mixers).

*Housekeeping.* Good housekeeping practices, including the cleanup of spills and residues, are imperative. Cleanup programs should follow a regular schedule, and every effort should be made to keep the plant as clean and orderly as possible. Nitrocellulose residues should be swept up using a wet-chamber vacuum only. Loose material and scraps must be stored in metal containers with tight-fitting, self-closing or automatic-closing lids.

Installed fire protection systems must conform to the code and the requirements of the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>) or another building code in effect at the time of construction, addition or alteration. Automatic sprinklers, foam-water sprinklers or deluge foam-water sprinklers must be installed and maintained, in accordance with the code and the appropriate referenced standard indicated in Chapter 9 of the code where required by the IBC or the code. Process hazards should be protected by special hazard systems designed, installed and maintained in accordance with the code and the appropriate NFPA standard (see Table 901.6.1) where flammable liquids exist. A method must be provided to notify employees and plant fire brigade personnel if a fire occurs. Portable fire extinguishers must be provided in the organic coating area and throughout the facility as provided in Section 2903.5 and Chapter 9.

### Purpose

Chapter 29 regulates materials and processes associated with the manufacture of paints, as well as bituminous, asphaltic and other organic coatings used for protective or decorative purposes. Painting and processes related to the manufacture of nonflammable and noncombustible or water-based products are exempt from the provisions of this chapter. Application of organic coatings is covered by Chapter 24. Elimination of ignition sources, maintenance of fire protection equipment and isolation or segregation of hazardous operations are emphasized.

## SECTION 2901 GENERAL

**2901.1 Scope.** Organic coating manufacturing processes shall comply with this chapter, except that this chapter shall not apply to processes manufacturing nonflammable or water-thinned coatings or to operations applying coating materials.

❖ Manufacture of flammable and combustible paints and other protective or decorative coatings is regulated by this chapter. Materials and processes associated with organic coatings manufacture may present explosion hazards from the ignition of vapors or dusts. Manufacture of nonflammable or water-based products and painting operations are not regulated by this chapter because hazards associated with those operations are insignificant.

**2901.2 Permits.** Permits shall be required as set forth in Section 105.6.

❖ Any manufacturing operation producing more than 1 gallon (4 L) of an organic coating per day must obtain approval from the fire code official. The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of activities requiring an operational permit and Section 105.6.35 for discussion of the specific operational permit for organic coating manufacturing operations. The process also notifies the fire department of the need for prefire planning for the hazardous property.

**2901.3 Maintenance.** Structures and their service equipment shall be maintained in accordance with this code and NFPA 35.

❖ NFPA 35 is referenced to cover maintenance requirements not specifically addressed by this chapter. Note that the prescribed extent of the reference to NFPA 35 is to only its maintenance provisions, not the entire standard. See commentary to Section 102.7.

## SECTION 2902 DEFINITION

**2902.1 Definition.** The following term is defined in Chapter 2:

### ORGANIC COATING.

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated term used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

## SECTION 2903 GENERAL PRECAUTIONS

**2903.1 Building features.** Manufacturing of organic coatings shall be done only in buildings that do not have pits or *basements*.

❖ The IBC classifies organic coating processes in Group H-2 or H-3 occupancies, depending on the types and amounts of materials, when the maximum allowable quantity per control area (MAQ) of hazardous materials in Table 307.1(1) of that code is exceeded. Basements, pits or depressed first-floor construction are prohibited because of the tendency for hazardous materials vapors to accumulate in low areas and the difficulty in fighting fires in such areas and occupancies.

**2903.2 Location.** Organic coating manufacturing operations and operations incidental to or connected with organic coating manufacturing shall not be located in buildings having other occupancies.

❖ Incidental occupancies involve operations and activities closely related to the primary occupancy and are necessary for efficient, continuous and safe organic coatings manufacture. Administration, storage, shipping and receiving, as well as other related but not indispensable operations, should be located in separate buildings. Separations must have a fire-resistance rating, separation distance or a combination of the two as required by the IBC.

**2903.3 Fire-fighting access.** Organic coating manufacturing operations shall be accessible from not less than one side for the purpose of fire control. *Approved aisles* shall be maintained for the unobstructed movement of personnel and fire suppression equipment.

❖ Access from at least one side conforming to Sections 503 and 504 is required. Fire department connections, fire protection valves, yard hydrants and related fire-fighting equipment should be sited with respect to the provided access and hazards present (see commentary, Chapter 5). Fire department preincident plans should consider operational alternatives if the access is unusable when only one means of access is provided. Design and layout of equipment and processes must facilitate access for fire control. If provided, standpipes and hose reels should be located at intersections between aisles to facilitate movement of hose lines. Portable fire extinguishers must be located in the path of egress travel.

**2903.4 Fire protection systems.** *Fire protection systems* shall be installed, maintained, periodically inspected and tested in accordance with Chapter 9.

❖ Fire protection must be continuously maintained in order to remain effective. Prior permission of the fire code official is required for temporary outages for maintenance, repair, testing, alterations or additions. The fire code official may require special protection or precautions during any outage period. Every effort

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must be made to restore service as quickly as possible (see commentary, Chapter 9).

**2903.5 Portable fire extinguishers.** Not less than one portable fire extinguisher complying with Section 906 for extra hazard shall be provided in organic coating areas.

- ❖ At least one fire extinguisher is required, sized and located for the extra hazardous nature of organic coatings operations. The addition of wheeled fire extinguishers could provide more extinguishing agent, longer discharge time and greater stream reach for the higher hazard in large area operations.

**2903.6 Open flames.** Open flames and direct-fired heating devices shall be prohibited in areas where flammable vapor-air mixtures exist.

- ❖ Only indirect heat equipment employing hot water, steam or warm air, or heat equipment approved for use in Class I, Division 2, Group D hazardous locations must be used where flammable vapor-air mixtures exist.

**2903.7 Smoking.** Smoking shall be prohibited in accordance with Section 310.

- ❖ Smoking is prohibited in and around organic coating manufacturing areas, in accordance with Section 310, to control this ignition source. Approved signs must be posted at entrances and throughout the manufacturing area. Locations approved for smoking should be separated from the manufacturing area by fire-resistance-rated construction and provided with separate ventilation.

**2903.8 Power equipment.** Power-operated equipment and industrial trucks shall be of a type *approved* for the location.

- ❖ Section 309 of the code, Section 7-6 of NFPA 35 and NFPA 505 provide guidance on use, classification of hazards and selection of industrial lift trucks.

**2903.9 Tank maintenance.** The cleaning of tanks and vessels that have contained flammable or *combustible liquids* shall be performed under the supervision of persons knowledgeable of the fire and explosion potential.

- ❖ Trained people well versed in the hazards of the tank cleaning process must supervise the cleaning of tanks containing flammable or combustible vapors. NFPA 326 provides useful guidance on tank-cleaning safety practices. Oxygen deficiency and explosion potential hazards are paramount concerns.

**2903.9.1 Repairs.** Where necessary to make repairs involving “hot work,” the work shall be authorized by the responsible individual before the work begins.

- ❖ Extreme caution must be exercised when welding and cutting in or around flammable or combustible liquid tanks. Chapter 35 specifies safety requirements for welding and cutting operations and, in Section 3510, regulates hot work on tanks containing, or having contained, flammable or combustible liquids. Specific reference to NFPA 326 is also included in that section. See the commentary to Section 3510.

**2903.9.2 Empty containers.** Empty flammable or *combustible liquid* containers shall be removed to a detached, outside location and, if not cleaned on the premises, the empty containers shall be removed from the plant as soon as practical.

- ❖ Partially full and empty containers may pose an even greater hazard than full containers. Residual liquid must be completely removed and flammable vapors vented or purged from containers before they can be considered safe. Unused containers must be promptly removed from the premises. A special detached storage facility may be used for containers awaiting cleaning or disposal (see commentary, Section 5003.2.5).

**2903.10 Drainage.** Drainage facilities shall be provided to direct flammable and *combustible liquid* leakage and fire protection water to an *approved* location away from the building, any other structure, storage area or adjoining premises.

- ❖ Site drainage must be arranged to minimize hazards to adjacent properties and constructed to keep spills on site and away from significant buildings, means of egress and access routes. See Chapter 57 for further guidance on above-ground diking and drainage.

**2903.11 Alarm system.** An *approved* fire alarm system shall be provided in accordance with Section 907.

- ❖ A manual fire alarm system is required in areas where organic coatings are manufactured (see commentary, Section 907.2.5).

## SECTION 2904 ELECTRICAL EQUIPMENT AND PROTECTION

**2904.1 Wiring and equipment.** Electrical wiring and equipment shall comply with this chapter and shall be installed in accordance with NFPA 70.

- ❖ NFPA 70 and the requirements of this section apply to electrical wiring and equipment to reduce the fire hazard associated with the presence of such equipment in areas where organic coatings are being manufactured.

**2904.2 Hazardous locations.** Where Class I liquids are exposed to the air, the design of equipment and ventilation of structures shall be such as to limit the Class I, Division 1, locations to the following:

1. Piping trenches.
2. The interior of equipment.
3. The immediate vicinity of pumps or equipment locations, such as dispensing stations, open centrifuges, plate and frame filters, opened vacuum filters, change cans and the surfaces of open equipment. The immediate vicinity shall include a zone extending from the vapor liberation point 5 feet (1524 mm) horizontally in all directions and vertically from the floor to a level 3 feet (914 mm) above the highest point of vapor liberation.

- ❖ Class I, Division 1, hazardous locations are areas where flammable or explosive vapors generally exist

in quantities sufficient to support an ignition (vapor-air concentrations within the flammable range). Piping trenches and other depressed areas will accumulate vapors because these vapors are usually heavier than air. Vapor production generally creates higher concentrations where flammable liquids are dispensed. Other areas must be adequately ventilated to disperse and dilute vapors to prevent flammable or explosive concentrations. The zone description in Item 3 should be used to define the limitations of the "immediate vicinity." Most flammable vapors are susceptible to ignition within relatively narrow concentrations in air so these boundaries provide a relatively good safety margin.

**2904.2.1 Other locations.** Locations within the confines of the manufacturing room where Class I liquids are handled shall be Class I, Division 2, except locations indicated in Section 2904.2.

❖ Class I, Division 2, locations include all areas where flammable vapors may be liberated in sufficient quantities to present a hazard should an accidental release or spill occur. Areas extending beyond the boundaries defined in Section 2904.2, such as processing areas for Class I liquids, should be considered as such locations. NFPA 497 provides useful guidance for determining the extent of electrically classified boundaries. When Class II liquids are handled and the ambient temperature is cooler than the liquid's flash point, ordinary electrical equipment may be used, provided precautions are taken to prevent hot metal or slag from falling into the liquid.

**2904.2.2 Ordinary equipment.** Ordinary electrical equipment, including switchgear, shall be prohibited, except where installed in a room maintained under positive pressure with respect to the hazardous area. The air or other media utilized for pressurization shall be obtained from a source that will not cause any amount or type of flammable vapor to be introduced into the room.

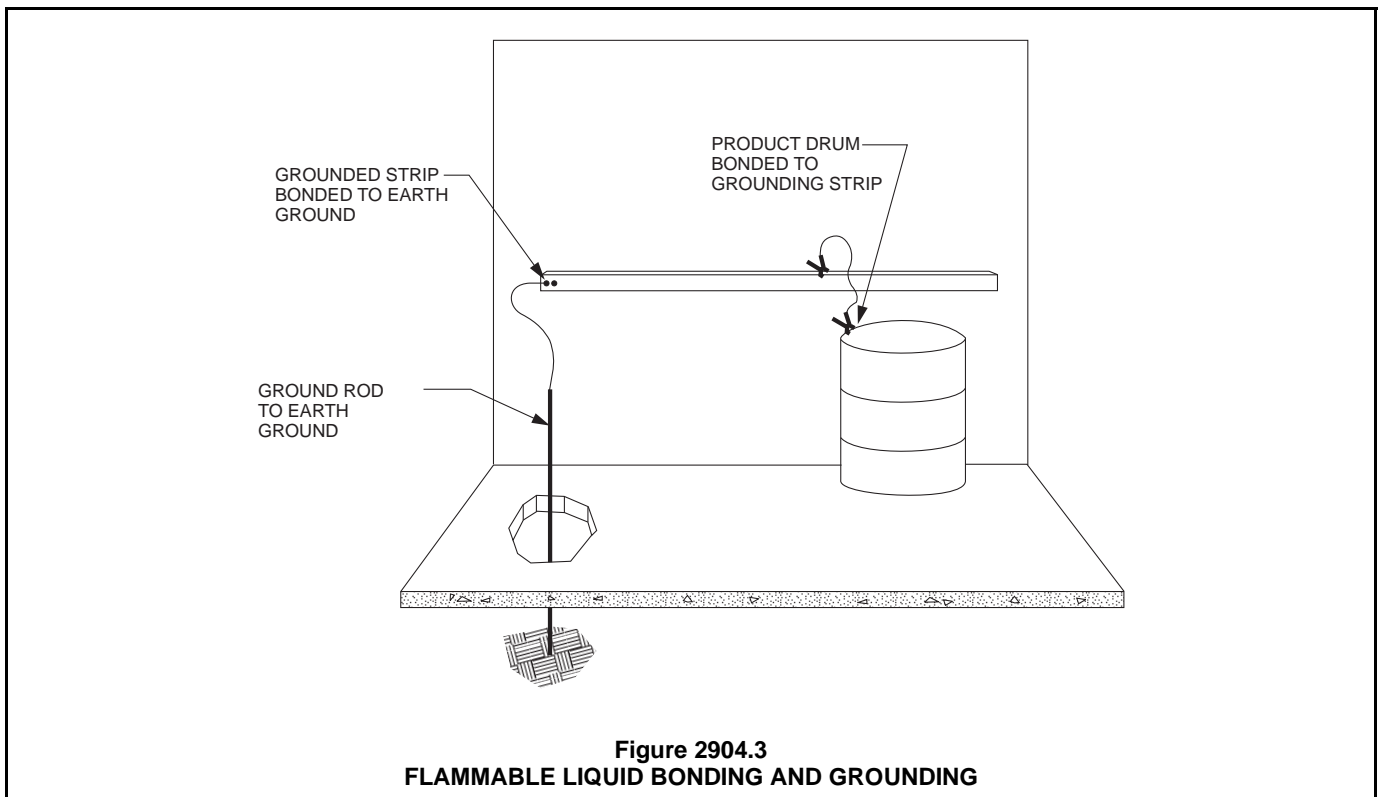
❖ Electrical equipment not classified for use in hazardous locations must be installed in separate rooms and provided with positive-pressure ventilation to prevent infiltration of flammable vapors. Care must be taken to avoid using air for ventilation that is contaminated with flammable vapors. Outside air taken from a source well above the adjacent grade is usually preferred. NFPA 496 provides useful guidance on the design of purged enclosures for electrical equipment.

**2904.3 Bonding.** Equipment including, but not limited to, tanks, machinery and piping shall be bonded and connected to a ground where an ignitable mixture is capable of being present.

❖ Both bonding and grounding prevent the accumulation of static charges and accidental release of electrical energy that could cause an ignition. The bond and ground may be physically applied or be a part of the design of the apparatus (see Commentary Figure 2904.3).

**2904.3.1 Piping.** Electrically isolated sections of metallic piping or equipment shall be grounded or bonded to the other grounded portions of the system.

❖ In order to maintain the continuity of the grounding path for all portions of a tank and piping system that



do not form a continuous conductive path, each electrically isolated section of piping must be independently grounded or, alternatively, be bonded to another properly grounded portion of the system.

**2904.3.2 Vehicles.** Tank vehicles loaded or unloaded through open connections shall be grounded and bonded to the receiving system.

- ❖ The bond between the tank vehicle and the receiving system may be designed into the dispensing equipment or require physical attachment by the operator (a bond wire is often part of the dispensing hose). The system must also be grounded.

**2904.3.3 Containers.** Where a flammable mixture is transferred from one portable container to another, a bond shall be provided between the two containers, and one shall be grounded.

- ❖ Like tank vehicles, the dispensing hose may have the bond designed into the equipment or, if no such bond exists, a separate bond may need to be applied by the operator. A system ground must also be present.

**2904.4 Ground.** Metal framing of buildings shall be grounded with resistance of not more than 5 ohms.

- ❖ In order to reduce the likelihood of static electricity being generated involving any portion of the structure, the metal structural frame of Type II metal buildings or, for that matter, the metal frame of a building of any construction type, must be bonded together and grounded with a maximum resistance of 5 ohms.

## SECTION 2905 PROCESS STRUCTURES

**2905.1 Design.** Process structures shall be designed and constructed in accordance with the *International Building Code*.

- ❖ The IBC classifies organic coating processes in occupancy Group H-2 or H-3, depending on the type and amounts of materials, when the MAQ of hazardous materials in Table 307.1(1) of that code is exceeded. IBC Section 418 further regulates these structures as to their physical configuration, location and finished product storage. See the commentary to IBC Sections 418.1 through 418.6 for further information.

**2905.2 Fire apparatus access.** Fire apparatus access complying with Section 503 shall be provided for the purpose of fire control to not less than one side of organic coating manufacturing operations.

- ❖ Access from at least one side that conforms to Section 503 is required. Fire department connections, fire protection valves, yard hydrants and related fire-fighting equipment should be located for ready access to hazards. Fire department preincident plans should consider operational alternatives if the access is unusable when only one means of access is provided.

**2905.3 Drainage.** Drainage facilities shall be provided in accordance with Section 2903.10 where topographical conditions are such that flammable and *combustible liquids* are capable of flowing from the organic coating manufacturing operation so as to constitute a fire hazard to other premises.

- ❖ Facility design should consider both spill containment and control provisions. Drains must discharge to approved containment basins. The location of containment facilities must not endanger adjacent facilities (see Sections 2903.10 and 5004.2).

**2905.4 Explosion control.** Explosion control shall be provided in areas subject to potential *deflagration* hazards as indicated in NFPA 35. Explosion control shall be provided in accordance with Section 911.

- ❖ Explosion control is required where Class I liquids or flammable dusts create a potential deflagration hazard; as defined by NFPA 35. Section 911 and IBC Section 414.5.1 prescribe requirements for explosion control. NFPA 68 also provides guidance on this subject.

**2905.5 Ventilation.** Enclosed structures in which Class I liquids are processed or handled shall be ventilated at a rate of not less than 1 cubic foot per minute per square foot [ $0.00508 \text{ m}^3/(\text{s} \cdot \text{m}^2)$ ] of solid floor area. Ventilation shall be accomplished by exhaust fans that take suction at floor levels and discharge to a safe location outside the structure. Noncontaminated intake air shall be introduced in such a manner that all portions of solid floor areas are provided with continuous uniformly distributed air movement.

- ❖ Ventilation systems must be designed to prevent the accumulation of vapors in the building where Class I flammable liquids are processed. Uncontaminated air, preferably from a source outside the building, should be distributed to dilute and disperse vapors over the entire solid floor area and then discharge them to a safe location outside the building. A ventilation rate of 1 cubic foot per minute per square foot ( $0.00508 \text{ m}^3/\text{s} \cdot \text{m}^2$ ) is required.

**2905.6 Heating.** Heating provided in hazardous areas shall be by indirect means. Ignition sources such as open flames or electrical heating elements, except as provided for in Section 2904, shall not be permitted within the structure.

- ❖ Only indirect-heat appliances are permitted in hazardous areas. Steam or hot-water radiators and forced warm air may be used, provided the fans and heat sources are located outside the hazardous area. Appliances and devices using or producing open flames, electrical elements or electric arcs are prohibited.

## SECTION 2906 PROCESS MILLS AND KETTLES

**2906.1 Mills.** Mills, operating with close clearances, which process flammable and heat-sensitive materials, such as nitro-

cellulose, shall be located in a detached building or in a non-combustible structure without other occupancies. The amount of nitrocellulose or other flammable material brought into the area shall not be more than the amount required for a batch.

❖ Milling of heat-sensitive materials, such as nitrocellulose, is an extraordinary hazard that must be located in single-purpose buildings, away from other uses and high-hazard operations. Pebble mills pose a special vapor ignition hazard caused by static electricity. Both the grinding material and inner lining of these mills are made of materials with good insulating characteristics. Because static electricity is produced during milling, it has nowhere to go. Generally, the atmosphere inside of this type of mill is made either partially or totally inert using nitrogen or carbon dioxide gas to prevent ignition.

**2906.2 Mixers.** Mixers shall be of the enclosed type or, where of the open type, shall be provided with properly fitted covers. Where flow is by gravity, a shutoff valve shall be installed as close as practical to the mixer, and a control valve shall be provided near the end of the fill pipe.

❖ Like any other part of the manufacturing process, mixing organic chemicals produces large quantities of static electricity. These requirements provide for controlling fires by smothering (closing the cover or lid) and interrupting fuel flow (closing the product valves).

**2906.3 Open kettles.** Open kettles shall be located in an outside area provided with a protective roof; in a separate structure of noncombustible construction; or separated from other areas by a noncombustible wall having a fire-resistance rating of not less than 2 hours.

❖ Kettles and reactors are large warming vessels used to cook various solid, liquid and gaseous materials, including monomers, which are usually solids or liquids, to initiate a controlled chemical reaction to produce resins. Most operations are exothermic and involve controlled polymerization. Finished resins are mixed with solvents, pigments and additives (for example, quality-control agents, texture materials, glass beads, etc.) to form the finished product in organic coating manufacturing. Principal dangers associated with open-fire kettles or reactors include the ignition of flammable vapors and uncontrolled polymerization. Vapors are released to the surrounding atmosphere, and uncontrolled reactions can lead to spills or discharges from the reactor vessel in open kettles. These operations must be conducted in an outside area under protective cover, if possible. Otherwise, open-fire kettles must be operated only in a separate building of noncombustible construction. An area separated from the main facility by a 2-hour fire wall or fire barrier would comply with this requirement. The area must be positively ventilated, with vapors discharged to a safe location away from the combustion air intake.

**2906.4 Closed kettles.** Contact-heated kettles containing solvents shall be equipped with safety devices that, in case of a

fire, will turn off the process heat, turn on the cooling medium and inject inert gas into the kettle.

❖ Closed reactors confine reaction byproducts within the vessel in a closed loop system. Closed kettles or reactors may be either continuous or batch reactors. In the former, reactants are continuously fed into the system as reactant mass and byproducts are removed. Generally, continuous reactors are safer from a fire protection standpoint.

By comparison, reactants are fed into the batch reactor vessel, which is then sealed before the reaction is initiated by the application of heat. Reaction mass and byproducts are removed upon completion of the reaction and a new batch is processed with new raw materials. To interrupt the chemical process once the reaction begins, heat must be removed and the reaction mass cooled. This often requires the simultaneous venting of gaseous byproducts. Normal and emergency pressure relief vents must be arranged to discharge flammable vapors to a safe location when necessary. Automatic inerting of the atmosphere further disrupts the reaction process by displacing oxygen and oxidation byproducts. For further information, see NFPA 35.

**2906.4.1 Vaporizer location.** The vaporizer section of heat-transfer systems that heat closed kettles containing solvents shall be remotely located.

❖ The vaporizer must be located remotely from the process area.

**2906.5 Kettle controls.** The kettle and thin-down tank shall be instrumented, controlled and interlocked so that any failure of the controls will result in a safe condition. The kettle shall be provided with a pressure-rupture disc in addition to the primary vent. The vent piping from the rupture disc shall be of minimum length and shall discharge to an *approved* location. The thin-down tank shall be adequately vented. Thinning operations shall be provided with an adequate vapor removal system.

❖ Reactors must be provided with automatic high-temperature limit switches or other approved automatic temperature control methods. Manual and automatic methods must be provided to interrupt the flow of fuel if a flameout or other emergency occurs. The rupture disc is intended to vent excess pressure if the normal vent fails. Ventilation must be by a condenser of adequate size to prevent the accumulation of a vapor fog in the reactor area.

## SECTION 2907 PROCESS PIPING

**2907.1 Design.** Piping, valves and fittings shall be designed for the working pressures and structural stresses to which the piping, valves and fittings will be subjected, and shall be of steel or other material *approved* for the service intended.

❖ Suitability of piping for the intended purpose is largely determined by compatibility with the material that it

will contain, adequate strength under normal working pressures and durability throughout the intended life of the system. Materials are permitted provided they are approved for the intended service. Piping systems for flammable and combustible liquids must comply with Section 5703.6. Good engineering judgment is needed in the design of these systems.

**2907.2 Valves.** Valves shall be of an indicating type. Terminal valves on remote pumping systems shall be of the dead-man type, shutting off both the pump and the flow of solvent.

- ❖ Indicating valves permit the system operator to determine the position of critical valves at a glance. This aids in prompt control of the product flow if a piping or process failure occurs. Dead-man valves interlocked with product supply pumps cause the interruption of product flow if there is an operator error.

**2907.3 Support.** Piping systems shall be supported adequately and protected against physical damage. Piping shall be pitched to avoid unintentional trapping of liquids, or *approved* drains shall be provided.

- ❖ Ideally, product lines should be designed without trapped sections. Cleaning and purging of the system is made easier without releasing vapors when drains are opened and ignition sources are adequately controlled. Sufficient support and protection of piping prevent product releases if accidents occur in the processing area.

**2907.4 Connectors.** *Approved* flexible connectors shall be installed where vibration exists or frequent movement is necessary. Hose at dispensing stations shall be of an *approved* type.

- ❖ Rigid connectors either loosen from repeated vibration or fail from stresses created. Hose should be reinforced and designed with an integral ground wire to permit container bonding.

**2907.5 Tests.** Before being placed in service, all piping shall be free of leaks when tested for not less than 30 minutes at not less than 1.5 times the working pressure or a minimum of 5 pounds per square inch gauge (psig) (35 kPa) at the highest point in the system.

- ❖ Tests are intended to demonstrate system integrity under both normal and abnormal conditions. The 50-percent margin represents a reasonable safety range if a malfunction occurs. No test provides absolute certainty that a failure will not occur.

## SECTION 2908 RAW MATERIALS IN PROCESS AREAS

**2908.1 Nitrocellulose quantity.** The amount of nitrocellulose brought into the operating area shall not exceed the amount required for a work shift. Nitrocellulose spillage shall be promptly swept up and disposed of properly.

- ❖ Nitrocellulose lacquer production is among the most hazardous organic coatings manufacturing processes. Nitrocellulose can support combustion in the absence of oxygen and is, therefore, considered very

dangerous. As the temperature of alcohol-wet nitrocellulose increases, it becomes unstable. Relatively small amounts of energy are required to initiate combustion. Small amounts of finely divided nitrocellulose fiber should be cleaned up only with a wet-vacuum apparatus. Loose nitrocellulose material, scraps and waste should be stored underwater in a metal container with a tight-fitting, self-closing or automatic-closing lid. The waste container should be removed from the building daily and its contents burned at an approved site. See Chapter 65 for further regulation of pyroxilin plastics.

**2908.2 Organic peroxides quantity.** Organic peroxides brought into the operating area shall be in the original shipping container. When in the operating area, the organic peroxide shall not be placed in locations exposed to ignition sources, heat or mechanical shocks.

- ❖ Organic peroxides are both flammable materials and strong oxidizers. Many organic peroxides are principal components in more dangerous compounds such as blasting agents. Contamination may sensitize organic peroxides, making them especially sensitive to heat and shock. Organic peroxides should be kept in their original shipping containers to permit easy identification and prevent accidents while transferring contents to other containers.

## SECTION 2909 RAW MATERIALS AND FINISHED PRODUCTS

**2909.1 General.** The storage, handling and use of flammable and *combustible liquids* in process areas shall be in accordance with Chapter 57.

- ❖ Chapter 57 details requirements for the storage and handling of flammable liquids. Moreover, it prescribes limitations on the size and location of containers, tanks and piles of flammable liquids in storage. The protection of flammable liquids in bulk storage has been the topic of considerable debate in the aftermath of the 1987 Sherwin-Williams warehouse fire. Fire code officials should carefully consider protection requirements. Annexes D and E of NFPA 30 contain extensive discussions of recommended protection for bulk flammable liquid storage. Also, investigations have been completed of flammable liquid storage in plastic containers. Reports from these tests conducted by the National Fire Protection Research Foundation (NFPRF) are available from NFPA.

**2909.2 Tank storage.** Tank storage for flammable and *combustible liquids* located inside of structures shall be limited to storage areas at or above grade which are separated from the processing area in accordance with the *International Building Code*. Processing equipment containing flammable and *combustible liquids* and storage in quantities essential to the continuity of the operations shall not be prohibited in the processing area.

- ❖ Tank storage located below grade is prohibited. Basements located under grade-level storage areas

should be discouraged. Below-grade flammable liquid fires are extremely difficult to fight. Similarly, above-grade spills will flow to lower floors, possibly resulting in spill fires on more than one building level. Tank storage of raw materials must be confined to locations at or above grade level. Tank storage must be separated from the processing area, in accordance with the IBC. If possible, these rooms should be accessible on at least one exterior side of the facility. IBC Section 418.4 contains requirements for the separation of these areas.

**2909.3 Tank vehicle.** Tank car and tank vehicle loading and unloading stations for Class I liquids shall be separated from the processing area, other plant structures, nearest lot line of property that can be built upon or public thoroughfare by a minimum clear distance of 25 feet (7620 mm).

- ❖ Like other separation requirements, the 25-foot (7620 mm) clearance is intended to limit accidental fire exposure to process, storage and adjacent buildings, as well as other areas. Additionally, clearance provides the same protection to the tanker or tank car if an incident involving an adjacent facility occurs. Finally, clearance provides access for establishing fire-fighting operations if an incident occurs.

**2909.3.1 Loading.** Loading and unloading structures and platforms for flammable and *combustible liquids* shall be designed and installed in accordance with Chapter 57.

- ❖ Chapter 57 specifies requirements for flammable liquid loading and unloading. Section 5706.5 and Chapter 28 of NFPA 30 specify requirements for tank vehicle and tank car loading and unloading operations, including separate piping and valves for Class I flammable liquids, and Class II and III combustible liquids; leak detection on the discharge side of dispensing pumps; provisions for bonding dispensing equipment to the tank vehicle; and flow control interlocks.

**2909.3.2 Safety.** Tank cars for flammable liquids shall be unloaded such that the safety to persons and property is ensured. Tank vehicles for flammable and *combustible liquids* shall be loaded and unloaded in accordance with Chapter 57.

- ❖ Section 5706.6 emphasizes the tank vehicle operator's responsibilities. Essentially, the operator must verify that all safety features are properly used and maintained. Before loading or unloading the product, the operator must verify that required bonding is in place, a liquid- and vapor-tight connection has been made and fill or discharge lines are protected from physical damage. The operator must remain with the vehicle during the loading or unloading operation, but not in the cab.

**2909.4 Nitrocellulose storage.** Nitrocellulose storage shall be located on a detached pad or in a separate structure or a room enclosed in accordance with the *International Building Code*. The nitrocellulose storage area shall not be utilized for any other purpose. Electrical wiring and equipment installed

in storage areas adjacent to process areas shall comply with Section 2904.2.

- ❖ Solvent-wet nitrocellulose is the most common type associated with lacquer production. In this case, the solvent is usually an alcohol, which is a Class I flammable liquid. Solvent-wet nitrocellulose possesses the same fire-hazard characteristics as the solvent in which it is stored, with important differences noted. Solvent-wet nitrocellulose becomes increasingly unstable as the temperature rises. Once ignited, nitrocellulose will continue to burn even in the absence of oxygen. Therefore, extra diligence must be used to prevent ignition and fire spread. IBC Section 418.5 contains requirements for the separation of these areas.

**2909.4.1 Containers.** Nitrocellulose shall be stored in closed containers. Barrels shall be stored on end and not more than two tiers high. Barrels or other containers of nitrocellulose shall not be opened in the main storage structure but at the point of use or other location intended for that purpose.

- ❖ Like other materials possessing unusual fire-hazard characteristics that may be susceptible to ignition if improperly handled, nitrocellulose must be kept in its Department of Transportation (DOTn) shipping container until used. This reduces the likelihood of accidents associated with unnecessary transfer operations and allows the material to be readily identified by its shipping and DOTn hazard labels. In order to avoid solvent leakage, containers must not be stored on their sides because nitrocellulose is commonly shipped in a wet solvent. One-drum-high storage is preferred, but two-drum-high storage is allowed. Stacking containers poses the risk of toppling or other physical damage to the container with the potential for spillage or ignition.

**2909.4.2 Spills.** Spilled nitrocellulose shall be promptly wetted with water and disposed of by use or burning in the open at an *approved* detached location.

- ❖ Wetting spills with water will help prevent ignition by diluting the flammable solvent, especially in the case of alcohol-wet nitrocellulose. The spilled material must be swept up immediately and placed in a tightly closed metal container and covered with water. Waste must be disposed of in accordance with applicable federal, state and local environmental regulations, or denitrated.

**2909.5 Organic peroxide storage.** The storage of organic peroxides shall be in accordance with Chapter 62.

- ❖ Organic peroxides pose a dual hazard of being both flammable and oxidizing materials (see Section 5001.1). Additionally, these compounds are sensitive to friction, heat and shock. Detached storage buildings are required when storage exceeds the amounts indicated in Table 5003.8.2 to prevent reactions with other materials. These buildings must be constructed in accordance with requirements of the IBC for Group H occupancies, depending on the classification of the organic peroxide involved. Separation distances

specified in Table 6204.1.2 are intended to reduce the likelihood of an incident causing injury or property damage arising from materials stored adjacent to hazardous operations that may cause personal injury or property damage. Adequate access must be provided to facilitate defensive fire-fighting operations and support the installed protection. If possible, the fire department connection or connections should be of the free-standing type located far away from the building along the fire service access route. An organic peroxide may be stored inside a building of another occupancy group in control areas in accordance with Sections 5003.1.1 and 6203.1.1.

Signs are to be posted at the entrance and in all storage areas. NFPA 704 hazard warning signs and signs indicating: "ORGANIC PEROXIDE STORAGE—NO OPEN FLAMES" are recommended for this purpose.

Organic peroxides must be stored in original shipping containers. This practice serves the following three important purposes: reduces the likelihood of accidents caused by unnecessary handling; keeps the material in labeled containers that clearly identify the contents and the hazard; and reduces the likelihood of contamination, which may sensitize the material or cause it to decay.

**2909.5.1 Size.** The size of the package containing organic peroxide shall be selected so that, as nearly as practical, full packages are utilized at one time. Spilled peroxide shall be promptly cleaned up and disposed of as specified by the supplier.

❖ Any leftover organic peroxide poses a storage and handling problem. Most organic peroxides become increasingly unstable if contaminated with foreign materials. Organic peroxides may spontaneously ignite if exposed to sufficient heat or shock because they are both flammables and oxidizers. Extreme care must be taken when cleaning up organic peroxide spills. Hydrocarbons and other volatile organic chemicals may sensitize an organic peroxide. Excessive heat or friction during cleanup operations could result in a deflagration or explosion if the material is contaminated.

**2909.6 Finished products.** Finished products that are flammable or *combustible liquids* shall be stored outside of structures, in a separate structure, or in a room separated from the processing area in accordance with the *International Building Code*. The storage of finished products shall be in tanks or closed containers in accordance with Chapter 57.

❖ Flammable liquid warehouses must comply with both the IBC and Chapter 57 requirements. Though flammable liquid warehouses are exempt from storage quantity limitations, pile size and height restrictions still apply. Separation requirements are contained in IBC Section 418.6.

## Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

Bradford, W.J. "Chemical Processes." *Industrial Fire Hazards Handbook*, 3rd ed. Quincy, MA: National Fire Protection Association, 1990.

Harris, M.V. and A.B. Swartz. "Chapter 10: Paints and Coatings Manufacture." *Industrial Fire Hazards Handbook*, 3rd ed. Quincy, MA: National Fire Protection Association, 1990.

# Chapter 30: Industrial Ovens

## General Comments

The basic cause of industrial oven and furnace explosions is the ignition of an accumulated combustible mixture within the confined space of the furnace. A dangerous combustible mixture within a furnace consists of an excessive quantity of fuel mixed with air in proportions that will result in rapid or uncontrolled combustion when an ignition source is supplied. The magnitude and intensity of the explosion will depend on the relative quantity of the fuel that has accumulated, and the fuel-air ratio at the moment of ignition. Explosions, including “puffs,” are often the result of improper design of the equipment or control systems, or a malfunction of one or the other.

The most common causes of oven fires and explosions are:

1. An interruption of the fuel supply, air supply or ignition source to the burners that results in a momentary loss of flame, which is subsequently followed by reignition of accumulated fuel-air mixtures.

2. Fuel leakage into an idle furnace resulting in a flammable fuel-air mixture, which causes an explosion upon start-up.
3. Repeated unsuccessful attempts to light the furnace without adequate purging of flammable fuel-air mixtures followed by ignition of the fuel-air mixture.
4. Ignition of flammable vapors emanating from a product or workpiece being dried where the volatiles enter the flammable range due to the materials being heated

This chapter addresses the fuel supply, ventilation, emergency shutdown equipment, fire protection, and the operation and maintenance of industrial ovens.

## Purpose

Compliance with this chapter is intended to reduce the likelihood of fires involving industrial ovens or to manage the impact if a fire should occur. Industrial ovens are sometimes referred to as industrial heat enclosures or industrial furnaces. Heat may be furnished by gas burners, oil burners, electric heaters, infrared lamps, induction heaters or steam radiation systems.

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## SECTION 3001 GENERAL

**3001.1 Scope.** This chapter shall apply to the installation and operation of industrial ovens and furnaces. Industrial ovens and furnaces shall comply with the applicable provisions of NFPA 86, the *International Fuel Gas Code*, *International Mechanical Code* and this chapter. The terms “ovens” and “furnaces” are used interchangeably in this chapter.

❖ This chapter contains provisions for the installation and operation of industrial ovens and furnaces. If a certain provision is not found in this chapter, applicable provisions of NFPA 86, the *International Mechanical Code*® (IMC®) and the *International Fuel Gas Code*® (IFGC®) must be used.

**3001.2 Permits.** Permits shall be required as set forth in Sections 105.6 and 105.7.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is

issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit. Because of the flammable nature of the contents and the operation of industrial ovens, an operational permit is required by Section 105.6.25. The process also notifies the fire department of the need for prefire planning for the hazardous property.

## SECTION 3002 DEFINITIONS

**3002.1 Definitions.** The following terms are defined in Chapter 2:

**FURNACE CLASS A.**

**FURNACE CLASS B.**

**FURNACE CLASS C.**

**FURNACE CLASS D.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper

## INDUSTRIAL OVENS

application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

### SECTION 3003 LOCATION

**3003.1 Ventilation.** Enclosed rooms or *basements* containing industrial ovens or furnaces shall be provided with combustion air in accordance with the *International Mechanical Code* and the *International Fuel Gas Code*, and with ventilation air in accordance with the *International Mechanical Code*.

❖ Placing an oven or furnace below grade presents difficulty in ventilation and offers severe obstacles to proper explosion release. When gas or oil is used, the furnace or oven should be vented separately unless the products of discharge deposit directly into the oven.

**3003.2 Exposure.** When locating ovens, oven heaters and related equipment, the possibility of fire resulting from overheating or from the escape of fuel gas or fuel oil and the possibility of damage to the building and injury to persons resulting from explosion shall be considered.

❖ Ovens and furnaces should be located where they will present the least possible hazard to property and life. To present the least possible hazard, walls or partitions may be needed around the furnaces or ovens.

**3003.3 Ignition source.** Industrial ovens and furnaces shall be located so as not to pose an ignition hazard to flammable vapors or mists or *combustible dusts*.

❖ Industrial ovens should be considered an ignition source and should be separated from any materials that may be easily ignited.

**3003.4 Temperatures.** Roofs and floors of ovens shall be insulated and ventilated to prevent temperatures at combustible ceilings and floors from exceeding 160°F (71°C).

❖ Furnaces and ovens should be designed to minimize their fire hazard when operating at elevated temperatures. Insulation and ventilation are important in preventing heat transfer from the oven to surrounding combustible products.

### SECTION 3004 FUEL PIPING

**3004.1 Fuel-gas piping.** Fuel-gas piping serving industrial ovens shall comply with the *International Fuel Gas Code*. Piping for other fuel sources shall comply with this section.

❖ Electrically wired, oil-fired and special-atmosphere furnaces are covered in this section. Fuel-gas piping is covered in the IFGC.

**3004.2 Shutoff valves.** Each industrial oven or furnace shall be provided with an *approved* manual fuel shutoff valve in accordance with the *International Mechanical Code* or the *International Fuel Gas Code*.

❖ Individual manual shutoff valves are used for equipment isolation. Requirements are found in either the IMC or IFGC.

**3004.2.1 Fuel supply lines.** Valves for fuel supply lines shall be located within 6 feet (1829 mm) of the appliance served.

**Exception:** When *approved* and the valve is located in the same general area as the appliance served.

❖ A fuel supply shutoff valve must be installed in the fuel supply line within 6 feet (1829 mm) of the appliance for easy shutoff of fuel in case of an emergency.

**3004.3 Valve position.** The design of manual fuel shutoff valves shall incorporate a permanent feature which visually indicates the open or closed position of the valve. Manual fuel shutoff valves shall not be equipped with removable handles or wrenches unless the handle or wrench can only be installed parallel with the fuel line when the valve is in the open position.

❖ Manual shutoff valves should have a permanently affixed visual indicator that is easily recognizable, and it should be in the open position. The removable handle requirement prevents fuel supply shutoff for any reason. Accidental shutoff could endanger property and people.

### SECTION 3005 INTERLOCKS

**3005.1 Shut down.** Interlocks shall be provided for Class A ovens so that conveyors or sources of flammable or combustible materials shall shut down if either the exhaust or recirculation air supply fails.

❖ If ventilation or airflow were lost, a safety control circuit would immediately shut down the heating system of the effected section. When necessary, loss of ventilation must shut down the entire system, as well as the conveyor.

### SECTION 3006 FIRE PROTECTION

**3006.1 Required protection.** Class A and B ovens that contain, or are utilized for the processing of, combustible materials shall be protected by an *approved* automatic fire-extinguishing system complying with Chapter 9.

❖ While this section requires that a fire protection system be installed in Class A and B ovens, it does not specify the type of fire-extinguishing system required—although automatic sprinklers would typically be considered the system of choice. As such, as an alternative to sprinklers, protection could be in the form of a water spray or mist system designed and installed in accordance with NFPA 13 or NFPA 750, respectively; or a dry chemical, carbon dioxide (CO<sub>2</sub>),

inert gas or foam system designed and installed in accordance with the applicable standard indicated in Section 904. This type of system must be compatible with the design of the oven and the materials being processed. The extent of the required fire protection system is dictated by the design standard and depends on the construction and arrangement of the oven, as well as the materials handled, and should include oven exhaust ducts.

**3006.2 Fixed fire-extinguishing systems.** Fixed fire-extinguishing systems shall be provided for Class C or D ovens to protect against such hazards as overheating, spillage of molten salts or metals, quench tanks, ignition of hydraulic oil and escape of fuel. It shall be the user's responsibility to consult with the *fire code official* concerning the necessary requirements for such protection.

❖ Class C and D ovens can operate with special processing atmospheres at very high temperatures and can present fire hazards to the areas around them. While this section requires that a fire protection system be installed in Class C and D ovens, it does not specify the type of fire-extinguishing system required, although automatic sprinklers would typically be considered the system of choice. As such, as an alternative to sprinklers, protection could be in the form of a water mist, dry chemical, CO<sub>2</sub> or foam system. The extent of the required fire protection system depends on the construction and arrangement of the oven, as well as the materials handled, and should extend into oven exhaust ducts. Decisions regarding the fire protection system type and design must be made by the owner with the consultation and approval of the fire code official.

**3006.3 Fire extinguishers.** Portable fire extinguishers complying with Section 906 shall be provided not closer than 15 feet (4572 mm) or not more than 50 feet (15 240 mm) or in accordance with NFPA 10. This shall apply to the oven and related equipment.

❖ Portable fire extinguishers of the proper size and type and using an appropriate extinguishing agent must be installed near the oven and related equipment. The distances mentioned in this section should be used unless requirements in NFPA 10 are more stringent. See the commentary to Section 906 for additional discussion of portable fire extinguishers.

## SECTION 3007 OPERATION AND MAINTENANCE

**3007.1 Furnace system information.** An *approved*, clearly worded, and prominently displayed safety design data form or manufacturer's nameplate shall be provided stating the safe operating condition for which the furnace system was designed, built, altered or extended.

❖ The equipment manufacturer establishes the need for adequate operational checks and maintenance.

Specifications, data sheets and procedures provide clear and complete inspection, testing and maintenance instructions.

**3007.2 Oven nameplate.** Safety data for Class A solvent atmosphere ovens shall be furnished on the manufacturer's nameplate. The nameplate shall provide the following design data:

1. The solvent used.
2. The number of gallons (L) used per batch or per hour of solvent entering the oven.
3. The required purge time.
4. The oven operating temperature.
5. The exhaust blower rating for the number of gallons (L) of solvent per hour or batch at the maximum operating temperature.

**Exception:** For low-oxygen ovens, the maximum allowable oxygen concentration shall be included in place of the exhaust blower ratings.

❖ Safety data must be included on the manufacturer's nameplate for Class A solvent atmosphere ovens to ensure that safety personnel, operators and maintenance technicians have the information at hand. This same information should also be included in installation, operation and maintenance procedures. The exception in this case is actually an additional nameplate requirement for low-oxygen ovens.

**3007.3 Training.** Operating, maintenance and supervisory personnel shall be thoroughly instructed and trained in the operation of ovens or furnaces.

❖ Alert and competent operators are essential to safe operations. New operators should be thoroughly trained and tested in the use of the equipment. Regular operators should be reevaluated at regular intervals to make certain their skills and knowledge are current.

**3007.4 Equipment maintenance.** Equipment shall be maintained in accordance with the manufacturer's instructions.

❖ There should be a program for inspecting and maintaining oven safety controls. The operating and supervisory control equipment should be checked and tested regularly.

## Bibliography

The following resource was used in the preparation of the commentary for this chapter of the code.

FM Global Property Loss Prevention Data Sheet 6-9, *Industrial Ovens and Dryers*. Johnson, RI: Factory Mutual Global Research, 2009.



# Chapter 31: Tents and Other Membrane Structures

## General Comments

Though they do not happen often, fires occurring in tents and other membrane structures have historically caused significant loss of life. Perhaps the most notable of these tragedies occurred on July 6, 1944, in Hartford, Connecticut, where a Ringling Bros. and Barnum & Bailey Circus tent caught fire during a matinee performance, killing 167 people and injuring 487. Since then, protection of tents and other membrane structures has focused on construction methods and materials, as well as limiting use and occupancy.

## Construction Methods and Materials

Tents and other membrane structures are constructed of diverse materials, usually fabrics, textiles and films. Section 3102 of the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>) requires these membrane materials to be noncombustible as described in IBC Section 703.5 or meet the fire propagation criteria of NFPA 701. The use of lightweight high-tensile-strength membrane coverings is perhaps the most significant similarity between tents and air-supported structures. Beyond this similarity, an increasingly wide variety of structural configurations is becoming common. Tents include all structures using rigid structural frames or supports for lateral and compressive stability. In the case of air-supported structures, a positive pressure differential between the inside and the outside of the structure, coupled with the favorable tensile properties of the membrane, yields these structural properties.

In every case, anchors and cables are used for either additional structural stability or to act as fail-safe devices against extreme wind, rain or snow loading. The more commonplace membrane coverings include cotton and plastic-canvas fabrics. Exotic new materials, such as high-tensile-strength plastic films, have spawned a new generation of air-supported structures, including the spectacularly covered and domed stadi-

ums built in recent years in many large metropolitan areas. Protecting the structure from collapse and fire remains the most significant fire and life safety concern.

## Occupancy

Fire poses a dual threat to a tent or other membrane structures. First, the fire presents a danger to the occupants by exposing them to heat, smoke and toxic combustion products. Just as important, the fire represents an imminent threat to the structure. Even the best flame-resistant fabrics may ignite or fail under extreme conditions posed by a fire, and the fire's demand for air may compromise the structural support of the air inside of, if not the integrity of the membrane itself, an air-supported structure. Full or partial collapse of the membrane covering of a tent or air-supported structure may occur earlier and with less warning than in any other structural type.

Egress may become difficult, if not nearly impossible, if a collapse occurs; therefore, this chapter limits the storage or handling of combustible materials inside tents and other membrane structures because of their contribution to fuel loading. Similarly, heat energy sources that may ignite the membrane fabric or other combustibles are prohibited or restricted. Even spot lighting must be used with caution to prevent heat energy from igniting the covering. Portable fire extinguishers must be readily available for incipient fire fighting as an additional safeguard against fire.

## Purpose

The requirements in this chapter are intended to protect tents and other membrane structures from fire by requiring regular inspections and continued compliance with fire safety regulations, as well as the applicable requirements of Chapter 31 of the IBC, regulating their use and occupancy.

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## SECTION 3101 GENERAL

**3101.1 Scope.** Tents, temporary stage canopies and membrane structures shall comply with this chapter. The provisions of Section 3103 are applicable only to temporary tents and membrane structures. The provisions of Section 3104 are applicable to temporary and permanent tents and membrane

structures. Other temporary structures shall comply with the *International Building Code*.

❖ This section defines the kinds of structures covered by this chapter and designates which sections apply to temporary structures and which apply to permanent structures. Structures can range from 10-foot by 10-foot (3048 mm by 3048 mm) canvas shelters to

major indoor sports arenas. The common feature of all types of membrane structures, whether they are air-supported, air-inflated or tensioned membrane structures, is the nature of the structural skin. In all cases, a pliable material is used to create an indoor or protected space by separating the area under the covering from wind, precipitation and temperature extremes. Although most membrane structures are intended for temporary or seasonal use, elegant all-weather permanent membrane structures are becoming increasingly common.

There has been past confusion over the proper application of the requirements of Chapter 31 to temporary structures. Typically this occurs because the fire code official is already involved with the temporary event regarding other operational permits required by the code. For example, a weekend concert is planned at the fair. The fire code official is already involved with various IFC operational permits for Place of Assembly, Carnival/Fair, and Temporary Membrane Structures and Tents. However, when a stage, platform or other temporary structure is erected, the IBC regulates the construction.

This section now sends the code user to the IBC for temporary structures other than tents and membrane structures. IBC Sections 108.2 and 3103 clearly address the design requirements for such temporary structures. IBC Section 3103.1 similarly sends the IBC code user to the IFC for temporary membrane structures and temporary tents. Clearly, the IFC is designed to address “temporary tents” and “temporary membrane structures,” while IBC Section 3103 is intended to address other “temporary structures.”

## SECTION 3102 DEFINITIONS

**3102.1 Definitions.** The following terms are defined in Chapter 2:

**AIR-INFLATED STRUCTURE.**

**AIR-SUPPORTED STRUCTURE.**

**MEMBRANE STRUCTURE.**

**TEMPORARY STAGE CANOPY.**

**TENT.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*® (I-Code®) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4 and to the definitions in Section 202).

## SECTION 3103 TEMPORARY TENTS AND MEMBRANE STRUCTURES

**3103.1 General.** Tents and membrane structures used for temporary periods shall comply with this section. Other temporary structures erected for a period of 180 days or less shall comply with the *International Building Code*.

❖ This section addresses tents and membrane structures that are considered temporary in terms of the duration of their erection and use (see Section 3103.5 for the definition of “Temporary” as it applies to membrane structures). This section is intended to ensure that if a membrane structure is used, it will be soundly designed so as not to present a hazard to its users, emergency responders or the public during the time it is in place. See also the commentary to Section 3101.1.

**3103.2 Approval required.** Tents and membrane structures having an area in excess of 400 square feet (37 m<sup>2</sup>) shall not be erected, operated or maintained for any purpose without first obtaining a permit and approval from the *fire code official*.

### Exceptions:

1. Tents used exclusively for recreational camping purposes.
2. Tents open on all sides that comply with all of the following:
  - 2.1. Individual tents having a maximum size of 700 square feet (65 m<sup>2</sup>).
  - 2.2. The aggregate area of multiple tents placed side by side without a fire break clearance of 12 feet (3658 mm), not exceeding 700 square feet (65 m<sup>2</sup>) total.
  - 2.3. A minimum clearance of 12 feet (3658 mm) to all structures and other tents.

❖ Use of membrane structures results in great flexibility and a large volume of weather-protected space; however, these benefits are balanced by the sensitivity of these structures to strict maintenance requirements. The approval process allows the fire code official to exercise strict control to achieve compliance with the requirements of this chapter.

This section sets the minimum size structure that requires approval. Exception 1 exempts from permit requirements tents that are normally used by families or very small groups for short periods under widely varying conditions that would be difficult or impossible for a fire code official to police. Exception 2 exempts from permit requirements, for example, a single tent approximately 25.5 square feet (2.4 m<sup>2</sup>) without sides or multiple tents without sides aggregating an area of not more than 700 square feet (65 m<sup>2</sup>) due to their limited size, limited fire load and limited

occupant load. The fact that these tents have no sides and are separated by a 12-foot (3658 mm) fire break also improves the occupants' situational awareness and provides the potential for occupant escape routes and fire department access all around the perimeter.

**3103.3 Place of assembly.** For the purposes of this chapter, a place of assembly shall include a circus, carnival, tent show, theater, skating rink, dance hall or other place of assembly in or under which persons gather for any purpose.

❖ This section gives examples of common types of assembly use for membrane structures, but leaves the issue open so that the fire code official has the discretion to determine whether some other intended use should be considered a place of assembly that would require permits and approvals.

**3103.4 Permits.** Permits shall be required as set forth in Sections 105.6 and 105.7.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations or special structures. Permit applicants should be required to demonstrate that their operation or construction complies with the intent of the code before the permit is issued. See the commentary to Section 105.7 for a general discussion of operations requiring a construction permit. The process also notifies the fire department of the need for prefire planning for the hazardous property.

**3103.5 Use period.** Temporary tents, air-supported, air-inflated or tensioned membrane structures shall not be erected for a period of more than 180 days within a 12-month period on a single premises.

❖ This section gives the fire code official control over the erection, maintenance and use of membrane structures by defining the term "Temporary" for the purpose of applying this chapter. Any membrane structure erected for more than 180 days in any 12-month period at a single location must be considered permanent and would be subject to all requirements for permanent structures as set forth in Section 3104 and the IBC. Note that the limiting factor is how long the structure is erected, not how many days it is in use, as was the case in older editions of the code. Without this level of specificity, a tent or membrane structure could literally remain erected indefinitely as long as it was not used for more than 180 days within any 12-month period, thus retaining its classification as a temporary structure while being, in effect, a permanent one.

**3103.6 Construction documents.** A detailed site and floor plan for tents or membrane structures with an *occupant load* of 50 or more shall be provided with each application for approval. The tent or membrane structure floor plan shall indicate details of the *means of egress* facilities, seating

capacity, arrangement of the seating and location and type of heating and electrical equipment.

❖ The requirement for a floor plan showing means of egress facilities and seating locations eliminates possible conflicts at the time of field inspection. Evaluating means of egress for hastily arranged or movable seating is a challenge to the inspector. The detailed means-of-egress plan allows the inspector to verify that the actual configuration matches the approved plan. The applicant and designer also benefit by having the plans reviewed in detail before construction begins.

**3103.7 Inspections.** The entire tent, air-supported, air-inflated or tensioned membrane structure system shall be inspected at regular intervals, but not less than two times per permit use period, by the permittee, *owner* or agent to determine that the installation is maintained in accordance with this chapter.

**Exception:** Permit use periods of less than 30 days.

❖ The periodic inspections required here are conducted by the permit holder, the owner or his or her agent to make certain the structure continues to meet code requirements and is being properly maintained.

The exception states that structures used for less than 30 days do not need to be reinspected.

**3103.7.1 Inspection report.** Where required by the *fire code official*, an inspection report shall be provided and shall consist of maintenance, anchors and fabric inspections.

❖ This section allows the fire code official to require submittal of a complete inspection report, including completed maintenance work, for each finished inspection by the permit holder, owner or agent.

**3103.8 Access, location and parking.** Access, location and parking for temporary tents and membrane structures shall be in accordance with this section.

❖ This section addresses the issues of fire apparatus access, separation from vehicles and other structures and the need for fire breaks for tents and other membrane structures that are considered temporary in terms of the duration of their erection and use.

**3103.8.1 Access.** Fire apparatus access roads shall be provided in accordance with Section 503.

❖ The same access rules apply to membrane structures and structures erected using conventional construction materials. Because membrane structures can become serious fire hazards, depending on membrane material and structure contents, maintaining code-required fire access roads and lanes is especially important.

**3103.8.2 Location.** Tents or membrane structures shall not be located within 20 feet (6096 mm) of *lot lines*, buildings, other tents or membrane structures, parked vehicles or internal

combustion engines. For the purpose of determining required distances, support ropes and guy wires shall be considered as part of the temporary membrane structure or tent.

**Exceptions:**

1. Separation distance between membrane structures and tents not used for cooking is not required where the aggregate floor area does not exceed 15,000 square feet (1394 m<sup>2</sup>).
  2. Membrane structures or tents need not be separated from buildings when all of the following conditions are met:
    - 2.1. The aggregate floor area of the membrane structure or tent shall not exceed 10,000 square feet (929 m<sup>2</sup>).
    - 2.2. The aggregate floor area of the building and membrane structure or tent shall not exceed the allowable floor area including increases as indicated in the *International Building Code*.
    - 2.3. Required *means of egress* are provided for both the building and the membrane structure or tent including travel distances.
    - 2.4. Fire apparatus access roads are provided in accordance with Section 503.
- ❖ The 20-foot (6096 mm) separation distance is consistent with requirements for conventional structures, especially those that could represent an above-average fire hazard. A fire of any size within a membrane structure would almost certainly involve the membrane itself. Because the support ropes and guy wires are under tension, particularly with large membrane structures, a membrane weakened by fire would fail, causing the ropes or wires to recoil and possibly pull portions of the burning membrane well clear of its original position. Requiring 20 feet (6096 mm) of clear ground around the structure helps reduce the likelihood that burning membrane sections and flying embers would endanger other structures or public trafficways.
- Exception 1 acknowledges the reduced hazard of small membrane structures that do not house cooking appliances.
- Exception 2 lists four criteria for determining whether a membrane structure must conform to the separation criteria of this section. To be exempt, the structure would have to meet all four criteria.
- 3103.8.3 Location of structures in excess of 15,000 square feet in area.** Membrane structures having an area of 15,000 square feet (1394 m<sup>2</sup>) or more shall be located not less than 50 feet (15 240 mm) from any other tent or structure as measured from the sidewall of the tent or membrane structure unless joined together by a corridor.
- ❖ The larger separation distance required by this section is consistent with the hazards presented by the larger structures. The exception for structures connected by corridors considers the smaller hazard

posed by the covering of the corridor. Corridors are not likely to contain significant amounts of combustible materials other than the membrane itself.

**3103.8.4 Membrane structures on buildings.** Membrane structures that are erected on buildings, balconies, decks or other structures shall be regulated as permanent membrane structures in accordance with Section 3102 of the *International Building Code*.

❖ Temporary membrane structures that are placed in a field or parking lot are afforded several safety features, including fire separation distance from other hazards (buildings, vehicles) and separation from other tents, and provide an unobstructed means-of-egress path for the uniformly located exits. When a membrane structure is placed on a building or deck, Section 3103 does not regulate exiting from the temporary membrane structure to a set of stairs or door, nor does it regulate the hazards that could be below the temporary membrane structure. Section 3103 also does not contain requirements regulating the structural loads that the membrane structure would impose on the structure below. For these reasons, what would otherwise be considered as temporary membrane structures are regulated as permanent membrane structures and subject to the provisions of IBC Section 3102.

**3103.8.5 Connecting corridors.** Tents or membrane structures are allowed to be joined together by means of corridors. *Exit* doors shall be provided at each end of such corridor. On each side of such corridor and approximately opposite each other, there shall be provided openings not less than 12 feet (3658 mm) wide.

❖ Corridors connecting membrane structures to each other or to permanent structures must have openings in their side walls for convenient egress in case of an emergency. These openings could also be entry points for emergency response personnel.

**3103.8.6 Fire break.** An unobstructed fire break passageway or fire road not less than 12 feet (3658 mm) wide and free from guy ropes or other obstructions shall be maintained on all sides of all tents and membrane structures unless otherwise *approved by the fire code official*.

❖ This requirement for a clear path makes the membrane structures more accessible to emergency response personnel. It also results in an open space into which flaming embers or other debris can fall without endangering other structures or public trafficways. Measurement of the required width must be consistent with the provisions of Section 3103.8.2.

**3103.9 Anchorage required.** Tents or membrane structures and their appurtenances shall be adequately roped, braced and anchored to withstand the elements of weather and prevent against collapsing. Documentation of structural stability shall be furnished to the *fire code official* on request.

❖ Having secure anchorage to prevent damage or loss caused by wind or precipitation makes good economic sense. This section also gives the fire code

official the authority to review and approve both plans and actual installations to ensure that the structures have been designed and erected using good engineering practices.

**3103.9.1 Tents and membrane structures exceeding one story.** Tents and membrane structures exceeding one story shall be designed and constructed to comply with Chapter 16 of the *International Building Code*.

❖ In recent times, there has been an increasing number of multiple-story tents and membrane structures showing up in jurisdictions across the country. These structures can be seen at concerts, outdoor functions, fairs, etc. Many of these temporary tents and temporary membrane structures have multiple floors and are over 30 feet in height. As the height increases, the potential for collapse increases. Even though the provision of “temporary” limits the usability of these multistory structures to less than 180 days, improper structural design can pose a significant safety hazard to event patrons, performers and first responders.

Section 3103.9 requires that documentation of structural stability be furnished to the fire code official on request but provides no guidance on what an acceptable level of structural integrity is. Since these structures are temporary, they often do not go through a full building code structural analysis and review. This section closes that loophole by requiring that multistory tents and membrane structures be designed and constructed in accordance with IBC Chapter 16. This provides the fire code official with a

solid tool to use to verify proper structural design. Most fire code officials, however, do not routinely review structural integrity. This is most commonly performed by the building code official. But the requirement for a construction permit is in Section 105.7.18 since this is a temporary structure. As such, enforcement of this requirement may take some coordination with the building official prior to the issuance of the IFC construction permit. Commentary Figures 3103.9.1(1) and 3103.9.1(2) illustrate a multistory membrane structure.

**3103.10 Temporary air-supported and air-inflated membrane structures.** Temporary air-supported and air-inflated membrane structures shall be in accordance with Sections 3103.10.1 through 3103.10.4.

❖ This section addresses air-supported and air-inflated membrane structures that are considered temporary in terms of the duration of their erection and use (see Section 3103.5 for the definition of “Temporary” as it applies to these structures). The intent of this section is that if air-supported or air-inflated membrane structures are used, they should be soundly designed so as not to present a hazard to their users, emergency responders or the public during the time they are in place.

**3103.10.1 Door operation.** During high winds exceeding 50 miles per hour (22 m/s) or in snow conditions, the use of doors in air-supported structures shall be controlled to avoid excessive air loss. Doors shall not be left open.

❖ Because the design pressure is critical in maintaining the structural integrity of an air-supported structure,



**Figure 3103.9.1(1)**  
**TWO-STORY MEMBRANE STRUCTURE AT THE AMERICA'S CUP RACE**  
(Photo courtesy of HTS-USA)

doors must not be kept open for extended periods. Controls on door usage help prevent excessive losses of internal pressure. When large openings are necessary, such as for vehicular traffic, vestibules help avoid excessive pressure loss.

**3103.10.2 Fabric envelope design and construction.** Air-supported and air-inflated structures shall have the design and construction of the fabric envelope and the method of anchoring in accordance with Architectural Fabric Structures Institute ASI 77.

❖ The referenced document is both a design manual that contains the engineering formulas needed to calculate stresses and other parameters associated with structural stability and a design standard for air-supported structures.

**3103.10.3 Blowers.** An air-supported structure used as a place of assembly shall be furnished with not less than two blowers, each of which has adequate capacity to maintain full inflation pressure with normal leakage. The design of the blower shall be so as to provide integral limiting pressure at the design pressure specified by the manufacturer.

❖ Requiring two blowers that have the capacity to keep the structure fully inflated builds redundancy into the system. Should one blower fail, the other would be capable of maintaining full inflation while the failed unit was repaired or replaced. The pressure-limiting device is required to prevent overpressurizing the structure and thus causing failure.

**3103.10.4 Auxiliary inflation systems.** Places of public assembly for more than 200 persons shall be furnished with an auxiliary inflation system capable of powering a blower

with the capacity to maintain full inflation pressure with normal leakage in accordance with Section 3103.10.3 for a minimum duration of 4 hours. The auxiliary inflation system shall be either a fully automatic auxiliary engine-generator set or a supplementary blower powered by an internal combustion engine that shall be automatic in operation. The system shall be capable of automatically operating the required blowers at full power within 60 seconds of a commercial power failure.

❖ Because an air-supported structure must be maintained at full design pressure, a power failure that would disable all of the blowers used to maintain that pressure would result in a gradual collapse of the structure as pressure drops as a result of normal leakage. Having an auxiliary power source on site is intended to prevent this situation. This section allows either an auxiliary generator that will supply power to the blowers or a self-contained supplementary blower unit that has an internal combustion engine to drive it.

**3103.11 Seating arrangements.** Seating in tents or membrane structures shall be in accordance with Chapter 10.

❖ See the commentary to Section 3104.14.

**3103.12 Means of egress.** *Means of egress* for temporary tents and membrane structures shall be in accordance with Sections 3103.12.1 through 3103.12.8.

❖ Because of the unique nature of the structures regulated by this chapter, it is vital that their means of egress systems be carefully designed and constructed. This section regulates the access to, number, location, marking and illumination of the means of egress for temporary membrane structures.



Figure 3103.9.1(2)  
 INTERIOR OF TWO-STORY MEMBRANE STRUCTURE  
 (Photo courtesy of Losberger-USA)

**3103.12.1 Distribution.** *Exits* shall be spaced at approximately equal intervals around the perimeter of the tent or membrane structure, and shall be located such that all points are 100 feet (30 480 mm) or less from an *exit*.

❖ The requirement for exits to be equally spaced around the perimeter of the membrane structure considers the probability that any one structure could be used for several different purposes over its life and that each use could represent a different seating arrangement. Because travel distances to an exit must not exceed 100 feet (30 480 mm), exits must be located to minimize travel distances no matter how the seating is arranged.

**3103.12.2 Number.** Tents, or membrane structures or a usable portion thereof shall have not less than one *exit* and not less than the number of *exits* required by Table 3103.12.2. The total width of *means of egress* in inches (mm) shall be not less than the total *occupant load* served by a *means of egress* multiplied by 0.2 inches (5 mm) per person.

❖ This section specifies the use of the exit requirements contained in Table 3103.12.2 to determine the number and size of exits for all membrane structures. The formula given in the last sentence of the section allows for the calculation of total exit requirements for any given number of occupants.

**TABLE 3103.12.2.** See below.

❖ The minimum means of egress widths shown in this table were established on two very different bases. For tents, the widths are possibly conservative because so many in the fire service remember the Ringling Bros. and Barnum & Bailey Circus tent fire that happened in Hartford, Connecticut, in July 1944. In that fire, 167 people died and 487 were injured because they were unable to escape from the burning tent. Also, because the side panels of a tent can be constructed to varying widths without too much difficulty, the wider openings are practical.

On the other hand, means-of-egress widths required for air-supported structures seem to be much more optimistic. The narrower means-of-egress widths are necessary to prevent excess loss of inter-

nal air pressure in the air-supported structure and can be linked to the exit requirements in ASI 77. Excessive inflation pressure losses could lead to the collapse of the structure onto the very occupants the exits are serving.

**3103.12.3 Exit openings from tents.** *Exit* openings from tents shall remain open unless covered by a flame-resistant curtain. The curtain shall comply with the following requirements:

1. Curtains shall be free sliding on a metal support. The support shall be not less than 80 inches (2032 mm) above the floor level at the *exit*. The curtains shall be so arranged that, when open, no part of the curtain obstructs the *exit*.
2. Curtains shall be of a color, or colors, that contrasts with the color of the tent.

❖ The requirement for exit openings to remain free and clear is meant to ensure that the exit is not blocked or hidden from the view of the occupants attempting to exit. Allowing the opening to be covered by an easily moveable curtain is meant to add to the comfort of occupants by protecting them from wind, precipitation and temperature extremes. The requirement for the curtains to be of a contrasting color makes the exits readily identifiable even at a distance.

**3103.12.4 Doors.** *Exit* doors shall swing in the direction of *exit* travel. To avoid hazardous air and pressure loss in air-supported membrane structures, such doors shall be automatic closing against operating pressures. Opening force at the door edge shall not exceed 15 pounds (66 N).

❖ Pressure loss in an air-supported structure is always a concern. The requirement that the door be capable of closing automatically against the internal pressure supporting the membrane structure is intended to protect against this kind of loss. The 15-pound (66 N) force required for opening acknowledges that the door must be held closed against the interior air pressure. This level of opening force is, however, consistent with the requirements of the IBC for exterior doors in conventional buildings.

**TABLE 3103.12.2  
MINIMUM NUMBER OF MEANS OF EGRESS AND MEANS OF  
EGRESS WIDTHS FROM TEMPORARY MEMBRANE STRUCTURES AND TENTS**

OCCUPANT LOAD	MINIMUM NUMBER OF MEANS OF EGRESS	MINIMUM WIDTH OF EACH MEANS OF EGRESS (inches)	
		Tent	Membrane Structure
10 to 199	2	72	36
200 to 499	3	72	72
500 to 999	4	96	72
1,000 to 1,999	5	120	96
2,000 to 2,999	6	120	96
Over 3,000 <sup>a</sup>	7	120	96

For SI: 1 inch = 25.4 mm.

a. When the occupant load exceeds 3,000, the total width of means of egress (in inches) shall be not less than the total occupant load multiplied by 0.2 inches per person.

**3103.12.5 Aisle.** The width of *aisles* without fixed seating shall be in accordance with the following:

1. In areas serving employees only, the minimum *aisle* width shall be 24 inches (610 mm) but not less than the width required by the number of employees served.
  2. In public areas, smooth-surfaced, unobstructed *aisles* having a minimum width of not less than 44 inches (1118 mm) shall be provided from seating areas, and *aisles* shall be progressively increased in width to provide, at all points, not less than 1 foot (305 mm) of *aisle* width for each 50 persons served by such *aisle* at that point.
- ❖ The first requirement for areas serving only employees is indefinite because the configuration of the area could vary widely from one use to another. Required width beyond 24 inches (610 mm) would have to be determined based on seating arrangements, if any, and traffic patterns in the affected area. Guidance for assembly areas of fixed conventional structures is given in Chapter 10 of the code as well as in Chapter 10 of the IBC. The judgment of the fire code official would also have to be considered in the final decision.

The second requirement is quite specific for public-use areas. The wide aisles are intended to make egress quicker and easier because a fire in an air-supported structure could easily burn through the membrane covering and cause the structure to collapse on the occupants.

**3103.12.5.1 Arrangement and maintenance.** The arrangement of *aisles* shall be subject to approval by the *fire code official* and shall be maintained clear at all times during occupancy.

- ❖ This section gives the fire code official the authority to approve seating arrangements in air-supported structures and to inspect those arrangements periodically to verify that they have not been changed to an unacceptable configuration or that they have become obstructed or their use otherwise compromised. This is consistent with Section 1030.2.

**3103.12.6 Exit signs.** *Exits* shall be clearly marked. *Exit* signs shall be installed at required *exit* doorways and where otherwise necessary to indicate clearly the direction of egress where the *exit* serves an *occupant load* of 50 or more.

- ❖ This charging statement establishes the requirement for exit signs. See the commentary to Section 1011.2 for further discussion of exit sign requirements.

**3103.12.6.1 Exit sign illumination.** *Exit* signs shall be either *listed* and *labeled* in accordance with UL 924 as the internally illuminated type and used in accordance with the listing or shall be externally illuminated by luminaires supplied in either of the following manners:

1. Two separate circuits, one of which shall be separate from all other circuits, for *occupant loads* of 300 or less.
2. Two separate sources of power, one of which shall be an *approved* emergency system, shall be provided

where the *occupant load* exceeds 300. Emergency systems shall be supplied from storage batteries or from the on-site generator set, and the system shall be installed in accordance with NFPA 70. The emergency system provided shall have a minimum duration of 90 minutes when operated at full design demand.

- ❖ Because there is always the possibility of power failure in a fire or other emergency, exit signs must have a power source—batteries, backup power or auxiliary power—that will keep them illuminated if the primary power source to the structure's lighting system fails. The requirement for this power source is established in Section 604.2.3 and is further defined in Section 1011.6.3. This section also provides correlation with Section 1011.4 since internally illuminated exit signs listed in accordance with UL 924, including electrically powered, self-luminous and photoluminescent types, all provide for a minimum of 90 minutes of luminosity upon loss of normal power.

**3103.12.7 Means of egress illumination.** *Means of egress* shall be illuminated with light having an intensity of not less than 1 footcandle (11 lux) at floor level while the structure is occupied. Fixtures required for *means of egress* illumination shall be supplied from a separate circuit or source of power.

- ❖ All means of egress must be continuously illuminated by artificial lighting during the entire time the air-supported structure is occupied so that the paths of exit travel are always visible and available for evacuation of the occupants during emergencies. The code makes a special point of noting that the exit discharge must also be provided with adequate illumination so that occupants can safely find the public way should the emergency occur at night.

The intensity of floor lighting illuminating the entire means of egress, including open-plan spaces, aisles, corridors, exit access passageways and exit doors, must not be less than 1 foot candle (11 lux). It has been found that this low level of lighting renders enough visibility for the occupants to evacuate the building safely. This lighting level is measured at the floor to make the floor surface visible. Levels of illumination above the floor may be higher or lower.

The means of egress must be illuminated, especially in times of emergency when the occupants must have a lighted path of exit travel to evacuate the building safely.

So that there will be a continuing source of electrical energy for lighting the means of egress when the main power supply is lost, the means-of-egress lighting system must be connected to an emergency electrical system that consists of storage batteries, unit equipment or an on-site generator. This emergency power-generating facility must be capable of supplying electricity for at least 90 minutes, thereby giving the occupants sufficient time to leave the premises. In most cases, where the loss of the main electrical supply is attributed to a malfunction in the distribution system of the electric power company, experience

has shown that such power outages do not usually last as long as 90 minutes.

**3103.12.8 Maintenance of means of egress.** The required width of *exits*, *aisles* and passageways shall be maintained at all times to a *public way*. Guy wires, guy ropes and other support members shall not cross a *means of egress* at a height of less than 8 feet (2438 mm). The surface of *means of egress* shall be maintained in an *approved* manner.

❖ It is important for occupant safety that the pathway from any point in the building to the exit discharge be kept clear so that occupants can exit the structure at any time without obstructions in the egress path. This requirement applies to all structures, but it is especially important for membrane structures and tents because of the added hazards that they present. The structural stability of tents relies on ropes or cables and stakes which, if not carefully arranged, can become an impediment to occupant egress flow. A clearly defined and well-lighted egress path without any rope or guy wire vertical or horizontal impingement is essential for these types of structures.

As the pace of exit travel becomes hurried during emergency situations, the probability of slipping on smooth or slick surfaces increases. To minimize the hazard in buildings, floor surfaces in the means of egress are required to be slip resistant by Section 1003.4. However, in tents and membrane structures, the structure “floor” may very well be dirt, gravel, grass or other nontraditional surfaces that defy traditional regulation. The fire code official must apply common sense in reviewing egress path surfaces, applying safety criteria for them and then requiring that the required conditions be maintained throughout the occupancy of the structure.

## SECTION 3104 TEMPORARY AND PERMANENT TENTS AND MEMBRANE STRUCTURES

**3104.1 General.** Tents and membrane structures, both temporary and permanent, shall be in accordance with this section. Permanent tents and membrane structures shall also comply with the *International Building Code*.

❖ This section addresses tents and membrane structures that are considered either temporary or permanent in terms of the duration of their erection and use (see Section 3103.5 for the definition of “Temporary” and, by default, “Permanent” as they apply to membrane structures). This section is intended to ensure that if a tent or other membrane structure is used, it will be soundly designed so as not to present a hazard to its users, emergency personnel or the public during the time it is in place, whether that is more or less than 180 days per calendar year.

**3104.2 Flame propagation performance treatment.** Before a permit is granted, the *owner* or agent shall file with the *fire code official* a certificate executed by an *approved* testing laboratory certifying that the tents and membrane structures and their appurtenances; sidewalls, drops and tarpaulins;

floor coverings, bunting and combustible decorative materials and effects, including sawdust where used on floors or passageways, are composed of material meeting the flame propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701 or shall be treated with a flame retardant in an *approved* manner and meet the flame propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701, and that such flame propagation performance criteria are effective for the period specified by the permit.

❖ The reference to NFPA 701 in this section is consistent with the requirements of IBC Section 3102 for structural materials, IBC Sections 802 and 806 and Section 807 of the code for decorative materials. Making certain the structure and as much of its contents as possible are either noncombustible or are treated to make them less prone to flame propagation is an important first step in fire safety. This section also gives the fire code official the authority to inspect the facility, its contents and documentation of applied flame-retardant treatment to ensure permit requirements have been met.

**3104.3 Label.** Membrane structures or tents shall have a permanently affixed label bearing the identification of size and fabric or material type.

❖ This required label gives the fire code official important information about the membrane and the designed size of the structure. This information will help him or her determine whether the structure and its covering meet code requirements.

**3104.4 Certification.** An affidavit or affirmation shall be submitted to the *fire code official* and a copy retained on the premises on which the tent or air-supported structure is located. The affidavit shall attest to all of the following information relative to the flame propagation performance criteria of the fabric:

1. Names and address of the *owners* of the tent or air-supported structure.
2. Date the fabric was last treated with flame-retardant solution.
3. Trade name or kind of chemical used in treatment.
4. Name of person or firm treating the material.
5. Name of testing agency and test standard by which the fabric was tested.

❖ The certificate is another piece of information the fire code official must have to make a decision on code compliance. The certificate will indicate whether the membrane fabric needs retreatment and at what frequency to maintain its low flame propagation properties.

**3104.5 Combustible materials.** Hay, straw, shavings or similar combustible materials shall not be located within any tent or membrane structure containing an assembly occupancy, except the materials necessary for the daily feeding and care of animals. Sawdust and shavings utilized for a public performance or exhibit shall not be prohibited provided the sawdust

and shavings are kept damp. Combustible materials shall not be permitted under stands or seats at any time.

❖ This section contains a “laundry list” of unacceptable practices. Hay, straw, shavings and sawdust are all readily ignitable materials. Minimizing their use is important to fire safety. A carelessly discarded match or other smoking material could easily cause any of these materials to catch fire.

Requiring finely divided combustible materials, such as sawdust and shavings, to be maintained damp significantly reduces their ignition potential.

Keeping areas under seating areas free of readily ignitable combustible materials removes a significant fire hazard from these areas of high-occupant density.

**3104.6 Smoking.** Smoking shall not be permitted in tents or membrane structures. *Approved* “No Smoking” signs shall be conspicuously posted in accordance with Section 310.

❖ Because smoking is prohibited in membrane structures, the requirement for posting signage is obvious. Because no specification exists for standard signs, each jurisdiction having authority is responsible for establishing its own criteria. To be approved, signs must be large enough to be read from a distance and be worded simply and clearly.

**3104.7 Open or exposed flame.** Open flame or other devices emitting flame, fire or heat or any flammable or *combustible liquids*, gas, charcoal or other cooking device or any other unapproved devices shall not be permitted inside or located within 20 feet (6096 mm) of the tent or membrane structures while open to the public unless *approved* by the *fire code official*.

❖ This section gives the fire code official the authority to approve an open-flame or exposed-flame appliance if it is determined that it poses a minimal fire hazard when properly used. These might include catalytic heaters that are located well away from the membrane walls, and any combustible materials or limited cooking facilities using charcoal or liquefied petroleum gas (LP gas) for fuel and located under a tent or membrane structure. Such approvals, however, would be subject to the provisions of Section 308.

**3104.8 Fireworks.** Fireworks shall not be used within 100 feet (30 480 mm) of tents or membrane structures.

❖ Fireworks, whether designed to explode at ground level or as aerial displays, result in hot embers that could become a source of ignition if they contact the membrane of the structure. Establishing a 100-foot (30 480 mm) clear zone not only reduces the likelihood of hot embers contacting the membrane but also gives air-borne embers time to cool before they can reach membrane level.

**3104.9 Spot lighting.** Spot or effect lighting shall only be by electricity, and all combustible construction located within 6 feet (1829 mm) of such equipment shall be protected with

*approved* noncombustible insulation not less than 9<sup>1</sup>/<sub>4</sub> inches (235 mm) thick.

❖ Spotlights can generate considerable heat. The metal housings of these lights generally become too hot to touch if they are on for more than a minute or two. Requiring that they be positioned well away from combustible materials and that the nearby combustibles be insulated helps ensure that the heat from the lights does not become an ignition source for either the membrane structure or combustibles inside the structure. Noncombustible insulation must conform to the requirements of IBC Section 720.

**3104.10 Safety film.** Motion pictures shall not be displayed in tents or membrane structures unless the motion picture film is safety film.

❖ The display of motion pictures on cellulose nitrate film is prohibited because of the extreme hazards associated with this type of material; however, such motion pictures are extremely rare because production of the raw film was suspended in 1951. Most known motion pictures printed on cellulose nitrate film are in the possession of special film repositories, such as the National Archives and the Smithsonian Institution, or are being restored by conservators.

**3104.11 Clearance.** There shall be a minimum clearance of at least 3 feet (914 mm) between the fabric envelope and all contents located inside membrane structures.

❖ The 3-foot (914 mm) clearance is intended not only to give fire fighters all-sides hose stream and overhaul access to burning materials, but also to reduce exposure of the membrane envelope if stored material becomes involved in a fire.

**3104.12 Portable fire extinguishers.** Portable fire extinguishers shall be provided as required by Section 906.

❖ Section 906 states that portable extinguishers are required in Group A occupancies and in special-hazards areas as designated by the fire code official. This section also refers to NFPA 10 for guidance on selection and placement of the extinguishers. Employees and staff who will be manning the membrane structure must be trained to use the extinguishers because they are likely to become the first line of emergency response in case of a fire.

**3104.13 Fire protection equipment.** Fire hose lines, water supplies and other auxiliary fire equipment shall be maintained at the site in such numbers and sizes as required by the *fire code official*.

❖ This section gives the fire code official the authority to establish reasonable equipment requirements for membrane structures. Because the size, construction and intended use of membrane structures vary so widely, each installation must be evaluated individually.

**3104.14 Occupant load factors.** The *occupant load* allowed in an assembly structure, or portion thereof, shall be determined in accordance with Chapter 10.

❖ This reference to Chapter 10 tells us that a membrane structure used as a place of assembly is treated in the same way that a permanent structure would be. The same means-of-egress requirements apply whether the structure is conventional construction or a membrane structure.

**3104.15 Heating and cooking equipment.** Heating and cooking equipment shall be in accordance with Sections 3104.15.1 through 3104.15.7.

❖ Because of the unique nature of the structures regulated by this chapter, it is vital that ignition sources be carefully regulated. This section regulates the dual hazards of heat-producing appliances and cooking equipment in membrane structures.

**3104.15.1 Installation.** Heating or cooking equipment, tanks, piping, hoses, fittings, valves, tubing and other related components shall be installed as specified in the *International Mechanical Code* and the *International Fuel Gas Code*, and shall be approved by the fire code official.

❖ This section refers to the cooking equipment installation requirements contained in the *International Fuel Gas Code*® (IFGC®) and *International Mechanical Code*® (IMC®), and gives the fire code official the authority to inspect and approve completed installations. Because of the special hazards that exist in membrane structures of all kinds, the importance of proper installation cannot be stressed enough.

Another issue with respect to this section is the question of whether cooking that produces grease-laden vapors is allowed inside of a tent or membrane structure without requiring the ventilation and fire suppression systems normally required for commercial cooking operations by Sections 609 and 904.2.1 and the referenced standards. Literally speaking, there is nothing in Chapter 31 that would specifically exempt cooking operations in any tent or membrane structure (whether or not it is open to the public) from the ventilation or fire suppression system requirements of the code or IMC for commercial cooking appliances that produce grease or smoke. The provisions of Section 3104.15 are equally applicable to all tents, canopies or membrane structures in which cooking is conducted.

It should be noted, however, that a key element in the use of a tent or membrane structure for commercial cooking and the application of ventilation and cooking fire suppression requirements is the evaluation and approval of the fire code official. Temporary facilities such as tents or membrane structures present a unique circumstance in which the strict application of code requirements to what is, in all likelihood, a temporary operation may not be practical or desirable. When applying the provisions of Section 104.8,

the judicious review and application of the code to these circumstances should focus on the scope, nature and duration of the hazards created by the cooking operation and how best to mitigate them in a manner acceptable to all parties concerned while maintaining public safety. Consistent with Section 3104.7, in conducting such an evaluation, special attention should be paid to cooking operations using charcoal or other solid fuels due to the potential for sparks or flying embers coming into contact with membrane materials.

**3104.15.2 Venting.** Gas, liquid and solid fuel-burning equipment designed to be vented shall be vented to the outside air as specified in the *International Fuel Gas Code* and the *International Mechanical Code*. Such vents shall be equipped with approved spark arresters where required. Where vents or flues are used, all portions of the tent or membrane structure shall be not less than 12 inches (305 mm) from the flue or vent.

❖ As with the installation requirements in Section 3104.15.1, venting must comply with the applicable provisions of the IFGC and IMC, and be approved by the fire code official. The 12-inch (305 mm) separation between the vent or flue stack and the membrane fabric and support structures is intended to prevent heating of those elements to possible points of ignition.

**3104.15.3 Location.** Cooking and heating equipment shall not be located within 10 feet (3048 mm) of *exits* or combustible materials.

❖ This location requirement is intended to help make certain that equipment items would not be likely to block a means of egress during a fire or other emergency. Equipment locations would be subject to the approval of the fire code official in all cases.

**3104.15.4 Operations.** Operations such as warming of foods, cooking demonstrations and similar operations that use solid flammables, butane or other similar devices that do not pose an ignition hazard, shall be approved.

❖ This section authorizes the listed operations, but at the same time authorizes the fire code official to make certain the operations meet the requirements of the other subsections within this section.

**3104.15.5 Cooking tents.** Tents with sidewalls or drops where cooking is performed shall be separated from other tents or membrane structures by not less than 20 feet (6096 mm).

❖ This separation requirement is consistent with the overall requirement covering open or exposed flames that is contained in Section 3104.7. The 20-foot (6096 mm) separation provides protection from hot embers from a fire reaching the main membrane structure. The requirements for keeping the open area free of combustible materials or debris that could limit access to emergency response personnel also apply.

**3104.15.6 Outdoor cooking.** Outdoor cooking that produces sparks or grease-laden vapors shall not be performed within 20 feet (6096 mm) of a tent or membrane structure.

- ❖ As with cooking in tents, the 20-foot (6096 mm) separation is intended to separate this potential source of ignition from the membrane structure. Requirements for keeping the open area free of combustible materials or other debris that could hinder emergency response efforts also apply.

**3104.15.7 Electrical heating and cooking equipment.** Electrical cooking and heating equipment shall comply with NFPA 70.

- ❖ This reference to NFPA 70 establishes the requirements for the equipment and its installation.

**3104.16 LP-gas.** The storage, handling and use of LP-gas and LP-gas equipment shall be in accordance with Sections 3104.16.1 through 3104.16.3.

- ❖ Because of the unique nature of the structures regulated by this chapter, it is vital that the storage, handling and use of hazardous materials in or around such structures be carefully regulated. In general, Chapter 61 regulates LP-gas. This section specifically regulates its storage, handling and use in connection with membrane structures.

**3104.16.1 General.** LP-gas equipment such as tanks, piping, hoses, fittings, valves, tubing and other related components shall be *approved* and in accordance with Chapter 61 and with the *International Fuel Gas Code*.

- ❖ The requirements stated in this section mean that LP-gas containers and all associated equipment used in or around membrane structures of any kind will be inspected and must meet basically the same requirements as similar installations and equipment in conventional structures.

**3104.16.2 Location of containers.** LP-gas containers shall be located outside. Safety release valves shall be pointed away from the tent or membrane structure.

- ❖ Containers must be located outdoors to prevent vapors from safety-release valves, inadvertent spills during filling or from any other source from accumulating inside the membrane structure to flammable levels. Requiring the safety-release valves to be pointed away from the structure also helps to ensure that vapors do not infiltrate the structure.

**3104.16.2.1 Containers 500 gallons or less.** Portable LP-gas containers with a capacity of 500 gallons (1893 L) or less shall have a minimum separation between the container and structure not less than 10 feet (3048 mm).

- ❖ The 10-foot (3048 mm) separation distance is consistent with the requirements of Table 6104.3. See the commentary to Section 6104.3 and Table 6104.3 for further discussion.

**3104.16.2.2 Containers more than 500 gallons.** Portable LP-gas containers with a capacity of more than 500 gallons

(1893 L) shall have a minimum separation between the container and structures not less than 25 feet (7620 mm).

- ❖ The 25-foot (7620 mm) separation distance is consistent with the requirements of Table 6104.3. See the commentary to Section 6104.3 and Table 6104.3 for further discussion.

**3104.16.3 Protection and security.** Portable LP-gas containers, piping, valves and fittings that are located outside and are being used to fuel equipment inside a tent or membrane structure shall be adequately protected to prevent tampering, damage by vehicles or other hazards and shall be located in an *approved* location. Portable LP-gas containers shall be securely fastened in place to prevent unauthorized movement.

- ❖ LP-gas containers and associated equipment must be protected from impact by vehicles or other objects that could cause damage and leakage. They must also be protected from tampering, vandalism and theft. See Sections 312 and 6107 for additional guidance on protection and security.

**3104.17 Flammable and combustible liquids.** The storage of flammable and *combustible liquids* and the use of flammable-liquid-fueled equipment shall be in accordance with Sections 3104.17.1 through 3104.17.3.

- ❖ Because of the unique nature of the structures regulated by this chapter, it is vital that the storage, handling and use of hazardous materials in or around such structures be carefully regulated. In general, Chapter 57 regulates flammable and combustible liquids. This section specifically regulates their storage, handling and use in connection with membrane structures.

**3104.17.1 Use.** Flammable-liquid-fueled equipment shall not be used in tents or membrane structures.

- ❖ Equipment of any kind that uses a flammable liquid for fuel must not be used inside a membrane structure because of the possibility of fuel leakage as well as the risk of accumulation of noxious exhaust fumes. Fluid leaks could vaporize and reach a flammable concentration. Exhaust fumes normally contain carbon monoxide and other gases that are harmful to occupants. Membrane structures, particularly air-supported and air-inflated structures, are not ventilated to the same extent that conventional structures are. Harmful vapors and fumes, therefore, are not diluted or dispersed as quickly or as efficiently as they are in those structures.

**3104.17.2 Flammable and combustible liquid storage.** Flammable and *combustible liquids* shall be stored outside in an *approved* manner not less than 50 feet (15 240 mm) from tents or membrane structures. Storage shall be in accordance with Chapter 57.

- ❖ This section provides a general separation requirement for containers used to store flammable or combustible liquids. The more detailed requirements are contained in Chapter 57 and depend, for the most

part, on whether the liquid is Class I, II or III and the quantity of the liquid being stored. Storage arrangements must comply with Chapter 57 requirements. They should, however, be discussed in advance with the fire code official to make certain all affected parties are in agreement.

**3104.17.3 Refueling.** Refueling shall be performed in an *approved* location not less than 20 feet (6096 mm) from tents or membrane structures.

- ❖ This section gives only a general guideline for location of a refueling station and gives the fire code official the authority to approve the selected location. When planning a station of this kind, the requirements of Chapter 57 must be considered. Some of the requirements of Sections 2304, 2305 and 2306 might also apply if vehicles are being refueled.

**3104.18 Display of motor vehicles.** Liquid- and gas-fueled vehicles and equipment used for display within tents or membrane structures shall be in accordance with Sections 3104.18.1 through 3104.18.5.3.

- ❖ This statement is an introduction to the subsections that follow. It contains only the kinds of structures, vehicles and equipment covered by the overall section. The provisions of these sections are similar to Section 314 on indoor displays.

**3104.18.1 Batteries.** Batteries shall be disconnected in an appropriate manner.

- ❖ Requiring that batteries be disconnected serves two purposes. First, it prevents unauthorized persons from starting and running engines that exhaust noxious fumes. Second, it removes a potential ignition source from the site by opening the battery-powered electrical circuit, thereby removing the possibility that the circuit could give off a stray spark. Equipment/vehicle manufacturers will, in all likelihood, have a recommended procedure in their owner's manuals for disconnecting batteries safely. The fire code official would also want to make sure the procedures used present no hazards.

**3104.18.2 Fuel.** Vehicles or equipment shall not be fueled or defueled within the tent or membrane structure.

- ❖ This section requires that all equipment and vehicle fueling must be conducted outdoors to avoid the accumulation of ignitable vapors within the membrane structure.

**3104.18.2.1 Quantity limit.** Fuel in the fuel tank shall not exceed one-quarter of the tank capacity or 5 gallons (19 L), whichever is less.

- ❖ Vehicles and equipment on display are allowed only a limited quantity of fuel in their tanks. Full fuel tanks could leak if temperatures reach a level that would cause the contained fuel to expand beyond the capacity of the tank. This kind of liquid spill would evaporate with the potential for enough flammable vapor to accumulate to reach a flammable level. Full tanks also leave very little room for vapors given off by the contained fuel. Practically all fuel tanks have

some kind of pressure-release valve built in to prevent overpressurization of the tank. Leaving three quarters of the tank empty allows space for moderate quantities of vapor to accumulate without being released to the building atmosphere.

**3104.18.2.2 Inspection.** Fuel systems shall be inspected for leaks.

- ❖ This statement places an inspection requirement on the party displaying the vehicles or equipment. The requirement should be looked at as being a routine housekeeping chore. The statement also gives the fire code official the authority to inspect the facility to achieve compliance with code requirements.

**3104.18.2.3 Closure.** Fuel tank openings shall be locked and sealed to prevent the escape of vapors.

- ❖ Locking and sealing fuel tank openings not only prevents vapors from escaping from the tanks, but will also deter malicious mischief that could result in a fire by denying access to a fuel source. Locking and sealing the fill pipe also deters vandalism to the vehicle that could occur by placing foreign objects or substances into the fuel tank.

**3104.18.3 Location.** The location of vehicles or equipment shall not obstruct *means of egress*.

- ❖ If the structure is occupied, blocking a means of egress would interfere with orderly evacuation of the space. Whether the structure is occupied or not, blocking a means of egress could interfere with access for emergency response personnel.

**3104.18.4 Places of assembly.** When a compressed natural gas (CNG) or liquefied petroleum gas (LP-gas) powered vehicle is parked inside a place of assembly, all the following conditions shall be met:

1. The quarter-turn shutoff valve or other shutoff valve on the outlet of the CNG or LP-gas container shall be closed and the engine shall be operated until it stops. Valves shall remain closed while the vehicle is indoors.
2. The hot lead of the battery shall be disconnected.
3. Dual-fuel vehicles equipped to operate on gasoline and CNG or LP-gas shall comply with this section and Sections 3104.18.1 through 3104.18.5.3 for gasoline-powered vehicles.

- ❖ The three requirements given in this section are applicable to vehicles powered by compressed natural gas (CNG) or LP-gas, but they are consistent with the requirements for gasoline-fueled vehicles given elsewhere in the code.

The first requirement is intended to prevent vapor buildup in confined spaces, such as inside an engine compartment. Fuel left standing in a warm engine will "cook off" (vaporize) after the engine is turned off. Requiring the engine to be left running after the supply valve is closed means that all fuel left in the engine will be burned off through internal combustion, leaving the engine relatively free of fuel that could vaporize.

The second requirement is a restatement of Section 3104.18.1 (see the commentary to that section).

The third requirement states that specialty vehicles designed to run on either gasoline or CNG/LP-gas must comply with the same requirements as vehicles designed to run on gasoline alone.

**3104.18.5 Competitions and demonstrations.** Liquid and gas-fueled vehicles and equipment used for competition or demonstration within a tent or membrane structure shall comply with Sections 3104.18.5.1 through 3104.18.5.3.

❖ The provisions of this section introduce Sections 3104.18.5.1 through 3104.18.5.3, which contain requirements for controlling the hazards associated with the use of liquid-fueled vehicles, or the equipment inside of tents or other membrane structures.

**3104.18.5.1 Fuel storage.** Fuel for vehicles or equipment shall be stored in *approved* containers in an *approved* location outside of the structure in accordance with Section 3104.17.2.

❖ This section gives the fire code official the authority to approve both the storage containers used and the location of those containers. The site designer, competition manager or other responsible party must have the fire code official's approval before the storage scheme is put into use. See also Section 6104 for further discussion of LP-gas storage, and Sections 2303 and 2306 for additional information on the storage of CNG.

**3104.18.5.2 Fueling.** Refueling shall be performed outside of the structure in accordance with Section 3104.17.3.

❖ This section refers back to Section 3104.17.3, which states a requirement for a 20-foot (6096 mm) separation between the fueling station and the membrane structure. Further information on fueling with LP gas is contained in Section 6106. Similar information covering CNG is contained in Sections 2304, 2307 and 2308.

**3104.18.5.3 Spills.** Fuel spills shall be cleaned up immediately.

❖ Controlling spills is important to fire safety. Section 2305.3 gives requirements for spill containment. The requirements for immediate cleanup are intended to prevent the buildup of flammable vapors to hazardous levels. Provisions for fuel spill containment and cleanup would require approval from the fire code official.

**3104.19 Separation of generators.** Generators and other internal combustion power sources shall be separated from tents or membrane structures by not less than 20 feet (6096 mm) and shall be isolated from contact with the public by fencing, enclosure or other *approved* means.

❖ This section states two requirements. First, consistent with other separation requirements, generators and other equipment driven by internal combustion engines must be kept separated from the membrane structure to minimize fire hazards if the generator or other equipment should fail and catch on fire. Sec-

ond, the isolation requirement is intended to both keep the public from coming into contact with hazardous equipment and protect the equipment from vandalism or accidental damage by the public.

**3104.20 Standby personnel.** Where, in the opinion of the *fire code official*, it is essential for public safety in a tent or membrane structure used as a place of assembly or any other use where people congregate, because of the number of persons, or the nature of the performance, exhibition, display, contest or activity, the *owner*, agent or lessee shall employ one or more qualified persons, as required and *approved*, to remain on duty during the times such places are open to the public, or when such activity is being conducted.

❖ This section authorizes the fire code official, at his or her discretion, to require the owner of a tent or membrane structure-based venue used for public assembly purposes to provide qualified supervisory personnel to enhance the safety profile of the event during its duration.

**3104.20.1 Duties.** Before each performance or the start of such activity, standby personnel shall keep diligent watch for fires during the time such place is open to the public or such activity is being conducted and take prompt measures for extinguishment of fires that occur and assist in the evacuation of the public from the structure.

❖ This section enumerates the duties and responsibilities of the individuals employed as standby personnel. These duties are that they: maintain a careful fire watch during whatever event is occurring, respond immediately to control fires and assist patrons in safely exiting the structure. They also could serve as ushers, tour guides or service supervisors for table seating; or in some other capacity related to making sure occupants are moved to or from assigned places in an orderly manner.

**3104.20.2 Crowd managers.** There shall be trained crowd managers or crowd manager/supervisors at a ratio of one crowd manager/supervisor for every 250 occupants, as *approved*.

❖ The key to this section is that the crowd managers must be trained in crowd management procedures appropriate to the activity being carried on in the membrane structure and they must be present in the required numbers. Training of personnel and the duties assigned to them would have to be approved by the fire code official. See also the commentary to Section 403.3 for further information on crowd managers.

**3104.21 Combustible vegetation.** Combustible vegetation that could create a fire hazard shall be removed from the area occupied by a tent or membrane structure, and from areas within 30 feet (9144 mm) of such structures.

❖ Because dry grass and weeds both within and outside of a membrane structure represent a significant fuel accumulation and fire hazard, this section requires that all combustible vegetation be removed from within the membrane structure and from the

area outside of and within a 30-foot (9144 mm) perimeter of the structure. Where the membrane structure is a tent that relies on ropes and stakes for its structural stability, the 30-foot (9144 mm) perimeter is to be measured outward from the furthest reach of the stake line, which is consistent with Section 3103.8.2. This will reduce the chances that a grass or brush fire originating outside the tent will damage the structural support system, which could lead to failure and collapse of the tent with potential injury to occupants. See the commentary to Section 304.1.2 for further information on combustible vegetation.

**3104.22 Combustible waste material.** The floor surface inside tents or membrane structures and the grounds outside and within a 30-foot (9144 mm) perimeter shall be kept free of combustible waste and other combustible materials that could create a fire hazard. Such waste shall be stored in *approved* containers and removed from the premises not less than once a day during the period the structure is occupied by the public.

❖ Accumulated waste, trash or debris and the fire load they represent can become a serious fire hazard if allowed to remain within a membrane structure or in close proximity outside of the structure. Accordingly, this section requires frequent collection and removal of trash and other combustibles from the area inside the structure and within a 30-foot (9144 mm) perimeter of the structure. Consistent with Section 3103.8.2, where the membrane structure is a tent that relies on ropes and stakes for its structural stability, the 30-foot (9144 mm) perimeter should be measured outward from the furthest reach of the stake line to reduce the chances that a trash fire originating outside the tent will damage the structural support system, which could lead to failure and collapse of the tent. Once collected and moved outside the structure, the trash and other combustible waste materials must be kept in an approved container, which should also be located outside of the 30-foot (9144 mm) perimeter. See Section 304.3 for requirements for approved trash containers. See also the commentary to Sections 304.1 and 304.1.1 for further information on waste accumulation.

## SECTION 3105 TEMPORARY STAGE CANOPIES

**3105.1 General.** Temporary stage canopies shall comply with Section 3104, Sections 3105.2 through 3105.8 and ANSI E1.21.

❖ Temporary stage canopies are by their nature very specialized and complex structures. The nature of the structures must accommodate a wide variety of changing components such as audio equipment, video walls and scenery. The entertainment industry is continually evolving with new ways to improve shows creating larger and more complex spectacles.

There were four high-profile temporary stage canopy collapses during the 2011 summer concert sea-

son: August 7 at Brady District Block Party, Tulsa, Oklahoma; July 17 at the Cisco Ottawa Blues Festival in Ottawa, Canada; August 13 at the Indiana State Fairgrounds, which resulted in seven people killed and 50 injured; and August 18 at the Pukkelpop Festival in Kiewit, Belgium. In the summer of 2012, another life was lost at a Radiohead concert in Toronto, Canada. All resulted in tremendous property damage and two in multiple fatalities. The obvious concern is for the safety of the performers, audiences, stagehands, lighting technicians, security personnel and every other profession or individual in close proximity to a temporary stage.

Due to the unique design of temporary stage canopies, it is difficult for most fire inspectors to find adequate guidance in current code language to satisfactorily regulate these specialized structures. This section introduces new regulations for these unique structures that will improve the safety profile of their construction and use, and provides an appropriate referenced standard to guide the fire code official in enforcing the new section. ANSI E1.21 was produced by the Entertainment Services and Technology Association (ESTA). ESTA recently merged with an international organization, Professional Lighting and Sound Association (PLASA). Fire code officials may download the standard at no charge, provided they register at [www.plasa.org](http://www.plasa.org). ANSI E1.21 includes requirements that the temporary stage canopy be designed not only to support the weight of the equipment, but also to withstand seismic loads, wind loads, rain and snow loading, and uplift. There is a necessity for a design professional to fully analyze and design the structure to comply with the structural loads. Section 3.4 of ANSI E1.21 requires: engineering drawings and calculations for the design; allowable payload; and maximum wind speed during the erection process and use of the structure. Commentary Figures 3105.1(1) and 3105.1(2) illustrate temporary stage structures.

**3105.2 Approval.** Temporary stage canopies in excess of 400 square feet (37 m<sup>2</sup>) shall not be erected, operated or maintained for any purpose without first obtaining approval and a permit from the *fire code official* and the building official.

❖ This section requires that both the fire code official and the building official issue a permit to construct a temporary stage canopy where the structure exceeds 400 square feet in area. This provides coordination of the respective expertise of the fire code official and the building official. The size is consistent with the threshold provided in Section 3103.2.

**3105.3 Permits.** Permits shall be required as set forth in Sections 105.6 and 105.7.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a

general discussion of operations requiring an operational permit. Because of the hazards inherent in the construction and the operation of temporary stage canopies, an operational permit is required by Section 105.6.45 and a construction permit is required by Section 105.7.18. The process also notifies the fire department of the need for prefire planning for the operation.



**Figure 3105.1(1)  
TEMPORARY STAGE CANOPY  
IN AN OUTDOOR SETTING**

**3105.4 Use period.** Temporary stage canopies shall not be erected for a period of more than 45 days.

❖ Temporary stage canopies are very complex and specialized for each individual event. The nature of these structures must accommodate a wide variety of changing components, such as audio and lighting equipment, video walls and scenery. As such, one difference when compared to other temporary structures regulated in Chapter 31 of the code is that the time period considered as “temporary” for temporary stage canopies in this section is a maximum of 45

days. For structures to be used longer than that period, they would be treated as permanent structures and be regulated by the IBC. This use period is based on the provisions of the referenced standard ANSI E1.21, which defines “temporary” as “A period of time that is less than 6 weeks in duration.”

**3105.5 Required documents.** The following documents shall be submitted to the *fire code official* and the building official for review before a permit is approved:

1. Construction documents: *Construction documents* shall be prepared in accordance with the *International Building Code* by a registered design professional. *Construction documents* shall include:
  - 1.1. A summary sheet showing the building code used, design criteria, loads and support reactions.
  - 1.2. Detailed construction and installation drawings.
  - 1.3. Design calculations.
  - 1.4. Operating limits of the structure explicitly outlined by the registered design professional including environmental conditions and physical forces.
  - 1.5. Effects of additive elements such as video walls, supported scenery, audio equipment, vertical and horizontal coverings.
  - 1.6. Means for adequate stability including specific requirements for guying and cross-bracing, ground anchors or ballast for different ground conditions.
2. Designation of responsible party: The *owner* of the temporary stage canopy shall designate in writing a person to have responsibility for the temporary stage canopy on the site. The designated person shall have sufficient knowledge of the construction documents, manufacturer’s recommendations and operations plan to make judgments regarding the structure’s safety and to coordinate with the *fire code official*.
3. Operations plan: The operations plan shall reflect manufacturer’s operational guidelines, procedures for environmental monitoring and actions to be taken under specified conditions consistent with the *construction documents*.

❖ This section is a summary of the relevant requirements of ANSI E1.21 necessary to provide guidance to the fire code official. Stage canopies are subject to more diverse loads than most permanent structures. Because of varying equipment weight, changing weather conditions and the need to raise and lower the roof to install equipment, a design professional must fully analyze the structure and a responsible person who understands this complexity of considerations must be on site. The operations plan must identify the responsible person, designate safe evacuation routes and locations, and evaluate the potential for canceling the show when the weather creates an unsafe condition.

**3105.6 Inspections.** Inspections shall comply with Section 106 and Sections 3105.6.1 and 3105.6.2.

❖ This section simply introduces the inspection requirements that follow.

**3105.6.1 Independent inspector.** The *owner* of a temporary stage canopy shall employ a qualified, independent approved agency or individual to inspect the installation of a temporary stage canopy.

❖ It is unlikely many fire inspectors will be familiar with the specialized nature of these structures. Accordingly, this section requires a qualified specialized inspector to be employed by the owner to inspect and report to the authority having jurisdiction and the designated responsible person. An Entertainment Technician Certification Program (ETCP) certification exists that would demonstrate competence to inspect the majority of temporary stage canopies. For large, unusually complex canopies there is latitude for the fire code official to require inspection by a structural engineer familiar with these types of temporary structures. Although it is not specified in the code, IBC Chapter 17, *Special Inspections and Tests*, could be used as a guide for this particular inspection requirement. The use of a special inspector could be a condition of approval from the building and fire code official.

**3105.6.2 Inspection report.** The inspecting agency or individual shall furnish an inspection report to the *fire code official*. The inspection report shall indicate that the temporary stage canopy was inspected and was or was not installed in accordance with the approved *construction documents*. Discrepancies shall be brought to the immediate attention of the installer for correction. Where any discrepancy is not corrected, it shall be brought to the attention of the *fire code official* and the designated responsible party.

❖ The specialized inspector must perform a construction inspection and issue a report, the primary objective of which is to verify that the temporary stage canopy was constructed in accordance with the approved construction documents and the conditions of the construction permit. Discrepancies must be identified and corrected before the structure can be utilized/occupied. Failure to correct any discrepancy must be reported to the fire code official and the responsible party that was designated in accordance with Section 3105.5(2).

**3105.7 Means of egress.** The *means of egress* for temporary stage canopies shall comply with Chapter 10.

❖ This section simply directs the code user to Chapter 10 for means of egress requirements.



Figure 3105.1(2)  
TEMPORARY STAGE CANOPY AFTER STRUCTURAL COLLAPSE AT THE INDIANA STATE FAIR—AUGUST 13, 2011  
(Photo courtesy of Anne vonWeller)

**3105.8 Location.** Temporary stage canopies shall be located a distance from property lines and buildings to accommodate distances indicated in the construction drawings for guy wires, cross-bracing, ground anchors or ballast. Location shall not interfere with egress from a building or encroach on fire apparatus access roads.

❖ Separation distance requirements of this section are consistent with requirements for conventional structures, especially those that could represent an above-average fire hazard. A fire of any size within a temporary stage structure would almost certainly involve any membrane coverings and structural support elements. Because the support ropes and ground anchors are under tension, particularly with large structures, a structure weakened by fire would likely fail, causing the ropes or wires to recoil and possibly pull portions of the burning temporary stage structure out of its original position. Requiring clear space around the structure helps reduce the likelihood that burning membrane sections and flying embers would endanger other structures or interfere with the functions of the open space, which include providing a clear egress path from the stage canopy or any structure adjacent to it and fire department access to the structure. Note that Section 3103.8.2 considers guy wires to be part of the structure when measuring open spaces around structures and it would seem prudent to apply that principle to this section as well.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

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# Chapter 32: High-Piled Combustible Storage

## General Comments

High-piled combustible storage facilities present great challenges in fire incident management. The sheer mass of commodities in concentrated form, along with a different configuration for access to those commodities, has led to the development of some unique fire protection and life safety measures. Experience with automatic sprinkler protection has demonstrated over the years that such systems are reliable and effective in suppressing fires and in supplementing manual fire suppression and extinguishing operations. However, the design and maintenance of any system or measure is essential to ensuring that, when needed, it will serve its function until such time as the fire service arrives to take command of the incident.

Chapter 32 presents fundamental concepts of fire and life safety protection within high-piled combustible storage areas and buildings. Fire tests and past fire experience have shown that the class and quantity of commodities, their relationship to one another and the maintenance and inspection of the systems and building are essential in preventing fires or limiting the spread of fire. This chapter has provisions aimed at verifying the proper design and installation of given fire and life safety protection systems. In some cases, the referenced standards will contain more specific design and installation criteria than are found in this chapter.

Other chapters of the code that contain provisions related to Chapter 32 are Chapters 3, 4, 5, 7, 9 and 10. The *International Building Code*® (IBC®) is mentioned within this chapter, which addresses construction classification, occupancy, fire protection features, means of egress and structural requirements.

This chapter does not specifically cover miscellaneous combustible materials storage (see Section 315)

or storage facilities of unusual design. Under those circumstances, the provisions of Chapter 1, specifically Section 102.7, would apply. Unusual storage facilities may include, but are not limited to, storage warehouses located on piers, storage of vehicles, refrigerated storage, underground storage facilities and air-supported storage structures. Each type of specialty storage offers a challenge to the fire department that will require unconventional fire incident management planning and unusual fire-fighting techniques. Access by fire-fighting vehicles and personnel is the greatest of those challenges. As a result, preplanning of the design of the storage facility may require coordination with the fire code official and fire service to determine the means and methods of the fire service to handle an approach by water, addressing floating burning debris from a fire, hazards of other neighboring piers and vessels, etc.

## Purpose

Chapter 32 provides guidance for reasonable protection of life from hazards associated with high-piled combustible storage. It contains requirements for identifying various classes of commodities; general fire and life protection safety features; and housekeeping and maintenance requirements. This chapter attempts to define potential fire severity and determine fire and life safety protection measures needed to control or suppress a potential fire. Design considerations for the construction, occupancy and fire protection features of the building or structure accommodating the high-piled combustible storage is the responsibility of the design professional and the building owner. Housekeeping, building maintenance and development and upkeep of an evacuation plan are the responsibility of the building owner, tenant or lessee.

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## SECTION 3201 GENERAL

**3201.1 Scope.** *High-piled combustible storage* shall be in accordance with this chapter. In addition to the requirements of this chapter, the following material-specific requirements shall apply:

1. Aerosols shall be in accordance with Chapter 51.
2. Flammable and *combustible liquids* shall be in accordance with Chapter 57.
3. Hazardous materials shall be in accordance with Chapter 50.

4. Storage of combustible paper records shall be in accordance with NFPA 13.
5. Storage of *combustible fibers* shall be in accordance with Chapter 37.
6. General storage of combustible material shall be in accordance with Chapter 3.

❖ This section is intended as an introduction and references those other chapters within the code that are to be used in conjunction with Chapter 32, when applicable. In many cases, the referenced chapter contains more stringent provisions regarding fire

protection and life safety measures, and may also cite other referenced standards. For example, Chapter 28 references NFPA 30B, Chapter 57 references NFPA 30 and Chapter 50 references NFPA 704.

**3201.2 Permits.** A permit shall be required as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit. The permit process also notifies the fire department of the need for prefire planning for the hazardous property.

**3201.3 Construction documents.** At the time of building permit application for new structures designed to accommodate high-piled storage or for requesting a change of occupancy/use, and at the time of application for a storage permit, plans and specifications shall be submitted for review and approval. In addition to the information required by the *International Building Code*, the storage permit submittal shall include the information specified in this section. Following approval of the plans, a copy of the *approved* plans shall be maintained on the premises in an *approved* location. The plans shall include all of the following:

1. Floor plan of the building showing locations and dimensions of *high-piled storage areas*.
2. Usable storage height for each storage area.
3. Number of tiers within each rack, if applicable.
4. Commodity clearance between top of storage and the sprinkler deflector for each storage arrangement.
5. Aisle dimensions between each storage array.
6. Maximum pile volume for each storage array.
7. Location and classification of commodities in accordance with Section 3203.
8. Location of commodities that are banded or encapsulated.
9. Location of required fire department access doors.
10. Type of fire suppression and fire detection systems.
11. Location of valves controlling the water supply of ceiling and in-rack sprinklers.
12. Type, location and specifications of smoke removal and curtain board systems.
13. Dimension and location of transverse and longitudinal flue spaces.
14. Additional information regarding required design features, commodities, storage arrangement and fire protection features within the high-piled storage area shall be provided at the time of permit, when required by the *fire code official*.

❖ Section 3201.3 contains provisions that are unique to the needs of the fire department. These construction

document requirements are in addition to those encountered in the IBC and specifically require detailed information that is essential for the permit review process and for future use when conducting fire inspections, in the development of the fire department's prefire emergency plans and when conducting fire incident management during an emergency. Items 1, 2, 3 and 5 are general requirements that address the general description of work for which the application must be submitted. Item 4 is significant because the height of any storage in relation to the sprinkler heads will determine sprinkler effectiveness. Sprinklers should be designed for the maximum allowable heights of the stored commodities and the minimum amount of unobstructed space below the sprinkler heads. Items 6, 7 and 8 recognize that a storage building can contain multiple classes and groups of commodities. As a result, this section requires that the construction documents illustrate the location, size and classification of the various types of commodities. Items 9, 10, 11 and 12 are important for the development of a prefire emergency plan. Such a plan can be established by the building owner or the tenant in cooperation with the local fire department that will be called to the building during an emergency. Developing and maintaining a prefire emergency plan can help during the incipient stages of a fire by reducing the amount of damage from the fire and containing the fire within a short time. Item 13 requires a detailed description of the locations of transverse and longitudinal flue spaces. The provisions for minimum flue space dimensions are contained in Section 3208.3. Item 14 allows the fire code official to use the enforcement powers of that office to collect more detailed information to make a more educated decision. These provisions recognize that technology is evolving. As a result, the situation presented to the fire code official can require that additional fire protection and life safety measures be applied to address those new designs for storage or new class of commodity.

**3201.4 Evacuation plan.** Where required by the *fire code official*, an evacuation plan for public accessible areas and a separate set of plans indicating location and width of *aisles*, location of *exits*, *exit access* doors, *exit* signs, height of storage, and locations of hazardous materials shall be submitted at the time of permit application for review and approval. Following approval of the plans, a copy of the *approved* plans shall be maintained on the premises in an *approved* location.

❖ Section 3201.4 contains provisions that are designed to compel additional information about the facility in terms of the layout of the egress system. This feature serves both the occupants of the building or structure and the fire department by addressing unique conditions. The plans are to be accessible at the site and are for use by the fire code official or fire department during inspections of the building or structure. Maintenance of the plans is the responsibility of the building owner, tenant or lessee.

Note that Chapter 4 addresses fire safety and

evacuation plans for various occupancies. High-piled storage is not addressed directly, but larger Group M and F occupancies are required to provide these plans. Such occupancies have the possibility of containing high-piled storage.

### SECTION 3202 DEFINITIONS

**3202.1 Definitions.** The following terms are defined in Chapter 2:

**ARRAY.**

**ARRAY, CLOSED.**

**AUTOMATED RACK STORAGE.**

**BIN BOX.**

**COMMODITY.**

**EARLY SUPPRESSION FAST-RESPONSE (ESFR) SPRINKLER.**

**EXPANDED PLASTIC.**

**EXTRA-HIGH-RACK COMBUSTIBLE STORAGE.**

**HIGH-PILED COMBUSTIBLE STORAGE.**

**HIGH-PILED STORAGE AREA.**

**LONGITUDINAL FLUE SPACE.**

**MANUAL STOCKING METHODS.**

**MECHANICAL STOCKING METHODS.**

**SHELF STORAGE.**

**SOLID SHELVING.**

**TRANSVERSE FLUE SPACE.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*® (I-Code®) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4).

### SECTION 3203 COMMODITY CLASSIFICATION

**3203.1 Classification of commodities.** Commodities shall be classified as Class I, II, III, IV or high hazard in accordance with this section. Materials listed within each commodity classification are assumed to be unmodified for improved combustibility characteristics. Use of flame-retarding modifiers or the physical form of the material could change the classification. See Section 3203.7 for classification of Group A, B and C plastics.

❖ The classification of commodities contains information addressing the materials that make up the commodity and its packaging (see Commentary Figure 3203.1). As an example, lubricating fluid in metal

cans is designated as Class III, whereas lubricating fluid in plastic containers is designated as Class IV. Although this section addresses only the classification, such factors as the location of the commodity, location relative to other commodities of differing classes, flue spaces, fire protection, ventilation, access and egress will affect the storage layout. Among the most important considerations are the packaging of the commodity and the type of support the commodity is resting on (e.g., pallets). For rack storage, the distinction between the classes is made with respect to the arrangement of the products; for example, products encapsulated with plastic wrap and those products not encapsulated. The plastic wrap acts effectively as a container for the entire arrangement of products, and because it encapsulates five of the six sides of the arrangement, it can prevent sprinklers from having an effect on the products if they do ignite and makes it difficult for prewetting of the surrounding commodities. The encapsulated category can be considered nonencapsulated by removing, at a minimum, the plastic wrap from the top of the arranged products, thus allowing some penetration for the sprinklers.

Low Fire Hazard	
Class I	Essentially noncombustible products on noncombustible pallets
High Fire Hazard	
Class II	Essentially Class I products on wood pallets or crates
Class III	Essentially wood, paper and fiber products and Group C plastics (limited Class A and B plastics)
Class IV	Essentially Class I, II or III containing significant Group A plastics (unlimited Class B plastics and free-flowing Group A plastics)
High Hazard	
—	Essentially present fire hazard beyond Class I, II, III or IV

**Figure 3203.1  
CLASSIFICATION LEVELS**

**3203.2 Class I commodities.** Class I commodities are essentially noncombustible products on wooden pallets, in ordinary corrugated cartons with or without single-thickness dividers, or in ordinary paper wrappings with or without pallets. Class I commodities are allowed to contain a limited amount of Group A plastics in accordance with Section 3203.7.4. Examples of Class I commodities include, but are not limited to, the following:

- Alcoholic beverages not exceeding 20-percent alcohol
- Appliances noncombustible, electrical
- Cement in bags
- Ceramics
- Dairy products in nonwax-coated containers (excluding bottles)

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Dry insecticides  
Foods in noncombustible containers  
Fresh fruits and vegetables in nonplastic trays or containers  
Frozen foods  
Glass  
Glycol in metal cans  
Gypsum board  
Inert materials, bagged  
Insulation, noncombustible  
Noncombustible liquids in plastic containers having less than a 5-gallon (19 L) capacity  
Noncombustible metal products

❖ Class I commodities are basically noncombustible products packaged in corrugated cardboard cartons. The products may be arranged on combustible pallets. Examples of products that create this hazard are listed in this section.

**3203.3 Class II commodities.** Class II commodities are Class I products in slatted wooden crates, solid wooden boxes, multiple-thickness paperboard cartons or equivalent combustible packaging material with or without pallets. Class II commodities are allowed to contain a limited amount of Group A plastics in accordance with Section 3203.7.4. Examples of Class II commodities include, but are not limited to, the following:

Alcoholic beverages not exceeding 20-percent alcohol, in combustible containers  
Foods in combustible containers  
Incandescent or fluorescent light bulbs in cartons  
Thinly coated fine wire on reels or in cartons

❖ Class II commodities consist of noncombustible products packaged in slatted wooden crates, solid wooden boxes, multiple-thickness paperboard cartons or equivalent combustible packaging materials that may or may not be arranged on pallets. If the commodity is stored on a rack storage system, it will generally be placed on wooden pallets. Examples of products that create this hazard are listed in this section.

**3203.4 Class III commodities.** Class III commodities are commodities of wood, paper, natural fiber cloth, or Group C plastics or products thereof, with or without pallets. Products are allowed to contain limited amounts of Group A or B plastics, such as metal bicycles with plastic handles, pedals, seats and tires. Group A plastics shall be limited in accordance with Section 3203.7.4. Examples of Class III commodities include, but are not limited to, the following:

Aerosol, Level 1 (see Chapter 51)  
Biomass briquettes, bagged, and static piles  
Biomass pellets, bagged, and static piles  
Charcoal  
Combustible fiberboard  
Cork, baled  
Corn cobs, static piles  
Corn stover, baled and chopped  
Feed, bagged  
Fertilizers, bagged

Firewood  
Food in plastic containers  
Forest residue, round wood or chipped (branches, bark, cross-cut ends, edgings and treetops)  
Furniture: wood, natural fiber, upholstered, nonplastic, wood or metal with plastic-padded and covered armrests  
Glycol in combustible containers not exceeding 25 percent  
Lubricating or hydraulic fluid in metal cans  
Lumber  
Mattresses, excluding foam rubber and foam plastics  
Noncombustible liquids in plastic containers having a capacity of more than 5 gallons (19 L)  
Paints, oil base, in metal cans  
Paper, waste, baled  
Paper and pulp, horizontal storage, or vertical storage that is banded or protected with approved wrap  
Paper in cardboard boxes  
Peanut hulls, bagged, and static piles  
Pillows, excluding foam rubber and foam plastics  
Plastic-coated paper food containers  
Plywood  
Rags, baled  
Recovered construction wood  
Rice hulls, bagged, and static piles  
Rugs, without foam backing  
Seasonal grasses, baled and chopped  
Straw, baled  
Sugar, bagged  
Wood, baled  
Wood chips, bagged, and static piles  
Woody biomass, round wood or chipped (vase-shaped stubby bushes, bamboo, willows; branches, bark and stem wood)  
Wood doors, frames and cabinets  
Wood pellets, bagged, and static piles  
Yarns of natural fiber and viscose

❖ Class III commodities are products of wood, paper, natural fiber or Group C plastics that may be arranged with or without pallets. The limitations concerning Group A are determined by Section 3203.7.4 and Figure 3203.7.4. Limited Group B plastics are allowed. Examples of products that create this hazard are listed in this section.

**3203.5 Class IV commodities.** Class IV commodities are Class I, II or III products containing Group A plastics in ordinary corrugated cartons and Class I, II and III products with Group A plastic packaging, with or without pallets. Group B plastics and free-flowing Group A plastics are also included in this class. The total amount of nonfree-flowing Group A plastics shall be in accordance with Section 3203.7.4. Examples of Class IV commodities include, but are not limited to, the following:

Aerosol, Level 2 (see Chapter 51)  
Alcoholic beverages, exceeding 20-percent but less than 80-percent alcohol, in cans or bottles in cartons  
Clothing, synthetic or nonviscose  
Combustible metal products (solid)  
Furniture, plastic upholstered

Furniture, wood or metal with plastic covering and padding  
Glycol in combustible containers (greater than 25 percent and less than 50 percent)

Linoleum products

Paints, oil base in combustible containers

Pharmaceutical, alcoholic elixirs, tonics, etc.

Rugs, foam back

Shingles, asphalt

Thread or yarn, synthetic or nonviscose

- ❖ Class IV commodities represent Class I, II or III products containing an appreciable amount of Group A plastics. These plastics can be a part of the actual product or may be part of the packaging. Packing is in ordinary corrugated cardboard cartons, and arrangement may or may not be on pallets. This class also allows unlimited Group B plastics and free-flowing Group A plastics. Examples of products that create this hazard are listed in this section.

**3203.6 High-hazard commodities.** High-hazard commodities are high-hazard products presenting special fire hazards beyond those of Class I, II, III or IV. Group A plastics not otherwise classified are included in this class. Examples of high-hazard commodities include, but are not limited to, the following:

Aerosol, Level 3 (see Chapter 51)

Alcoholic beverages, exceeding 80-percent alcohol, in bottles or cartons

Commodities of any class in plastic containers in carousel storage

Flammable solids (except solid combustible metals)

Glycol in combustible containers (50 percent or greater)

Lacquers that dry by solvent evaporation, in metal cans or cartons

Lubricating or hydraulic fluid in plastic containers

Mattresses, foam rubber or foam plastics

Pallets and flats that are idle combustible

Paper and pulp, rolled, in vertical storage that is unbanded or not protected with an *approved* wrap

Paper, asphalt, rolled, horizontal storage

Paper, asphalt, rolled, vertical storage

Pillows, foam rubber and foam plastics

Pyroxylin

Rubber tires

Vegetable oil and butter in plastic containers

- ❖ High-hazard commodities present a hazard inasmuch as they contain materials that readily support combustion or materials that can support a physical or health hazard. Those products that represent a physical hazard are those presenting a detonation hazard, deflagration hazard or that readily support combustion. The products representing a health hazard are those that present a risk to people from handling or exposure to the product. Examples of products that create this kind of hazard are listed in this section.

High-hazard commodities are not to be confused with high-hazard occupancy Group H. The term "high-hazard," in the context of this chapter, describes storage commodities that can present high-challenge fires. While some of the commodities listed

may result in a Group H occupancy classification, others will not.

**3203.7 Classification of plastics.** Plastics shall be designated as Group A, B or C in accordance with Sections 3203.7.1 through 3203.7.4.

- ❖ The classification of plastics is contained in Sections 3203.7.1 through 3203.7.4. This section recognizes that plastics tend to have high heat content and burning rates (heat release rates). For example, a Class IV commodity could be evaluated as a high-hazard commodity because of the quantity of Group A plastic cushioning within the container used to sustain or hold the product.

**3203.7.1 Group A plastics.** Group A plastics are plastic materials having a heat of combustion that is much higher than that of ordinary combustibles, and a burning rate higher than that of Group B plastics. Examples of Group A plastics include, but are not limited to, the following:

ABS (acrylonitrile-butadiene-styrene copolymer)

Acetal (polyformaldehyde)

Acrylic (polymethyl methacrylate)

Butyl rubber

EPDM (ethylene propylene rubber)

FRP (fiberglass-reinforced polyester)

Natural rubber (expanded)

Nitrile rubber (acrylonitrile butadiene rubber)

PET or PETE (polyethylene terephthalate)

Polybutadiene

Polycarbonate

Polyester elastomer

Polyethylene

Polypropylene

Polystyrene (expanded and unexpanded)

Polyurethane (expanded and unexpanded)

PVC (polyvinyl chloride greater than 15-percent plasticized, e.g., coated fabric unsupported film)

SAN (styrene acrylonitrile)

SBR (styrene butadiene rubber)

- ❖ Group A plastics are generally considered a high-hazard commodity because they have the highest burning rate (heat release rates) of the materials in the classes and groups. Examples of products that create this hazard include:

- Polyurethane foams used in sofas and beds.
- Polypropylene plastic toys.
- Majority of stuffed animals and toys.
- Rubber tires.

**3203.7.2 Group B plastics.** Group B plastics are plastic materials having a heat of combustion and a burning rate higher than that of ordinary combustibles, but not as high as those of Group A plastics. Examples of Group B plastics include, but are not limited to, the following:

Cellulosics (cellulose acetate, cellulose acetate butyrate, ethyl cellulose)

Chloroprene rubber

Fluoroplastics (ECTFE, ethylene-chlorotrifluoroethylene copolymer; ETFE, ethylene-tetrafluoroethylene

copolymer; FEP, fluorinated ethylene-propylene copolymer)

Natural rubber (nonexpanded)

Nylon (Nylon 6, Nylon 6/6)

PVC (polyvinyl chloride greater than 5-percent, but not exceeding 15-percent plasticized)

Silicone rubber

- ❖ Group B plastics represent the next level of plastics that have a heat of combustion and burning rate higher than that of ordinary combustibles, but less than Group A plastics. Examples of products that create this hazard include nylon rugs and nylon ropes.

**3203.7.3 Group C plastics.** Group C plastics are plastic materials having a heat of combustion and a burning rate similar to those of ordinary combustibles. Examples of Group C plastics include, but are not limited to, the following:

Fluoroplastics (PCTFE, polychlorotrifluoroethylene;

PTFE, polytetrafluoroethylene)

Melamine (melamine formaldehyde)

Phenol

PVC (polyvinyl chloride, rigid or plasticized less than 5 percent, e.g., pipe, pipe fittings)

PVDC (polyvinylidene chloride)

PVDF (polyvinylidene fluoride)

PVF (polyvinyl fluoride)

Urea (urea formaldehyde)

- ❖ Group C plastics are those products that can be similar to ordinary combustibles because of their heat of combustion and burning rates, which will be less than Group A and B plastics. Examples of products that create this hazard include hard, polyvinyl chloride (PVC) piping used in many swimming pools and irrigation products, and melamine dishware.

**3203.7.4 Limited quantities of Group A plastics in mixed commodities.** Figure 3203.7.4 shall be used to determine the quantity of Group A plastics allowed to be stored in a package or carton or on a pallet without increasing the commodity classification.

- ❖ Limited quantities of Group A plastics can be allowed within other classes of commodities. Figure 3203.7.4 shows the pertinent requirements, or limits, for determining to which class the limited amount of Group A plastic is assigned.

**FIGURE 3203.7.4.** See page 32-7.

- ❖ The figure represents an empirical judgment (as a result of fire testing experience) of the risks associated with assigning a limited amount of Group A plastics to another commodity class. The figure is intended to help determine the commodity classification of a mixed commodity in a package or carton or on a pallet when plastics are involved. Plastics can be involved (mixed) with products through the use of packaging or can be contained in or integrated into the actual product.

## SECTION 3204

### DESIGNATION OF HIGH-PILED STORAGE AREAS

**3204.1 General.** *High-piled storage areas*, and portions of *high-piled storage areas* intended for storage of a different commodity class than adjacent areas, shall be designed and specifically designated to contain Class I, Class II, Class III, Class IV or high-hazard commodities. The designation of a *high-piled combustible storage area*, or portion thereof intended for storage of a different commodity class, shall be based on the highest hazard commodity class stored except as provided in Section 3204.2.

- ❖ This section establishes designation requirements for different commodity classes, and designates areas within buildings for use in determining general fire protection and life safety features.

The highest hazard commodity will drive the classification of the storage area. Section 3204.2 offers an exception to this by taking advantage of the hydraulic design of sprinkler systems. Additionally, lower-hazard commodities can be separated from higher-hazard commodities in accordance with Sections 3206.3.2.1 and 3206.3.2.2.

**3204.2 Designation based on engineering analysis.** The designation of a *high-piled combustible storage area*, or portion thereof, is allowed to be based on a lower hazard class than that of the highest class of commodity stored when a limited quantity of the higher hazard commodity has been demonstrated by engineering analysis to be adequately protected by the *automatic sprinkler system* provided. The engineering analysis shall consider the ability of the sprinkler system to deliver the higher density required by the higher hazard commodity. The higher density shall be based on the actual storage height of the pile or rack and the minimum allowable design area for sprinkler operation as set forth in the density/area figures provided in NFPA 13. The contiguous area occupied by the higher hazard commodity shall not exceed 120 square feet (11 m<sup>2</sup>) and additional areas of higher hazard commodity shall be separated from other such areas by 25 feet (7620 mm) or more. The sprinkler system shall be capable of delivering the higher density over a minimum area of 900 square feet (84 m<sup>2</sup>) for wet pipe systems and 1,200 square feet (111 m<sup>2</sup>) for dry pipe systems. The shape of the design area shall be in accordance with Section 903.

- ❖ This section allows the designer to make use of the benefits of hydraulic design. In other words, in an area rated for a low-hazard commodity it is likely that in some portions of that space the available water and pressure will be sufficient for a higher-hazard commodity. This is true since sprinklers are designed for the most hydraulically remote areas; therefore, areas closer to the riser will receive more water and higher pressure. There are certain criteria accompanying this allowance that limit the size of the higher-hazard storage areas to 120 square feet (11 m<sup>2</sup>) each and require that they be separated from other similar

areas by 25 feet (7620 mm) (see Commentary Figure 3204.2). It also provides minimum areas in which this increased water supply needs to be available. It should be noted that there are some potential maintenance limitations. It may be difficult to keep track of these particular designated areas and the separation between the areas; therefore, it is suggested that the areas be delineated on the floor using durable traffic-type paint or tape. Recording the areas on a scaled floor plan available to inspectors could also be useful.

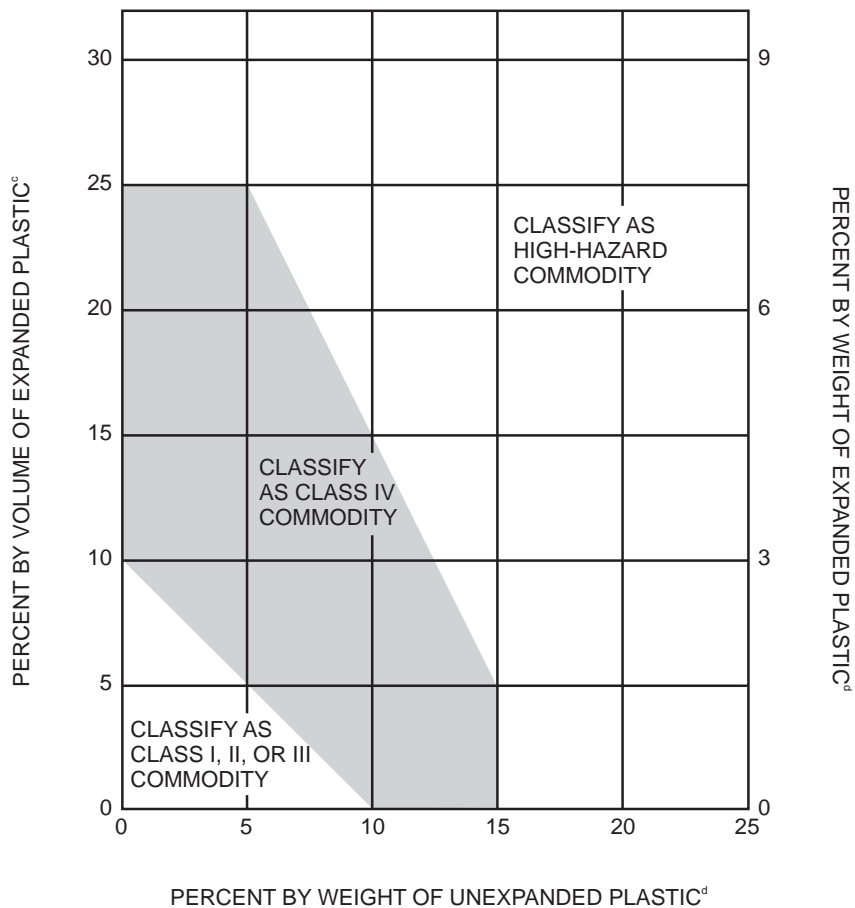
NFPA 13 also offers another alternative that allows higher-hazard commodities to be dispersed throughout a lower-hazard commodity storage area. There are limitations on how many commodities can be in

each mixed commodity area. The commodities must be randomly dispersed (see NFPA 13).

**SECTION 3205  
HOUSEKEEPING AND MAINTENANCE**

**3205.1 Rack structures.** The structural integrity of racks shall be maintained.

❖ This section’s emphasis on “structural integrity” has its roots in the IBC, specifically Chapters 16 and 22, which govern the structural design of rack storage installations. The integrity of rack storage includes such items as the primary structural components, the connections, bracing members and relationship with



**FIGURE 3203.7.4  
MIXED COMMODITIES<sup>a, b</sup>**

- a. This figure is intended to determine the commodity classification of a mixed commodity in a package, carton or on a pallet where plastics are involved.
- b. The following is an example of how to apply the figure: A package containing a Class III commodity has 12-percent Group A expanded plastic by volume. The weight of the unexpanded Group A plastic is 10 percent. This commodity is classified as a Class IV commodity. If the weight of the unexpanded plastic is increased to 14 percent, the classification changes to a high-hazard commodity.

c. Percent by volume =  $\frac{\text{Volume of plastic in pallet load}}{\text{Total volume of pallet load, including pallet}}$

d. Percent by weight =  $\frac{\text{Weight of plastic in pallet load}}{\text{Total weight of pallet load, including pallet}}$

## HIGH-PILED COMBUSTIBLE STORAGE

the superstructure of the building. Racks can be a very significant part of the structure and pose structural failure concerns, especially for the fire suppression forces that may be operating in close proximity to the racks.

**3205.2 Ignition sources.** Clearance from ignition sources shall be provided in accordance with Section 305.

❖ Section 3205.2 directs the reader to Section 305, which addresses housekeeping provisions for such things as open flames, heaters, flame-producing devices, light fixtures and materials subject to spontaneous combustion. The responsibility for the care and maintenance of the building rests with the building owner or the tenant.

**3205.3 Smoking.** Smoking shall be prohibited. *Approved* “No Smoking” signs shall be conspicuously posted in accordance with Section 310.

❖ This section prohibits smoking within combustible storage areas to limit the chance for a fire to ignite. Section 310 is referenced for signage requirements.

**3205.4 Aisle maintenance.** When restocking is not being conducted, aisles shall be kept clear of storage, waste material and debris. Fire department access doors, aisles and *exit* doors shall not be obstructed. During restocking operations using manual stocking methods, a minimum unobstructed aisle width of 24 inches (610 mm) shall be maintained in 48-

inch (1219 mm) or smaller aisles, and a minimum unobstructed aisle width of one-half of the required aisle width shall be maintained in aisles greater than 48 inches (1219 mm). During mechanical stocking operations, a minimum unobstructed aisle width of 44 inches (1118 mm) shall be maintained in accordance with Section 3206.9.

❖ This section emphasizes the importance of keeping aisles and access corridors open at all times for both occupant egress and fire-fighter access. Such aisles also serve as fire breaks. Miscellaneous storage, waste and other objects in the aisles negate or reduce these functions; therefore, the owner or tenant needs to have a rigorous maintenance program in place. This section is applicable to buildings that are accessible by the public, as well as those that are not. Restocking operations have the potential for being another impediment. Establishing minimum aisle widths coupled with strict enforcement increases the likelihood that clear aisle space will be available.

**3205.5 Pile dimension and height limitations.** Pile dimensions and height limitations shall comply with Section 3207.3.

❖ Pile dimensions and height limitations are directly regulated by the commodity class and the size of the storage area in accordance with Section 3207.3 and Table 3206.2. Section 3207.3 simply references

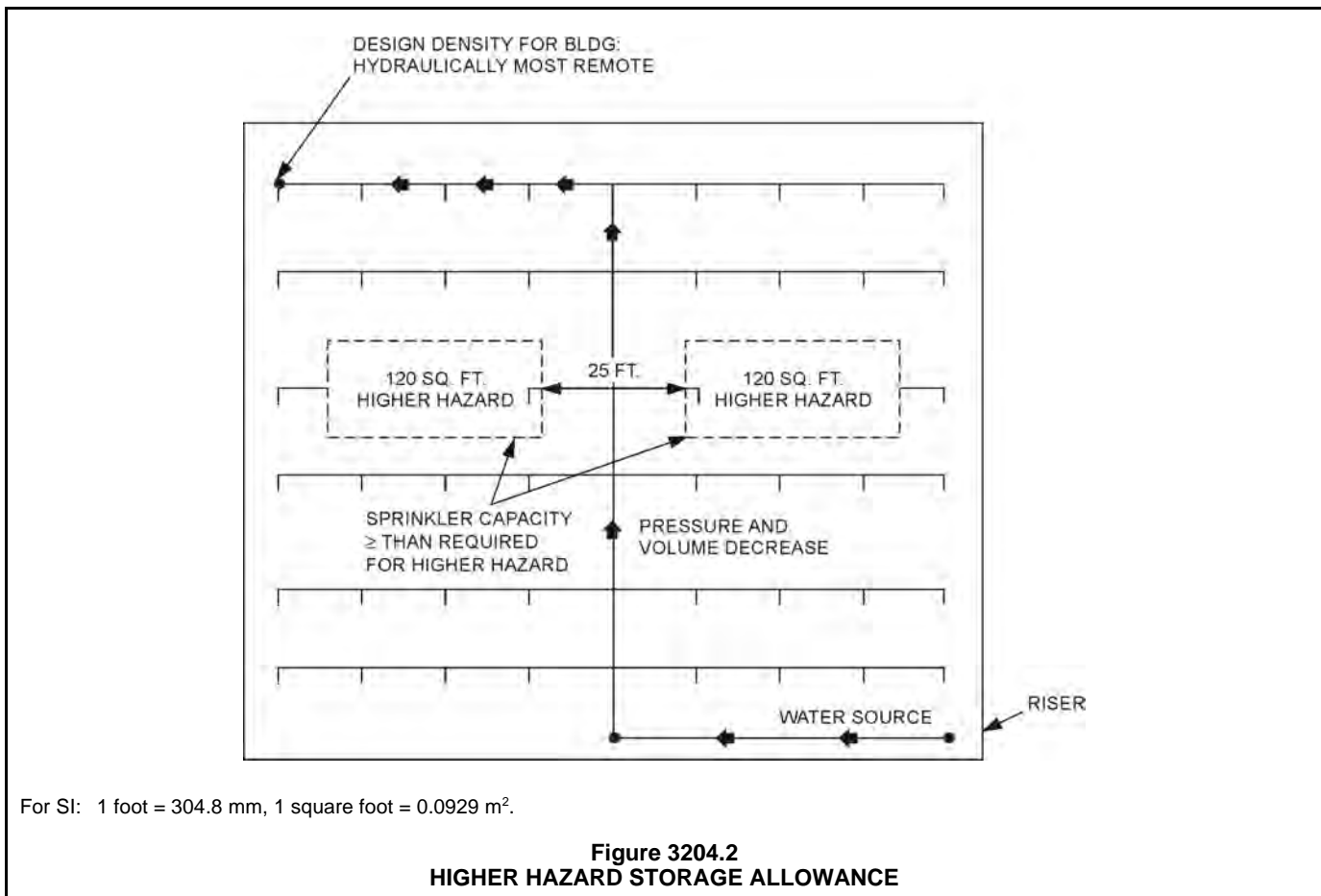


Table 3206.2, which provides these limitations. The only real variation in pile sizes is when a designer chooses Option 2 in the table, which omits the use of sprinklers. Therefore, control of combustibles is more critical and the code has more restrictive height limitations.

**3205.6 Designation of storage heights.** Where required by the *fire code official*, a visual method of indicating the maximum allowable storage height shall be provided.

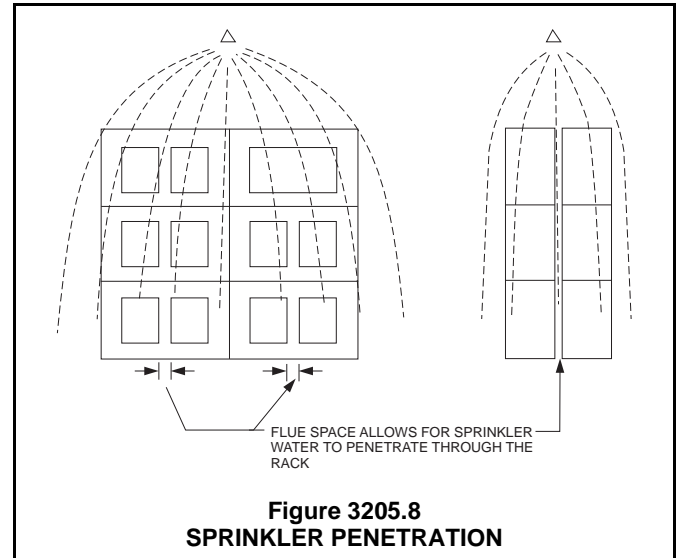
- ❖ The storage height of commodities is one of the most important variables when determining the adequacy of an automatic sprinkler system. A small increase in the height of storage can have major implications as to the minimum volume of water required to either control or suppress a fire involving high-piled combustible storage. This section was developed to provide code officials with a means of visually identifying the maximum allowable storage height in occupancies housing high-piled combustible storage. The requirement is not mandatory for all high-piled combustible storage, it is only required when specified by the fire code official. When applied, the requirement provides building owners and employees with a visual means of increasing the likelihood that the maximum allowable storage height will not be exceeded. This section does not specify the method required to satisfy its requirements. Compliance approaches could include the installation of barriers in rack sections; painting a line indicating the maximum storage height on the interior wall of the storage area or on the rack; posting signs; displaying a floor plan with storage heights indicated; or suspending objects from the roof structure. If the suspended objects method is selected, fire code officials should confirm that the design of the device does not create obstructions to the sprinkler discharge. A list of all possible methods to indicate maximum storage heights is not included in this section in order to avoid a “laundry list approach” that may limit creativity for a particular storage area.

**3205.7 Arrays.** Arrays shall comply with Section 3207.4.

- ❖ This section directs the reader to Section 3207.4, which in turn is governed by referenced standard NFPA 13. More specifically, it requires that any necessary spacings in accordance with the design be provided from the array to the ceiling to ensure sprinkler effectiveness.

**3205.8 Flue spaces.** Flue spaces shall comply with Section 3208.3.

- ❖ This section directs the reader to Section 3208.3, which in turn is governed by Table 3208.3 and provides criteria for flue spaces. Flue spaces are critical to sprinkler system effectiveness. See the definitions in Section 202 for “Flue spaces,” “Longitudinal” and “Transverse” (see Commentary Figure 3205.8).



**Figure 3205.8  
SPRINKLER PENETRATION**

## SECTION 3206 GENERAL FIRE PROTECTION AND LIFE SAFETY FEATURES

**3206.1 General.** Fire protection and life safety features for *high-piled storage areas* shall be in accordance with Sections 3206.2 through 3206.10.

- ❖ This section establishes the minimum requirements for fire protection and life safety features. These provisions include separation requirements; automatic sprinklers; fire detection; access and egress; smoke and heat removal; hose connections; minimum dimensions for aisles; clear heights; dead ends; and fire extinguishers. In addition to the fire protection and life safety requirements, Table 3206.2 contains provisions concerning commodity class and size of storage area requirements that define which fire protection and life safety requirements are to be used in the building design. Although this section addresses minimum fire protection and life safety features, the provisions that require proper maintenance of those features are included in Section 3205 and Chapter 3.

The responsibility for the care and maintenance of the fire protection and life safety features rests with the building owner, tenant or lessee. The responsibility for notifying the fire service (local fire department) when fire protection systems are inoperable also rests with the building owner, tenant or lessee. This notification is necessary so that another means of protection is provided and that the fire department response and fireground management operations are based on system condition (see commentary, Section 901.7).

**3206.2 Extent and type of protection.** Where required by Table 3206.2, fire detection systems, smoke and heat removal and automatic sprinkler design densities shall extend the lesser of 15 feet (4572 mm) beyond the *high-piled storage area* or to a permanent partition. Where portions of *high-*

## HIGH-PILED COMBUSTIBLE STORAGE

*piled storage areas* have different fire protection requirements because of commodity, method of storage or storage height, the fire protection features required by Table 3206.2 within this area shall be based on the most restrictive design requirements.

❖ The fire protection features noted in this section include a requirement for the extension of those features 15 feet (4572 mm) beyond the storage area if no partitions are present [see Commentary Figure 3206.2(1)]. For the fire protection systems to be effective, they must be designed with the knowledge that a fire within a storage area (high piled or rack) has the potential of jumping the aisle into another area of the same building. Note also that where mixed classes are stored in an area, the fire detection and protection system must be designed for the most hazardous commodity, except as allowed in Section 3204.2. The size of the high-piled storage area should include the aisles as required by NFPA 13 (only for rack storage). See the discussion in Section 3206.9 and the definition of “High-piled storage area.” The 15-foot (4572 mm) extension of protection should include the aisle width when determining how far to extend the protection [see Commentary Figure 3206.2(2)].

**TABLE 3206.2.** See page 32-11.

❖ In addition to the provisions of Sections 3206 through 3210, this table defines, through a prescriptive approach, the fire protection requirements for high-piled storage. The table bases the requirements on the commodity class and size of the high-piled storage area to indicate the necessary automatic fire-extinguishing system, fire detection, building access, smoke and heat removal, and curtain boards. In addition, the type of commodity and size of the high-piled storage area govern the limitations for the size, height and volume of solid-piled storage, shelf storage and palletized storage. The table presents the requirements in two commodity groupings. These groupings are Class I through IV commodities and high-hazard commodities. Essentially, all the same requirements apply, but at lower thresholds for high-hazard commodities.

Some of the key footnotes to the table are as follows:

- Note a reminds the reader that sprinkler systems must comply with the high-piled storage protection strategies found in NFPA 13 to be considered protected in accordance with the table.

- Note g requires special fire protection features, such as fire protection of exposed steel in very large high-piled storage areas. This is likely due to the potential size of a fire event with such a large amount of storage.
- Note h limits high-hazard storage areas to 500,000 square feet (46 450 m<sup>2</sup>). Each 500,000-square-foot (46 450 m<sup>2</sup>) area would be required to be separated with a 2-hour fire wall (separate buildings).
- Note i indicates that a fire detection system is not required by the table if the high-piled storage area is sprinklered. Without this footnote it would be unclear whether smoke detection would be required where sprinklers are voluntarily provided.
- Note j makes an exception to the smoke and heat removal requirements where early suppression fast response (ESFR) sprinklers or control mode special application sprinklers with a response time index of 50 or less listed to control a fire with 12 or fewer sprinklers are used. Similar exceptions are found in Section 910.1.

**Example:** A storage area contains 200,000 square feet (18 580 m<sup>2</sup>) of high-piled storage classified as commodity Class I. It is a single-story building with floor space only, no rack storage and is protected by standard automatic sprinklers. The subject building would be required to comply with the following:

- Automatic fire-extinguishing system throughout (see Section 3206.4).
- Building access (see Section 3206.6).
- Smoke and heat removal (see Section 3206.7).
- Maximum pile dimension of 100 feet (30 480 mm) (see Section 3206.9).
- Maximum permissible storage height of 40 feet (12 192 mm).
- Maximum pile volume of (100 feet by 100 feet by 40 feet tall) 400,000 cubic feet (11 328 m<sup>3</sup>).

**3206.3 Separation of high-piled storage areas.** *High-piled storage areas* shall be separated from other portions of the building where required by Sections 3206.3.1 through 3206.3.2.2.

❖ This section sets forth the requirements for separating the storage area from other uses within the same building and for multiple classifications and heights of storage.

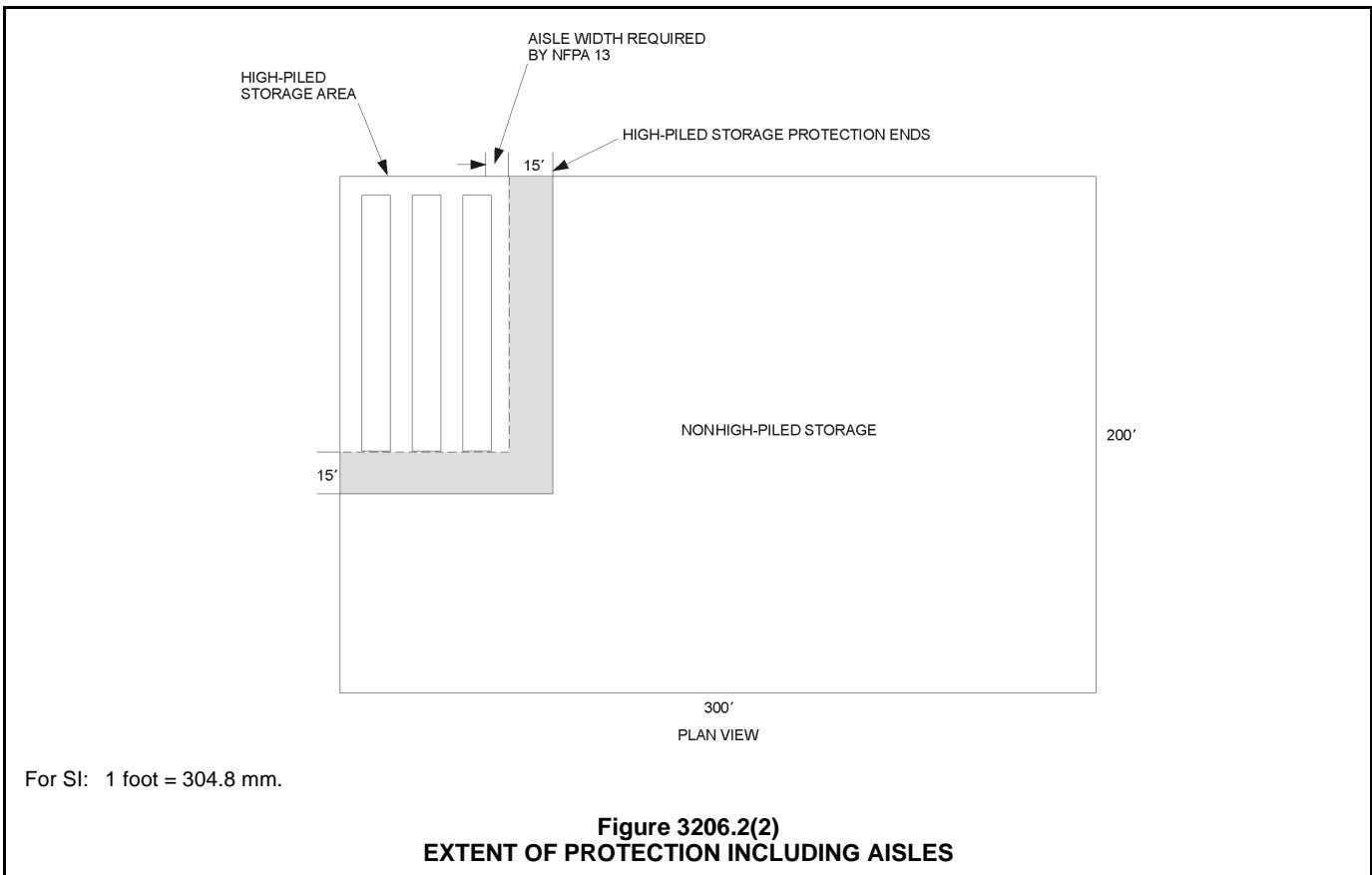
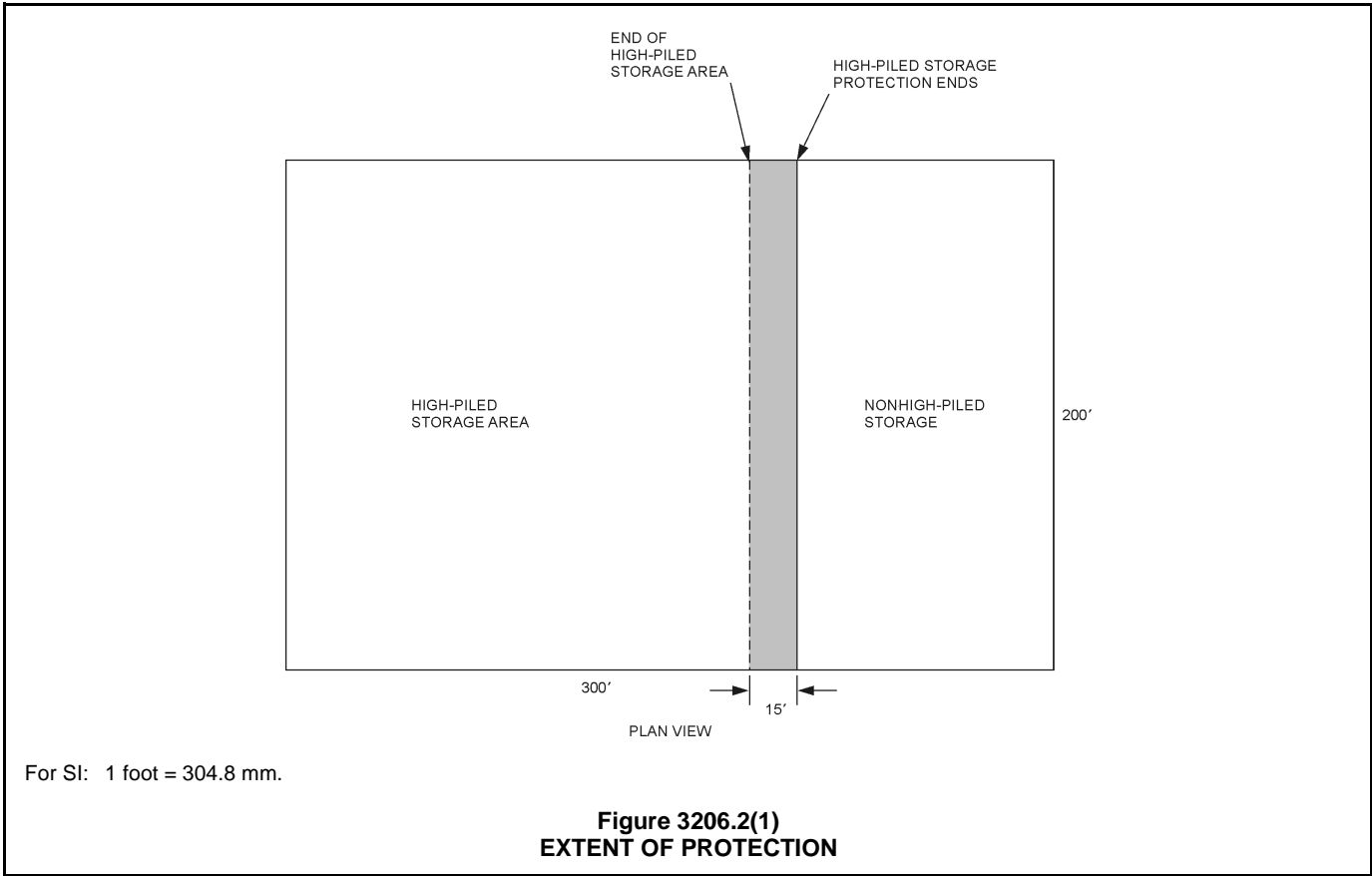
**TABLE 3206.2  
GENERAL FIRE PROTECTION AND LIFE SAFETY REQUIREMENTS**

COMMODITY CLASS	SIZE OF HIGH-PILED STORAGE AREA <sup>a</sup> (square feet) (see Sections 3206.2 and 3206.4)	ALL STORAGE AREAS (See Sections 3206, 3207 and 3208) <sup>b</sup>				SOLID-PILED STORAGE, SHELF STORAGE AND PALLETIZED STORAGE (see Section 3207.3)		
		Automatic fire-extinguishing system (see Section 3206.4)	Fire detection system (see Section 3206.5)	Building access (see Section 3206.6)	Smoke and heat removal (see Section 3206.7)	Maximum pile dimension <sup>c</sup> (feet)	Maximum permissible storage height <sup>d</sup> (feet)	Maximum pile volume (cubic feet)
I-IV	0-500	Not Required <sup>a</sup>	Not Required	Not Required <sup>e</sup>	Not Required	Not Required	Not Required	Not Required
	501-2,500	Not Required <sup>a</sup>	Yes <sup>i</sup>	Not Required <sup>e</sup>	Not Required	100	40	100,000
	2,501-12,000 Public accessible	Yes	Not Required	Not Required <sup>e</sup>	Not Required	100	40	400,000
	2,501-12,000 Nonpublic accessible (Option 1)	Yes	Not Required	Not Required <sup>e</sup>	Not Required	100	40	400,000
	2,501-12,000 Nonpublic accessible (Option 2)	Not Required <sup>a</sup>	Yes	Yes	Yes <sup>j</sup>	100	30 <sup>f</sup>	200,000
	12,001-20,000	Yes	Not Required	Yes	Yes <sup>j</sup>	100	40	400,000
	20,001-500,000	Yes	Not Required	Yes	Yes <sup>j</sup>	100	40	400,000
	Greater than 500,000 <sup>g</sup>	Yes	Not Required	Yes	Yes <sup>j</sup>	100	40	400,000
High hazard	0-500	Not Required <sup>a</sup>	Not Required	Not Required <sup>e</sup>	Not Required	50	Not Required	Not Required
	501-2,500 Public accessible	Yes	Not Required	Not Required <sup>e</sup>	Not Required	50	30	75,000
	501-2,500 Nonpublic accessible (Option 1)	Yes	Not Required	Not Required <sup>e</sup>	Not Required	50	30	75,000
	501-2,500 Nonpublic accessible (Option 2)	Not Required <sup>a</sup>	Yes	Yes	Yes <sup>j</sup>	50	20	50,000
	2,501-300,000	Yes	Not Required	Yes	Yes <sup>j</sup>	50	30	75,000
	300,001-500,000 <sup>g,h</sup>	Yes	Not Required	Yes	Yes <sup>j</sup>	50	30	75,000

For SI: 1 foot = 304.8 mm, 1 cubic foot = 0.02832 m<sup>3</sup>, 1 square foot = 0.0929 m<sup>2</sup>.

- Where automatic sprinklers are required for reasons other than those in Chapter 32, the portion of the sprinkler system protecting the high-piled storage area shall be designed and installed in accordance with Sections 3207 and 3208.
- For aisles, see Section 3206.9.
- Piles shall be separated by aisles complying with Section 3206.9.
- For storage in excess of the height indicated, special fire protection shall be provided in accordance with Note g where required by the fire code official. See Chapters 51 and 57 for special limitations for aerosols and flammable and combustible liquids, respectively.
- Section 503 shall apply for fire apparatus access.
- For storage exceeding 30 feet in height, Option 1 shall be used.
- Special fire protection provisions including, but not limited to, fire protection of exposed steel columns; increased sprinkler density; additional in-rack sprinklers, without associated reductions in ceiling sprinkler density; or additional fire department hose connections shall be provided required by the fire code official.
- High-piled storage areas shall not exceed 500,000 square feet. A 2-hour fire wall constructed in accordance with Section 706 the *International Building Code* shall be used to divide high-piled storage exceeding 500,000 square feet in area.
- Not required where an automatic fire-extinguishing system is designed and installed to protect the high-piled storage area in accordance with Sections 3207 and 3208.
- Not required where storage areas are protected by either early suppression fast response (ESFR) sprinkler systems or control mode special application sprinklers with a response time index of 50 (m • s)<sup>1/2</sup> or less that are listed to control a fire in the stored commodities with 12 or fewer sprinklers, installed in accordance with NFPA 13.

# HIGH-PILED COMBUSTIBLE STORAGE



**3206.3.1 Separation from other uses.** Mixed occupancies shall be separated in accordance with the *International Building Code*.

❖ IBC Section 508 describes the provisions governing the condition when a building contains more than one of the occupancy groups identified in IBC Sections 303 through 312 (see also the occupancy classification definitions in Section 202 of the code). Buildings very often will contain more than one occupancy group classification; for example, an office (Group B, business) connected to a storage area (Group S-1, moderate-hazard storage). Once a building is determined to house more than one occupancy group, the codes require that a combination of potential fire and life safety hazards be addressed. IBC Section 508.3 provides for several conditions under which certain dissimilar occupancies are treated: accessory occupancies, nonseparated occupancies and separated occupancies. It should be noted that when the mixed occupancy building is separated by a fire wall it technically becomes two buildings (see the definition of “Building area” in Section 202). As a result, the provisions of IBC Sections 503 through 507 will need to be reviewed for applicability and the evaluation and design adjusted for that difference.

**3206.3.2 Multiple high-piled storage areas.** Multiple *high-piled storage areas* shall be in accordance with Section 3206.3.2.1 or 3206.3.2.2.

❖ This section delineates how to determine fire and life safety requirements for a single building or area containing multiple classes of commodities.

**3206.3.2.1 Aggregate area.** The aggregate of all *high-piled storage areas* within a building shall be used for the application of Table 3206.2 unless such areas are separated from each other by 1-hour *fire barriers* constructed in accordance with Section 707 the *International Building Code*. Openings in such *fire barriers* shall be protected by opening protectives having a 1-hour *fire protection rating*.

❖ This section is intended to recognize that, in actual storage circumstances, storage arrays do not always correspond to any one commodity classification. It is not unusual for arrays to consist of thousands of products. As a result, this section recognizes that, in storage areas, multiple commodity classifications may be contained in one area and must be treated as an aggregate when applying Table 3206.2. As an alternative, this provision allows for each class of commodity to be separated within the same building by 1-hour fire barriers constructed in accordance with IBC Section 707, which applies to fire barriers used for separating fire areas. To maintain integrity of the separation of fire areas, fire barriers must be continuous from the top of the floor below to the underside of the roof slab or deck above and be securely attached thereto. As with any fire-resistance-rated assembly, consideration must be given to openings and penetrations. The number and size of openings in the fire barrier must comply with the provisions of IBC Sec-

tion 707, and the opening protectives must have a minimum fire protection rating of 1 hour. Note that IBC Section 716.5 allows an opening protective fire protection rating of  $\frac{3}{4}$  hour for nonexit-enclosure fire barriers; however, this section, with its specific requirement of a 1-hour opening protective assembly rating, would supersede that requirement. Penetrations of fire barriers must comply with IBC Section 714. Maintenance of the fire-resistance-rated construction rests with the building owner or the tenant as described in Section 703. The main purpose for this section is to determine what area is required to be used when addressing Table 3206.2. Section 3206.3.2.2 is focused on the need to separate different hazard levels of storage in order to increase or reduce the fire protection requirements (see also commentary, Section 3206.3.2.2).

**3206.3.2.2 Multiclass high-piled storage areas.** *High-piled storage areas* classified as Class I through IV not separated from *high-piled storage areas* classified as high hazard shall utilize the aggregate of all *high-piled storage areas* as high hazard for the purposes of the application of Table 3206.2. To be considered as separated, 1-hour *fire barriers* shall be constructed in accordance with Section 707 of the *International Building Code*. Openings in such *fire barriers* shall be protected by opening protectives having a 1-hour *fire protection rating*.

**Exception:** As provided for in Section 3204.2.

❖ This section is intended to recognize that, in actual circumstances, storage arrays may contain a combination of Class I through IV commodities alongside high-hazard commodities. It is not unusual for arrays to consist of thousands of products. As in Section 3206.3.2.1, this section recognizes that in storage areas multiples of commodity classifications may be contained in one area and must be treated as an aggregate under the highest hazard commodity class category found in that area when applying Table 3206.2. As with Section 3206.3.2.1, this provision allows for each class of commodity to be separated within the same building by 1-hour fire barriers constructed in accordance with IBC Section 707, which applies to fire barriers used for separating fire areas. To maintain integrity of the separation of fire areas, fire barriers must be continuous from the top of the floor below to the underside of the roof slab or deck above and be securely attached thereto. As with any fire-resistive barriers, consideration must be given to openings and penetrations. The number and size of openings in the fire barrier must comply with the provisions of IBC Section, and the opening protective assemblies must have a minimum fire-resistance rating of 1 hour. Note that IBC Section 716.5 allows an opening protection rating of  $\frac{3}{4}$  hour for nonexit-enclosure fire barriers; however, this section, with its specific requirement of a 1-hour opening protective assembly rating, would supersede that requirement. Penetrations of fire barriers must comply with IBC Section 714. Maintenance of the fire-resistance-rated

construction rests with the building owner or the tenant as described in Section 703. The use of separation allows the application of less-restrictive, active fire protection requirements in some areas containing lower hazard commodities. It also creates smaller areas that need to be applied to Table 3206.2. The exception permits the use of an accepted engineering analysis in accordance with Section 3204.2, which allows one to take advantage of the benefits of hydraulic design (see Section 3204.2).

**3206.4 Automatic sprinklers.** *Automatic sprinkler systems* shall be provided in accordance with Sections 3207, 3208 and 3209.

❖ This section refers the reader to Sections 3207, 3208 and 3209 for the specific sprinkler requirements based upon the type of high-piled storage. Sprinkler systems are discussed in Sections 3207.2, 3208.2 and 3209.2 for the various ways in which high-piled storage is configured.

**3206.4.1 Pallets.** Automatic sprinkler system requirements based upon the presence of pallets shall be in accordance with NFPA 13.

❖ The types of pallets used will alter the sprinkler protection provided for storage. NFPA 13 has extensive requirements for pallet use and storage based on the type of pallet that must be designed for and maintained during occupancy. Plastic pallets, when used, increase the fuel load to the commodity that is being stored on top of the pallet. NFPA 13 requires the commodity classification to be altered to address the additional hazard. There are specific adjustments for commodity class for unreinforced or reinforced polypropylene or unreinforced or reinforced high-density polyethylene plastic pallets. If a different type of plastic is used, the commodity shall either be adjusted by two classes or be tested to determine the classification. NFPA 13 does not specify a test.

**3206.4.1.1 Plastic pallets.** Plastic pallets listed and labeled in accordance with UL 2335 or FM 4996 shall be treated as wood pallets for determining required sprinkler protection.

❖ This section allows for plastic pallets that have passed UL 2335 or FM 4996 to be treated as wood pallets. UL 2335 and FM 4996 are tests specific to storage pallets and their associated flammability; those tests do not address smoke generation. The tests examine the comparative performance of the plastic pallet to a wood pallet.

**3206.5 Fire detection.** Where fire detection is required by Table 3206.2, an *approved* automatic fire detection system shall be installed throughout the *high-piled storage area*. The system shall be monitored and be in accordance with Section 907.

❖ Automatic fire detection systems are designed to increase the likelihood that the fire will be detected and the occupants given sufficient warning to allow area or building exit. The detectors must be smoke detectors approved for the particular use, as required

by Section 907.2. Table 3206.2 shows when a fire detection system is required to be installed in a storage area. Section 907 covers the application, installation, performance and maintenance of the fire alarm system and its components. Section 907.6.3 requires that the fire alarm system identify the specific initiation device address, location and device type. Several exceptions address issues such as small buildings where this is unnecessary, certain initiating devices and existing systems. Section 907.6.4 provides the minimum requirements for zoning the system, which limit the size of the zoned area to 22,500 square feet (2090 m<sup>2</sup>). Such systems are only required in some cases in Table 3206.2, primarily when the building is not sprinklered.

**3206.6 Building access.** Where building access is required by Table 3206.2, fire apparatus access roads in accordance with Section 503 shall be provided within 150 feet (45 720 mm) of all portions of the *exterior walls* of buildings used for high-piled storage.

**Exception:** Where fire apparatus access roads cannot be installed because of topography, railways, waterways, nonnegotiable grades or other similar conditions, the *fire code official* is authorized to require additional fire protection.

❖ This section contains the requirements for fire department access to a building. There are the same requirements found in Section 503.1.1. Section 503 discusses the minimum requirements for the location of such a roadway, additional access where required, minimum dimensions, minimum surface load tolerances, turning radii, grades, marking and overall access by the fire department. Additional measures are necessary when a road cannot be built on the property surrounding the building, including additional fire sprinkler protection, detection, building fire resistance, etc. This reliance on fire protection systems is necessary to compensate for the limited access available to fire department equipment.

**3206.6.1 Access doors.** Where building access is required by Table 3206.2, fire department access doors shall be provided in accordance with this section. Access doors shall be accessible without the use of a ladder.

❖ Building access requirements are summarized in Table 3206.2. The access requirements include the application of Sections 3206.6.1.1 through 3206.6.1.3. In addition, the provisions of Chapter 10, which address minimum clear width dimensions, allowable projections into the clear width, floor landings, door hardware, door identification, etc., must be considered. Section 504 states that an approved walkway must be provided from the fire apparatus access road, or from other approved fire apparatus access roadways, to an exterior door opening required for fire department access.

**3206.6.1.1 Number of doors required.** Not less than one access door shall be provided in each 100 linear feet (30 480 mm), or fraction thereof, of the exterior walls that face

required fire apparatus access roads. The required access doors shall be distributed such that the lineal distance between adjacent access doors does not exceed 100 feet (30 480 mm).

**Exception:** The linear distance between adjacent access doors is allowed to exceed 100 feet (30 480 mm) in existing buildings where no change in occupancy is proposed. The number and distribution of access doors in existing buildings shall be approved.

❖ In accordance with *International Fire Code*® (IFC®) Committee Interpretation No. 36-04, access door openings in exterior walls are to be located such that the distance between adjacent openings does not exceed 100 lineal feet (30 480 mm), providing the fire department short runs for quick access to assess, combat and control a fire in the high-piled storage areas of a building (see Commentary Figure 3206.6.1.1). The language is similar to that found in Section 903.2.11.1 for windowless stories or buildings. Table 3206.2 tends to require such doors for larger-sized, high-piled storage areas where fire fighting may be more difficult.

An exception is provided for existing buildings. This exception recognizes that there may be practical difficulties in adding doors to an existing building to meet the 100-foot limitations. The exception does not prescribe a specific number but instead requires the number and distribution to be approved. The current language limiting the distance to 100 feet first

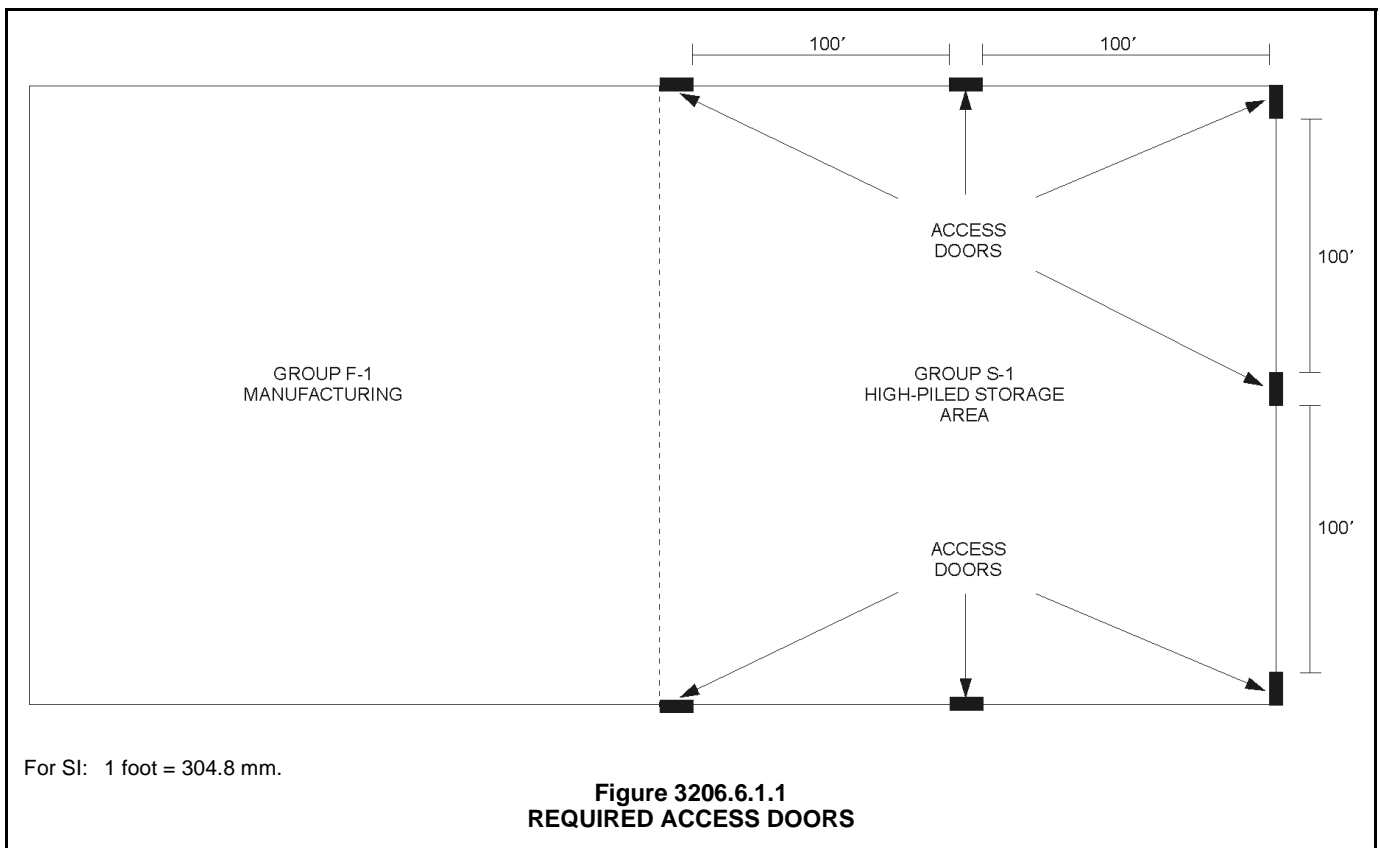
appeared in the 2009 edition of the code. Existing warehouses where one tenant moves out and a new tenant moves in will require a new high-piled storage permit. As part of the permit, the current/adopted edition of Chapter 32 is applied, often resulting in cutting holes in exterior walls, which are often concrete, and causing business restrictions as a result of adding doors where currently roll-up doors exist. This allows a small amount of flexibility for owners of existing buildings and the fire code official where adding doors appears costly or impractical.

**3206.6.1.2 Door size and type.** Access doors shall be not less than 3 feet (914 mm) in width and 6 feet 8 inches (2032 mm) in height. Roll-up doors shall not be used unless *approved*.

❖ Door sizes are the same as those in the means-of-egress door provisions of Chapter 10. The emphasis on the side-hinged type of door is to ensure that other door types, such as roll-up and sliding, are not used due to their historically poor reliability. The swing should be outward and no less than 90 degrees (1.75 rad). Section 1003.5, Exception 1, permits the door sill elevation to be above the outside grade if the door is not a required accessible route in accordance with the IBC. In some regions, the raised sill is preferred because of the potential buildup of snow and ice.

**3206.6.1.3 Locking devices.** Only *approved* locking devices shall be used.

❖ Locking mechanisms must be approved by the fire code official. The fire service must be able to open



the doors from the exterior side during an emergency. The locking mechanism must be designed to maintain the security of the building, to be readily openable from the egress side and to be openable by fire department personnel from the exterior.

**3206.7 Smoke and heat removal.** Where smoke and heat removal is required by Table 3206.2 it shall be provided in accordance with Section 910.

❖ Table 3206.2 identifies the requirements for smoke and heat removal based on the size and public accessibility of the high-piled storage area. If required, smoke and heat removal is to be designed and installed in accordance with Section 910. Smoke and heat removal would not be required if ESFR sprinklers or control mode special application sprinklers are installed in accordance with Note j of Table 3206.2. The concern addressed by Note j is that smoke and heat vents may affect sprinkler reliability and the general need for such features in sprinklered buildings. Also, these types of sprinkler systems are extremely successful in suppressing and extinguishing fires. They are also designed such that disruption from smoke and heat vents or even a mechanical smoke removal system would be detrimental to their successful operation. Smoke and heat vents and draft curtains were originally developed as a way to manage smoke in nonsprinklered large spaces. Draft curtains are no longer addressed in Chapter 32 or Section 910.

In addition, vent locations must reflect consideration of the temperature requirements of both the fusible link of the vent and the temperature rating range of the sprinkler heads. A vent opening could keep the temperature around nearby sprinkler heads low enough to prevent them from activating because of the cooler air passing to the opened vent; therefore, smoke and heat vents should have a higher temperature rating than the sprinklers. These concerns are addressed in more detail in standards UL793 and FM 4430.

**3206.8 Fire department hose connections.** Where *exit* passageways are required by the *International Building Code* for egress, a Class I standpipe system shall be provided in accordance with Section 905.

❖ An exit passageway is a means of continuing the exit enclosure protection horizontally to the exit discharge. Accordingly, an exit passageway may be used to connect an interior exit stairway to the exit discharge. Another use of an exit passageway is to bring an exit entrance within the allowable limit of exit access travel distance. This section states that when the IBC requires the installation of an exit passageway, a Class I standpipe system must be provided in accordance with Section 905. The intent is to recognize that the standpipe will provide a quick and convenient water source for fire department use where

fire hose lines would be in a protected area or would otherwise be impractical to use because of travel distance. The intent is to allow the fire department to initiate an attack on the fire more safely and quickly, thus reducing the possibility of loss of life or property.

**3206.9 Aisles.** Aisles providing access to *exits* and fire department access doors shall be provided in *high-piled storage areas* exceeding 500 square feet (46 m<sup>2</sup>), in accordance with Sections 3206.9.1 through 3206.9.3. Aisles separating storage piles or racks shall comply with NFPA 13. Aisles shall also comply with Chapter 10.

**Exception:** Where aisles are precluded by rack storage systems, alternate methods of access and protection are allowed when *approved*.

❖ Aisles in high-piled storage areas have multiple functions, which include the following:

- Exit access.
- Fire department access.
- Fire breaks.
- Everyday access to storage.

Under normal conditions, the aisles primarily serve people working in the building, and the design for minimum aisle width is based on the maneuvering capabilities of the commodity-handling methods and equipment. Under emergency situations, the aisle automatically becomes an egress pathway that must provide the required minimum width to accommodate the number of occupants that must use the aisles, and also serves to allow the water discharge from the sprinklers to penetrate the high-piled storage. Aisles also provide access for fire department personnel and serve as fire breaks between piles and racks.

Chapter 2 of both the code and the IBC define "Aisle" as an exit access component that defines and provides a path of egress travel. This is generally true when it comes to high-piled storage, but the aisles have other important functions as noted above.

This section differentiates between aisle requirements for fire department access and exit access for occupants from those required by NFPA 13. The aisle requirements in NFPA 13 are specific to rack storage and are based on the testing of specific commodity configurations. During tests of high-piled rack storage configurations, one of the criteria for success/failure has been whether the target array (commodity across the aisle) has been ignited. Therefore, as discussed in the definition of "High-piled storage areas" these aisle widths would be included in the area actually classified as high-piled combustible storage [see Commentary Figure 3206.9(2)]. Any of the aisles related solely to exit and access would be above and beyond the requirements in NFPA 13 and would not need to be included in the aggregate area. NFPA 13 does not address aisle widths for solid-piled or palletized storage; therefore, the aisle widths would not

need to be included as part of the high-piled storage area when applying Table 3206.2, but would be required by this section for egress and access. NFPA 13 does have a section that discusses the need for aisle widths in all high-piled storage areas as it relates to slowing the spread of fire, fire-fighter access, salvage and removal of storage but does not provide specific aisle widths (see also IFC Committee Interpretation No. 13-05 and the definition of “High-piled combustible storage” in Section 202).

Another scenario encountered when determining the high-piled storage area is high-piled storage surrounding other uses or low-piled storage. The aisle width when addressing rack storage should be included in the high-piled storage area determination [see Commentary Figure 3206.9(3)].

The exception to this section provides the ability to address situations where the required aisle width affects the ability of a facility to operate. Essentially, other strategies must be proposed. This may include the use of additional sprinkler protection within racks. The key is that egress and access for occupants and fire fighters be addressed appropriately. It should be noted that multiple-row racks specifically lack aisles, unlike single- and double-row racks. However, the increased hazard from such storage is already specifically addressed by NPFA 13 in the fire protection requirements.

**3206.9.1 Width.** Aisle width shall be in accordance with Sections 3206.9.1.1 and 3206.9.1.2.

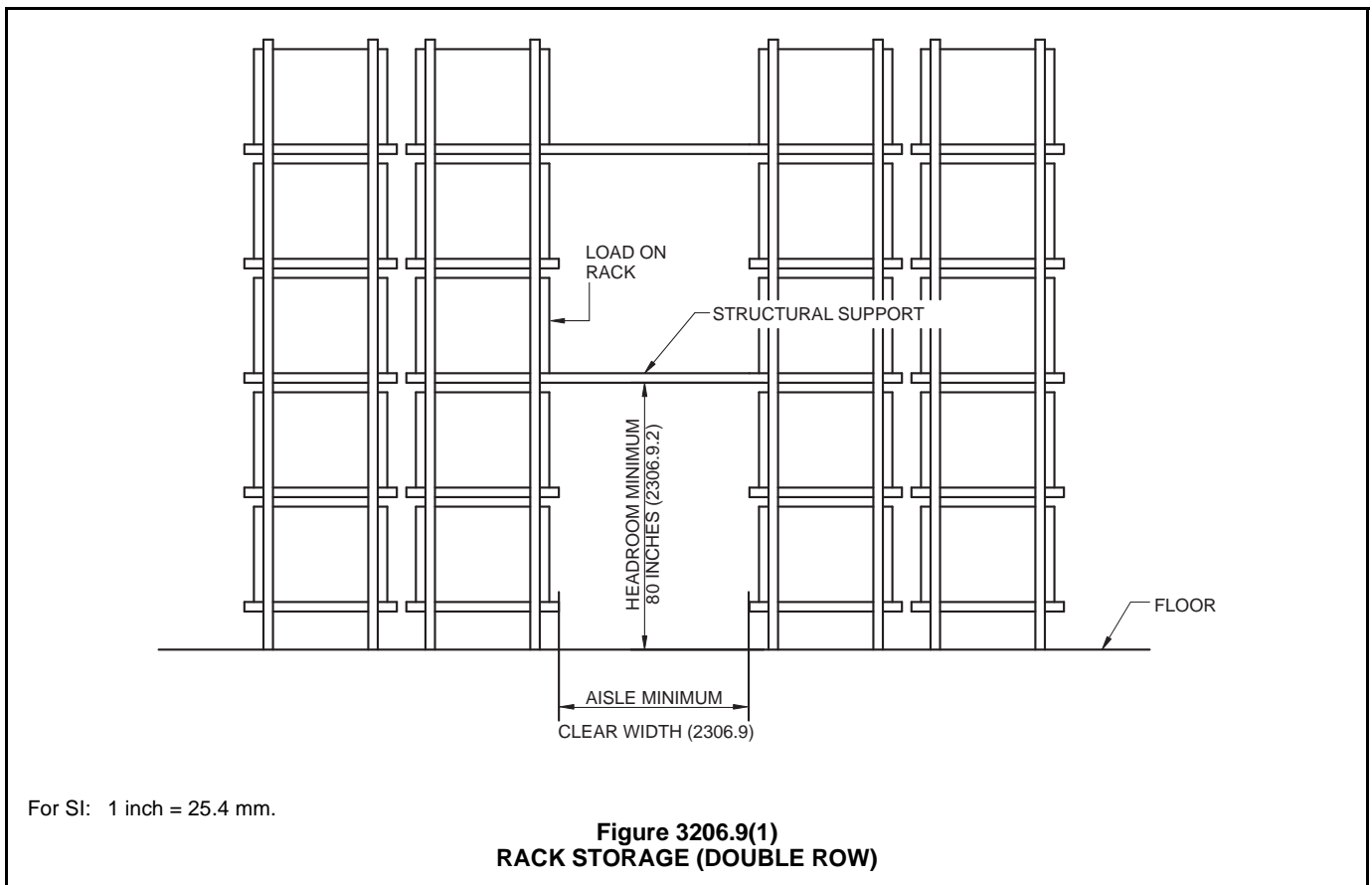
**Exceptions:**

1. Aisles crossing rack structures or storage piles, that are used only for employee access, shall be not less than 24 inches (610 mm) wide.
2. Aisles separating shelves classified as shelf storage shall be not less than 30 inches (762 mm) wide.

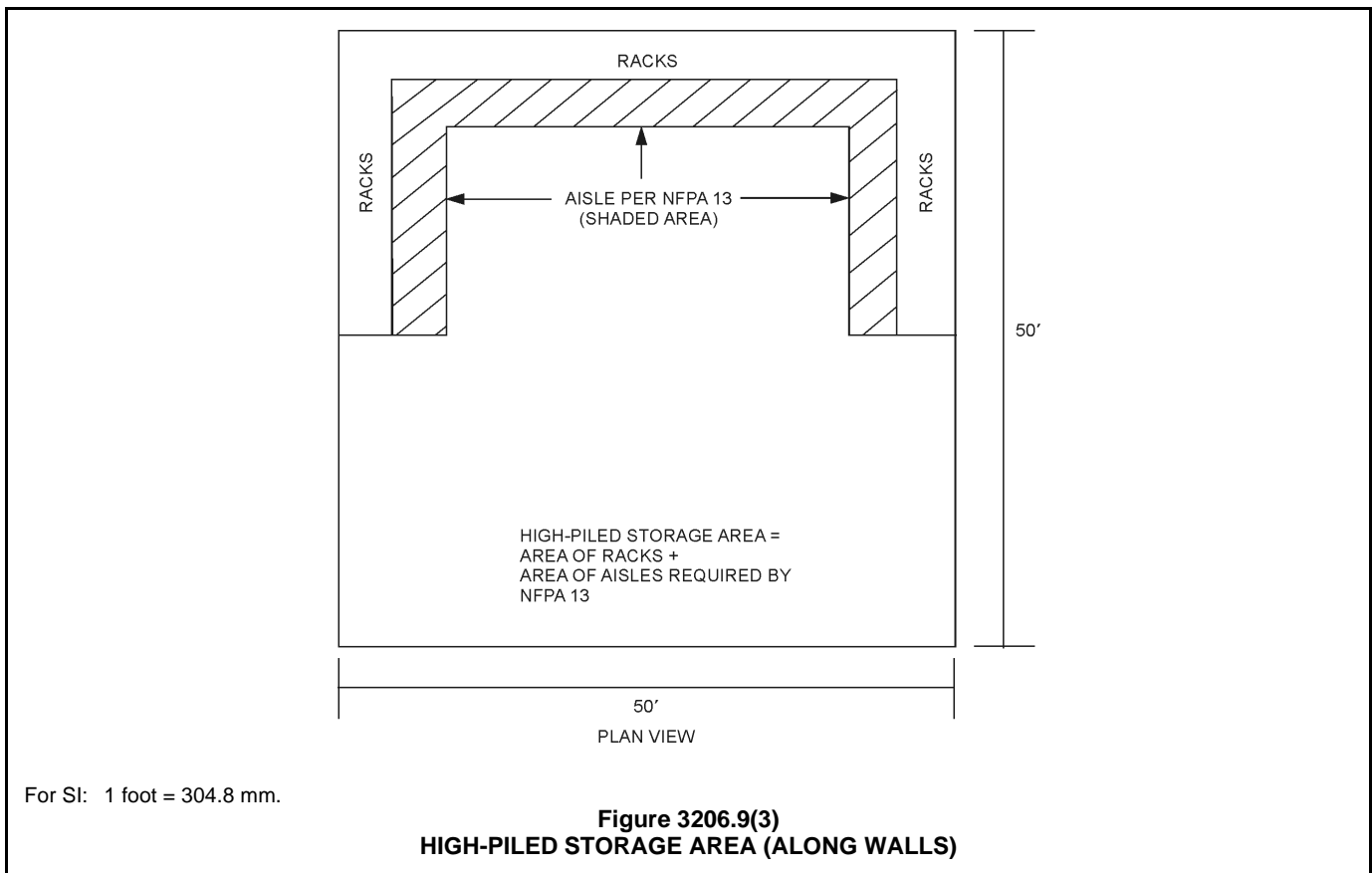
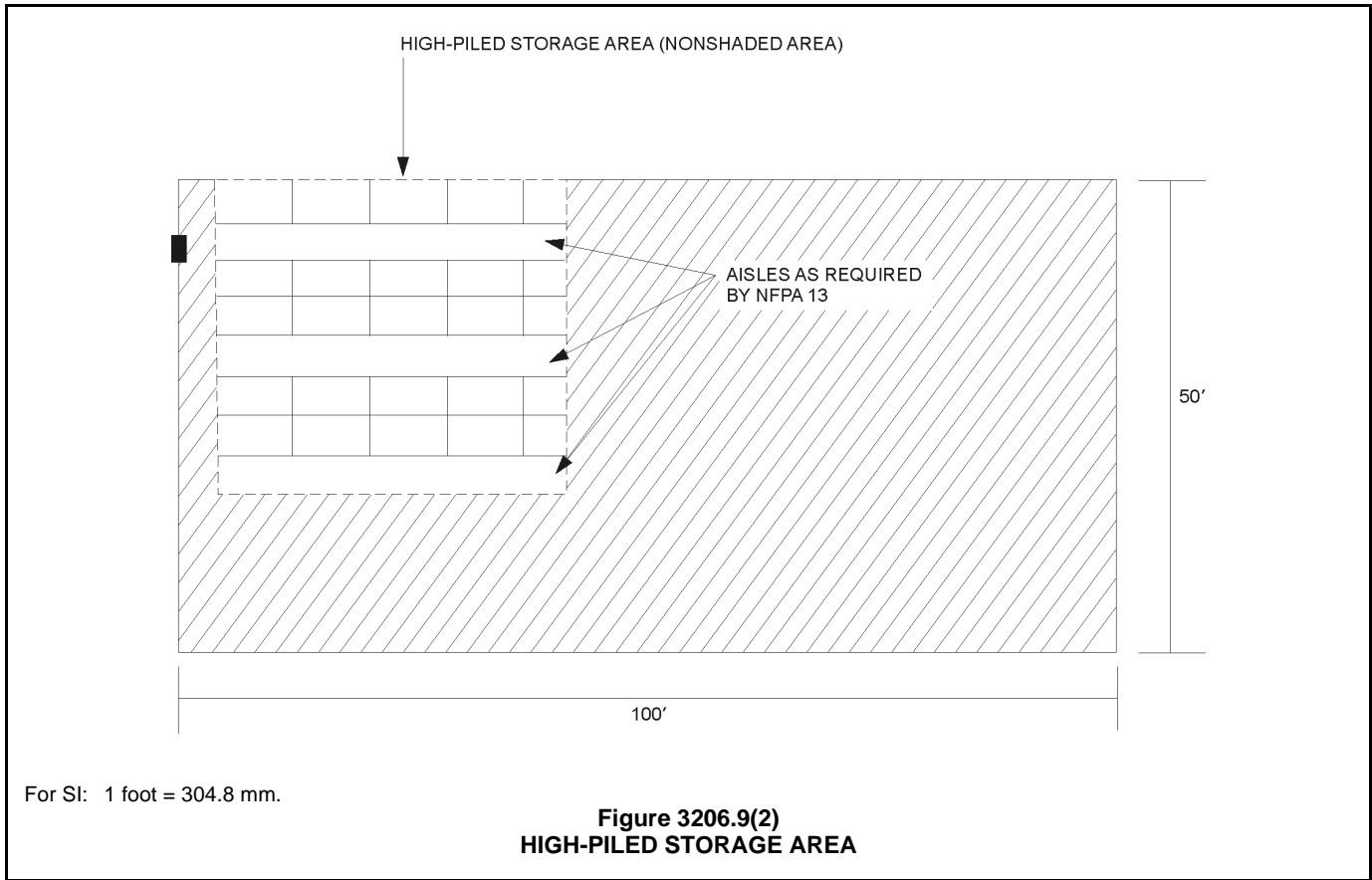
❖ This section alerts the code user to the various minimum aisle widths based on the commodity, commodity area and whether the building contains automatic sprinklers. It is important to note that for fire protection purposes, NFPA 13 defines “Aisle width” as “the horizontal dimension between the face of the loads in racks under consideration” (see Commentary Figure 3206.9.1).

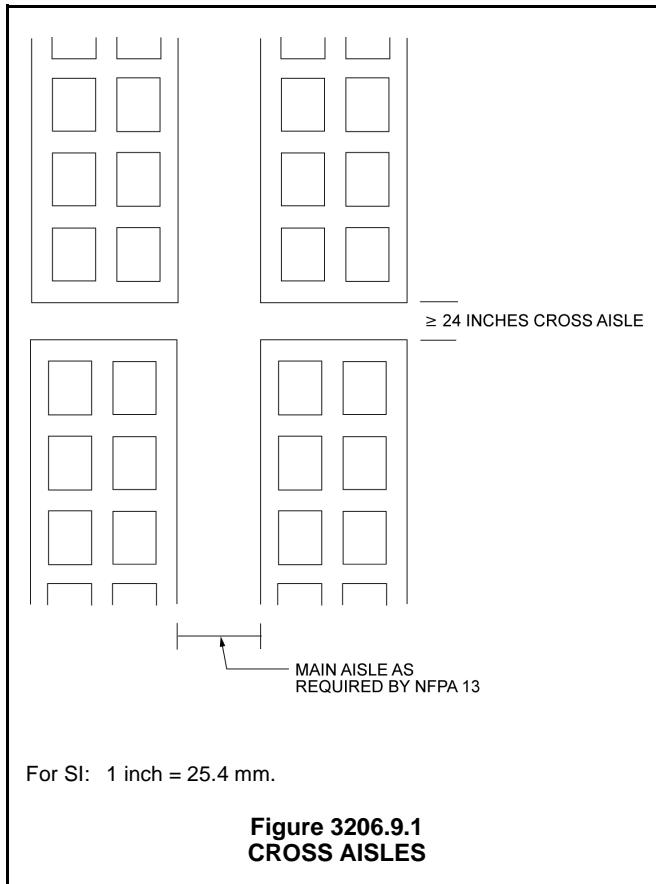
There are two exceptions to the aisle requirements. Exception 1 allows aisles that cross rack structures to be 24 inches (610 mm), the logic being that those aisles are not required (above and beyond egress, access and need for fire breaks) and are simply a convenience for building owners and users (see Commentary Figure 3206.9.1).

Exception 2 is for shelving that allows a 30-inch (762 mm) aisle. This is related to the requirements found in NFPA 13 for shelf storage that allows 30-inch (762 mm) aisles. Solid shelving in rack storage would not be addressed by this exception.



HIGH-PILED COMBUSTIBLE STORAGE





**3206.9.1.1 Sprinklered buildings.** Aisles in sprinklered buildings shall be not less than 44 inches (1118 mm) wide. Aisles shall be not less than 96 inches (2438 mm) wide in *high-piled storage areas* exceeding 2,500 square feet (232 m<sup>2</sup>) in area, that are accessible to the public and designated to contain high-hazard commodities.

**Exception:** Aisles in *high-piled storage areas* exceeding 2,500 square feet (232 m<sup>2</sup>) in area, that are accessible to the public and designated to contain high-hazard commodities, are protected by a sprinkler system designed for multiple-row racks of high-hazard commodities shall be not less than 44 inches (1118 mm) wide.

Aisles shall be not less than 96 inches (2438 mm) wide in areas accessible to the public where mechanical stocking methods are used.

- ❖ The 44-inch-minimum (1118 mm) aisle width allows two unimpeded parallel columns of occupants to travel in opposite directions in addition to anticipating other obstructions occurring during an emergency situation. These obstructions could be in the form of a lift truck, idle pallets, mercantile displays and even the results of unstable commodities falling into the aisle. In addition, the 96-inch (2438 mm) width further reduces the hazard of aisle jumps (radiant heat from a burning pile/rack causing the pile/rack across the aisle to ignite) in case of a fire and provides the fire

department with greater maneuvering capabilities during a fire, essentially providing an additional safety factor where more dangerous commodities are stored.

Aisles that provide access to exits and to the fire department access doors are required to comply with Section 3206.9.1. Therefore, where such exit access and fire department access doors are located, the aisles are required to be at least 44 inches. This would also require that single- or double-row racks have a minimum 44-inch aisle between racks when used as an aisle to provide access to exits and fire department access. This does not include cross aisles that are permitted to be 24 inches in width (Exception 1 to Section 3206.9.1). Note that NFPA 13 permits single- and double-row racks to have aisles as small as 3½ feet. This is slightly smaller than the minimum aisle width required by the code. Careful exit planning is needed in rack storage for single- and double-row racks.

This section would not require that all aisles within multirow rack installation be 44 inches. Again, only aisles necessary for egress and fire department access would need to meet these requirements. This may affect the layout of multirow rack systems to provide such access paths for egress and fire department access in some cases. Travel distance, common path of travel and dead ends may be limiting factors. This is similar to solid-piled storage which can take up large areas within a building without providing aisles within the storage pile itself.

The exception recognizes the increased safety provided by a higher level of sprinkler protection, such as using a multirow rack protection scheme in a single- or double-row rack system, an ESFR system or additional levels of in-rack sprinklers, by allowing for smaller aisle widths for high-hazard commodity areas exceeding 2,500 square feet (232 m<sup>2</sup>). If the sprinkler protection can protect multiple-row racks of high-hazard commodities, it should adequately protect small aisle displays between piles or racks.

It should be noted that NFPA 13 addresses two major configurations of rack storage. They include single- and double-row rack storage and multirow rack storage. The protection requirements are different and more stringent for multirow racks and are based specifically on test configurations with certain aisle spacings. NFPA considers any rack storage with less than 3½ foot (42 inches) aisles as multirow rack storage. NFPA 13 does not require aisles within multirow racks. NFPA 13 compensates for the increased fire hazard with more restrictive fire protection requirements. Therefore, within the multirow racking itself, aisles as required by Section 3206.9.1.1 are not required and small convenience aisles are appropriate. This is also consistent with Exception 1 to Section 3206.9.1 allowing 24-inch cross aisles for employee access.

## HIGH-PILED COMBUSTIBLE STORAGE

**3206.9.1.2 Nonsprinklered buildings.** Aisles in nonsprinklered buildings shall be not less than 96 inches (2438 mm) wide.

- ❖ The minimum 96-inch (2438 mm) aisle width for all aisles in nonsprinklered buildings recognizes the greater hazard caused by the lack of an automatic fire sprinkler system. This minimum width allows the building users a greater area for anticipating obstructions, as well as greater flexibility for the fire department personnel to assess, combat and control the fire.

**3206.9.2 Clear height.** The required aisle width shall extend from floor to ceiling. Rack structural supports and catwalks are allowed to cross aisles at a minimum height of 6 feet 8 inches (2032 mm) above the finished floor level, provided that such supports do not interfere with fire department hose stream trajectory.

- ❖ The clear ceiling height, or head room minimum [see Commentary Figure 3206.9(1)], is necessary for occupants to avoid an obstruction, to provide visibility to the occupants so that the path of travel can be planned and negotiated, and to allow sufficient area for effective use of the fire department's hose streams. The height is the vertical measurement above every point along the finished floor to a ceiling, to the underside of a rack storage catwalk or to the underside of a structural member. This requirement that aisles extend from floor to ceiling is for the primary aisles. Cross aisles are above and beyond that which is required for egress, access and the performance of fire protection systems. Though not specifically noted, it is within the intent of this code that cross aisles provide at least the minimum height of 6 feet 8 inches to be consistent with that required for structural supports and catwalks.

**3206.9.3 Dead-end aisles.** Dead-end aisles shall not exceed 20 feet (6096 mm) in length in Group M occupancies. Dead-end aisles shall not exceed 50 feet (15 240 mm) in length in all other occupancies.

**Exception:** Dead-end aisles are not limited where the length of the dead-end aisle is less than 2.5 times the least width of the dead-end aisle.

- ❖ Dead-end aisles can allow a single fire event to eliminate access to all the exits by trapping the occupants in the dead-end area. Dead ends, as they relate to high-piled storage, are similar to those formed by corridors. However, simply providing a reference back to Chapter 10 is somewhat confusing as to how the requirements would be intended to apply to warehouse configurations. This section provides two criteria specific to high-piled storage: one criterion for Group M occupancies of 20 feet; and, for all other occupancies, 50 feet. This is due to the fact that Group M occupancies are more likely to be open to the public where other occupancies, such as Group S, would not.

The exception recognizes aisles that are wide, which generally reduce the dangers of dead-end

aisles. The fire is less likely to completely block access to an exit in a larger space.

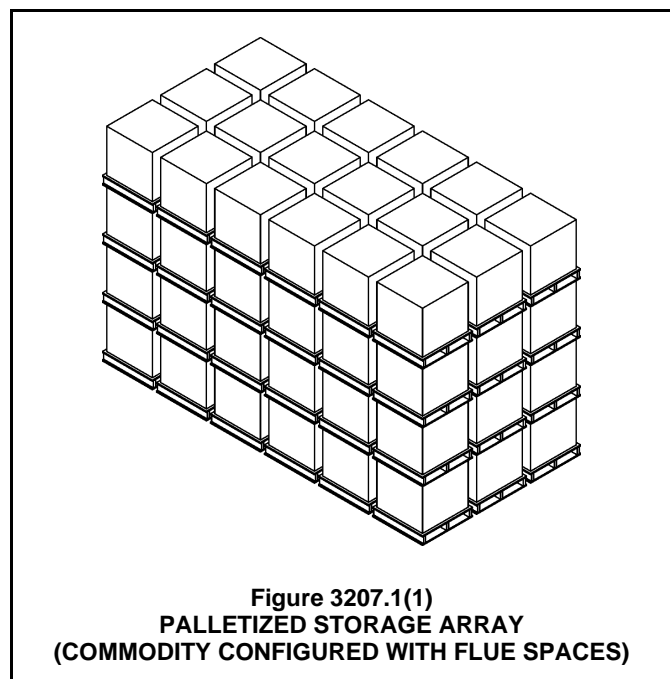
**3206.10 Portable fire extinguishers.** Portable fire extinguishers shall be provided in accordance with Section 906.

- ❖ Portable fire extinguishers provide the building occupants with an opportunity to suppress a fire in its incipient stage. In storage facilities, the fire extinguisher can contribute to the protection of occupants when there are evacuation difficulties or a specific hazard within that occupancy. For portable extinguishers to be effective, personnel must be properly trained in their use and maintenance (see Sections 3201.3 and 3201.4). Section 906 provides criteria for the location, installation, inspection and testing and maintenance of portable fire extinguishers. Section 906 also contains criteria for cabinets in which portable fire extinguishers may be stored, as well as the designated locations for wheeled portable fire extinguishers.

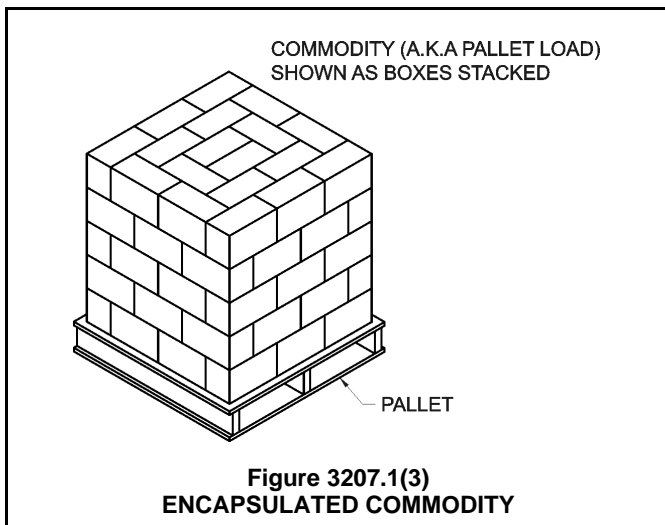
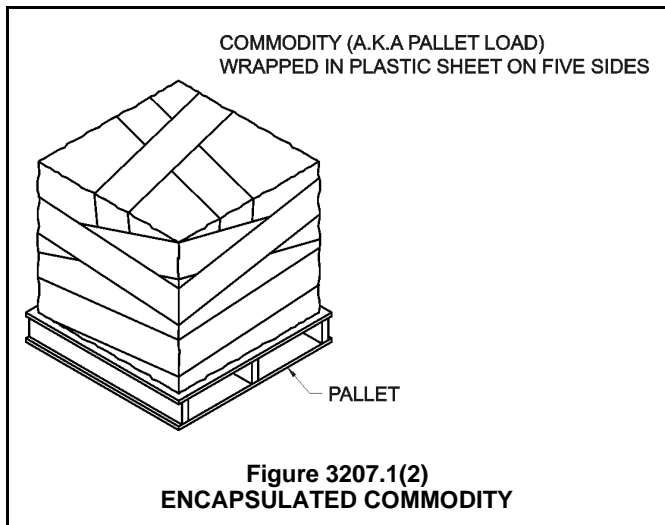
## SECTION 3207 SOLID-PILED AND SHELF STORAGE

**3207.1 General.** Shelf storage and storage in solid piles, solid piles on pallets and bin box storage in bin boxes not exceeding 5 feet (1524 mm) in any dimension, shall be in accordance with Sections 3206 and this section.

- ❖ Solid piling in piles or on pallets generally consists of commodities in cartons, boxes, bales or bags [see Commentary Figure 3207.1(1)] or which may be encapsulated in a plastic wrap for containment [see Commentary Figures 3207.1(2) and 3207.1(3)]. These commodities are usually stacked manually or with lift trucks. Palletized storage consists of commodities set onto pallets that are generally made of



wood or plastic, are square in shape and measure 3 to 4 feet (914 to 1219 mm) on each side. In this case, the cavity portion of the pallet is designed to accept the fork prongs of the lifting device for the commodity and pallet to be transported. The height limitations for stacking palletized storage are directly proportional to stackability of the commodity. Heights of palletized storage can reach 30 feet (9144 mm) in some cases.



**3207.2 Fire protection.** Where automatic sprinklers are required by Table 3206.2, an *approved automatic sprinkler system* shall be installed throughout the building or to 1-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code*. Openings in such *fire barriers* shall be protected by opening protectives having a 1-hour *fire protection rating*. The design and installation of the *automatic sprinkler system* and other applicable fire protection shall be in accordance with the *International Building Code* and NFPA 13.

❖ The provision for approved automatic sprinklers is based on the commodity class and the size of the storage area. Automatic sprinkler protection, when required, is to be provided throughout the area con-

taining the storage. For example, in a mixed-use occupancy, the area designated for storage would require an automatic sprinkler protection system throughout the storage area up to the fire barrier(s), whereas the other areas of the mixed-use occupancy may or may not require automatic sprinkler protection.

NFPA 13 is referenced for sprinkler protection and contains extensive requirements for high-piled storage, including the provisions that were originally found in NFPA 231 (NFPA 231C for rack storage). The development of these provisions was based on a number of large-scale fire tests conducted to determine the advantages and limitations of automatic sprinklers in various storage array configurations; however, test information was not available for all configurations. As a result, some of the protection criteria are based on extrapolation of the test information.

The automatic sprinkler system is expected to remain in operation as the fire fighters are attempting to control and extinguish the fire. As a result, design considerations for water supply must ensure that the water supply is not compromised by other operations. In no case should manual fire-fighting operations be substituted for automatic sprinklers. The sprinkler protection is to extend throughout the building containing the rack storage or to a fire barrier. The fire barrier is to comply with the provisions of IBC Section 707, which applies to fire barriers used for separating fire areas. To maintain integrity of fire area separations, fire barriers must be continuous from the top of the floor below to the underside of the roof slab or deck above and be securely attached thereto.

As with any fire-resistive barriers, consideration must be given to openings and penetrations. The number and size of openings in the fire barrier must comply with the provisions of IBC Section 707, and the opening protective assemblies must have a minimum fire-resistance rating of 1 hour. Note that IBC Section 716.5 allows an opening protection rating of  $\frac{3}{4}$  hour for nonexit-enclosure fire barriers; however, this section, with its specific requirement of a 1-hour rating, would supersede that requirement. Penetrations of fire barriers must comply with IBC Section 714. Maintenance of the fire-resistance-rated construction rests with the building owner or the tenant as described in Section 703.

**3207.2.1 Shelf storage.** Shelf storage greater than 12 feet (3658 mm) but less than 15 feet (4572 mm) in height shall be in accordance with the fire protection requirements set forth in NFPA 13. Shelf storage 15 feet (4572 mm) or more in height shall be protected in an *approved* manner with special fire protection, such as in-rack sprinklers.

❖ Storage on shelving presents a unique problem because it shields the fire from the sprinklers. This shielding can both delay activation of the sprinklers and make it difficult for the water to reach the fire. This section recognizes the provisions of NFPA 13 that apply to the height range in question because

## HIGH-PILED COMBUSTIBLE STORAGE

those provisions were developed based on full-scale tests of both unencapsulated and encapsulated products up to the 15-foot (4572 mm) height. Those provisions are found within NFPA 13 with the solid-piled and palletized storage requirements. As a result, the provisions related to solid shelving within the rack storage requirements of NFPA 13 should be used when addressing shelf storage of commodities above that height.

**3207.3 Pile dimension and height limitations.** Pile dimensions, the maximum permissible storage height and pile volume shall be in accordance with Table 3206.2.

❖ The commodity class and the size of the storage area directly regulate pile dimensions and height limitations. In Table 3206.2, these limitations include:

- Maximum pile dimension.
- Maximum permissible storage height.
- Maximum pile volume.

NFPA 13 only limits the pile height as it relates to the ceiling height and associated sprinkler requirements. The code takes it a step further and puts limits on the pile sizes. Specific aisle requirements are made in Section 3206.9, which the standard does not provide. The pile dimensions presented in Table 3206.2 are the same within each category of commodity class for the various high-piled storage area sizes except for height and volume limitations for the nonpublic accessible Option 2, which is not required to be sprinklered.

**3207.4 Array.** Where an *automatic sprinkler system* design utilizes protection based on a closed array, array clearances shall be provided and maintained as specified by the standard used.

❖ The closed array is defined in NFPA 13 as “a storage arrangement where air movement through a pile is restricted due to vertical flues 6 inches in width or narrower.” Since most protection requirements are based on full-scale testing using a specific method of storage (closed versus open array) the specific configuration must be maintained for the sprinkler system to be effective in controlling and suppressing a fire. A closed array does not let the water penetrate, but also does not allow the fire to grow as rapidly.

## SECTION 3208 RACK STORAGE

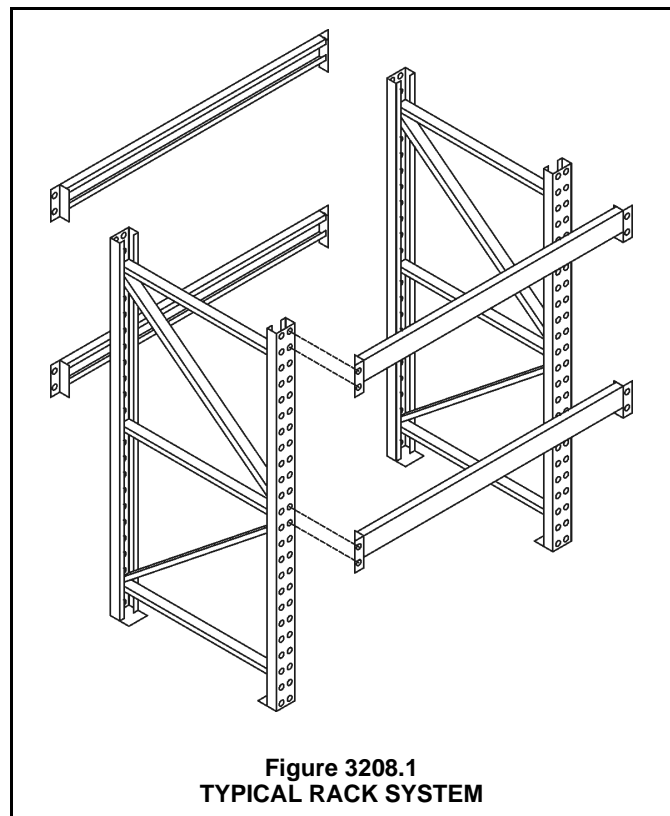
**3208.1 General.** Rack storage shall be in accordance with Section 3206 and this section. Bin boxes exceeding 5 feet (1524 mm) in any dimension shall be regulated as rack storage.

❖ Storage racks are commonly steel frames (see Commentary Figure 3208.1) able to store commodities in various configurations. There are numerous variations of rack storage, such as single-row, double-row and multiple-row racks. The rack structure may or may not be connected to the building superstructure,

which is governed by Chapters 16 and 22 of the IBC. The commodity is generally set on pallets for easy and economical transport using lift trucks or automated materials handling systems (automatic/unmanned). Manual rack storage operations require reasonably wide aisles to accommodate the lift trucks, whereas automated systems can operate in much narrower aisles.

**3208.2 Fire protection.** Where automatic sprinklers are required by Table 3206.2, an *approved automatic sprinkler system* shall be installed throughout the building or to 1-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code*. Openings in such *fire barriers* shall be protected by opening protectives having a 1-hour *fire protection rating*. The design and installation of the *automatic sprinkler system* and other applicable fire protection shall be in accordance with Section 903.3.1.1 and the *International Building Code*.

❖ The provision for approved automatic sprinklers is based on the commodity class and the size of the storage area. The automatic sprinkler protection, when required, is to be installed throughout the area containing the storage. For example, in a mixed-use occupancy, the area designated for storage would require an automatic sprinkler protection system throughout up to the fire barrier(s), whereas the other areas may or may not require automatic sprinkler protection. It should be noted that 15 feet (4572 mm) beyond the high-piled storage area a different type of sprinkler system can be used. It may be necessary to provide draft curtains to divide the two types of sys-



**Figure 3208.1  
TYPICAL RACK SYSTEM**

tems. An example is dividing an ESFR sprinkler system from a standard sprinkler system.

When the rack storage generally exceeds 25 feet (7620 mm) in height, in-rack automatic sprinkler systems should be incorporated into the design because ceiling sprinklers alone may not be able to provide protection for those commodities in the lower levels of the rack storage. There are some configurations involving systems such as ESFR sprinklers that would not require in-rack sprinklers. It depends on many factors and must be determined when applying NFPA 13. Factors include such things as whether the storage is single-, double- or multiple-row, storage height, ceiling height, type of sprinkler, flue spaces and other factors. In addition, the protection of the columns of a building by that same sprinkler may be necessary to satisfy the provisions of Section 3208.4 (see NFPA 13). NFPA 13 contains the protection requirements for rack storage. The provisions were incorporated into NFPA 13 from NFPA 231C, which was originally developed based on a number of large-scale fire tests conducted to determine the advantages and limitations of automatic sprinklers in various storage array configurations. However, test information was not available for all configurations. As a result, some of the protection criteria are based on extrapolation of the test information.

The automatic sprinkler system is expected to remain in operation as the fire fighters attempt to control and extinguish the fire. As a result, design considerations for water supply must ensure that the water supply is not compromised by other operations. In no case should manual fire-fighting operations be substituted for automatic sprinklers. The sprinkler protection is to extend throughout the building containing the rack storage or to a fire barrier. The fire barrier is to comply with the provisions of IBC Section 707, which applies to fire barriers used for separating fire areas. To maintain integrity of the separation of fire areas, fire barriers must be continuous from the top of the floor below to the underside of the roof slab or deck above and be securely attached thereto. As with any fire-resistance-rated barriers, consideration must be given to openings and penetrations. The number and size of openings in the fire barrier must comply with the provisions of IBC Section 707, and the opening protective assemblies must have a minimum fire-resistance rating of 1 hour. Note that IBC Section 716.5 allows an opening protection rating of  $\frac{3}{4}$  hour for nonexit-enclosure fire barriers; however, this section, with its specific requirement of a 1-hour rating, would supersede that requirement. Penetrations of fire barriers must comply with IBC Section 714. Maintenance of the fire-resistance-rated construction rests with the building owner or the tenant as described in Section 703.

**3208.2.1 Plastic shelves.** Storage on plastic shelves shall be protected by *approved* specially engineered *fire protection systems*.

❖ Plastic shelving, when used, increases the fuel load to the commodity that is being stored on top of the pallet or shelving. Specific requirements are not provided, but the code requires that special protection be provided as approved by the fire code official.

**3208.2.2 Racks with solid shelving.** Racks with solid shelving having an area greater than 20 square feet (1.9 m<sup>2</sup>), measured between *approved* flue spaces at all four edges of the shelf, shall be in accordance with this section.

**Exceptions:**

1. Racks with mesh, grated, slatted or similar shelves having uniform openings not more than 6 inches (152 mm) apart, comprising not less than 50 percent of the overall shelf area, and with *approved* flue spaces are allowed to be treated as racks without solid shelves.
  2. Racks used for the storage of combustible paper records, with solid shelving, shall be in accordance with NFPA 13.
- ❖ Racks with solid shelving provide a challenge to the fire protection system design (see Commentary Figure 3208.2.2). Ceiling-only automatic sprinkler protection will not provide sufficient suppression and protection of the neighboring commodities or the building. Additional sprinkler protection will be necessary to control and potentially suppress a fire. In this case, in-rack sprinklers have demonstrated that they can supplement the ceiling sprinklers for acceptable protection overall by reducing the fire's ability to develop a high rate of heat release. Designs for in-rack protection must consider necessary clearances, distance from structural components, flue space clearances and protection of the heads to allow the sprinklers to function properly.

In addition to Exception 1, NFPA 13 has provisions that allow slatted shelves to be considered equivalent to racks without solid shelves when certain criteria have been met. These criteria relate to restrictions on commodities (e.g., not allowing exposed expanded Group A plastics), certain types of sprinklers, minimum aisle widths, certain sprinkler configurations, flue spaces and other considerations (see NFPA 13).

**3208.2.2.1 Fire protection.** Fire protection for racks with solid shelving shall be in accordance with NFPA 13.

❖ The provisions of NFPA 13 stipulate the minimum requirements for the design and construction of an automatic fire suppression system within a building containing rack storage with solid shelving. Rack storage with solid shelving requires the installation of an in-rack automatic fire suppression system. Since

## HIGH-PILED COMBUSTIBLE STORAGE

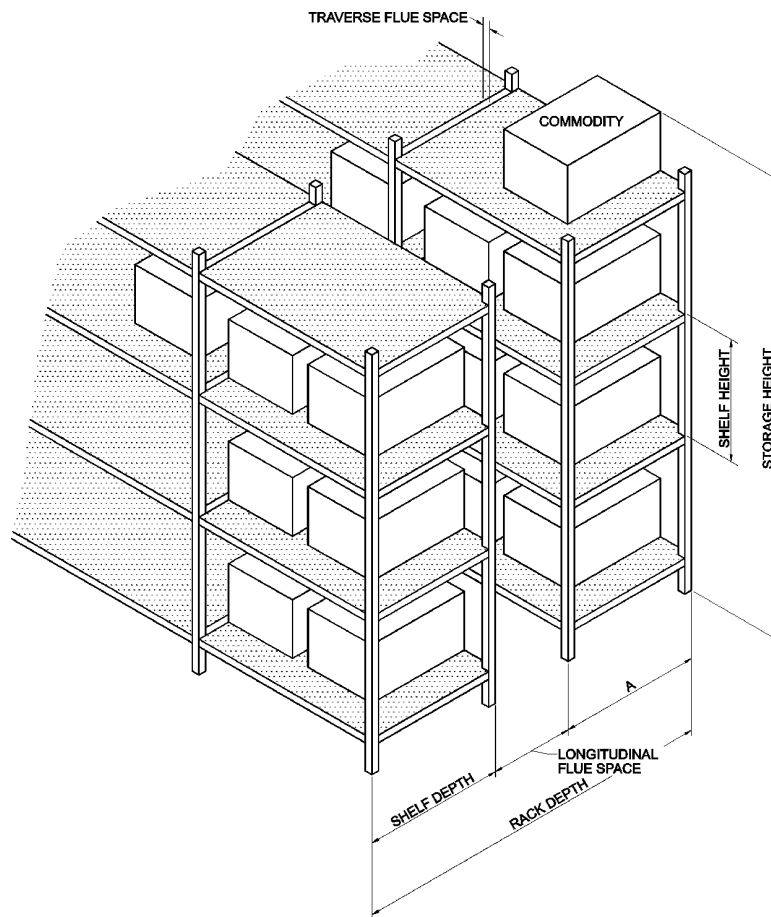
most rack storage systems are permanent, they can support the piping for the in-rack system. The in-rack fire suppression system provides an additional layer of protection that ceiling-only systems could not provide because the shelving prevents the water discharge from entering the individually shelved commodities. The in-rack sprinklers can contain the fire to a small area of the rack structure and wet the commodities adjacent to the fire, thus preventing the fire from spreading to other commodities located horizontally and vertically from the commodities involved in the fire. Important design considerations are the location and protection of supply lines from commodity storage and handling operations, protection of individual sprinkler heads and the separation of water supply to the in-rack fire suppression system from other systems, such as the ceiling-mounted fire suppression system.

**3208.3 Flue spaces.** Flue spaces shall be provided in accordance with Table 3208.3. Required flue spaces shall be maintained.

❖ This section refers to the requirements in Table 3208.3 for minimum longitudinal and transverse flue

dimensions and design for the automatic fire suppression system, in association with Table 3206.2. In high-piled combustible storage racks, flue spaces are an important component of the fire protection design. NFPA 13 categorizes flue spaces as either being longitudinal or transverse. Longitudinal flue spaces extend the length of the storage rack while transverse flue spaces extend the depth of the rack. Flue spaces permit water discharged from a ceiling sprinkler to penetrate into the rack system so it can begin to either control or suppress the fire, depending on the automatic sprinkler system design. When the sprinkler system is designed to control the fire, flue spaces allow the additional sprinkler discharge to prewet the storage commodities, which slows vertical and horizontal fire spread within the rack, thus limiting the number of sprinklers that may operate. Note that when in-rack sprinklers are provided or if the building is not sprinklered, flue spaces are not required.

Flue spaces in storage racks containing Class I through IV commodities greater than 12 feet (3658 mm) in height, high-hazard commodities greater than 6 feet (1829 mm) in height or bin box storage greater



**Figure 3208.2.2**  
**DOUBLE-ROW RACKS WITH SOLID SHELVES**

than 5 feet (1524 mm) in height must comply with all of the provisions in this section, which require longitudinal and transverse spaces to be maintained in accordance with Table 3208.3. Its requirements are dependent on the high-piled combustible storage area being unprotected or protected by an automatic sprinkler system, the height of rack storage, the type of storage rack system, and if partial or complete in-rack automatic sprinkler protection is provided. See Commentary Figures 3208.3(1-3) for the various flue space options based upon fire protection provided and storage height. Commentary Figure 3208.3(4) shows vertical alignment of flue spaces as required for storage over 25 feet in Table 3208.3.

Note that where proper maintenance of the flue spaces becomes a problem, Section 3208.3.1 may be applied by the fire code official. See also the commentary for the definitions of “Transverse” and “Longitudinal flue spaces” in Chapter 2.

**3208.3.1 Flue space protection.** Where required by the *fire code official*, flue spaces required by Table 3208.3, in single-, double- or multiple-row rack storage installations shall be equipped with *approved* devices to protect the required flue spaces. Such devices shall not be removed or modified.

❖ This section authorizes the fire code official to require installation of approved devices to maintain required flue spaces in storage rack systems. It is not the intent of this authority to require such devices in each instance, but rather when a business has an established history of poor flue space maintenance.

Available flue space protection devices that are designed to maintain transverse and longitudinal flue

spaces include but are not limited to brackets, cables or other elements that are securely fastened to the load-bearing columns of the rack system. The devices control the depth or width to which a product, pallet or similar material can be stored in the rack system, thereby preventing obstruction of the required flue space. However, device selection should consider if the rack tiers are designed for mechanized material handling equipment, such as forklifts, versus racks where hand picking is the preferred method of material handling, such as archive storage. Devices available for hand-picking operations may lack the mechanical strength to withstand the impact loads that can arise during movements of palletized unit loads.

Once approved devices are installed, most business owner confusion regarding flue space requirements is removed. Other benefits include: property loss reduction through quick activation of the fire protection system; improved penetration of sprinkler discharge through the rack system to the seat of the fire; faster activation of smoke and heat vent systems; and improved employee, public and fire fighter safety. See Commentary Figure 3208.3.1 for an example of flue space protection device.

**3208.4 Column protection.** Steel building columns shall be protected in accordance with NFPA 13.

❖ NFPA 13 provides steel-column protection criteria in areas used for the rack storage of Class I through IV commodities in Section 16.1.4, for rack storage of plastic and rubber products in Section 17.1.4 and for rack storage of rubber tires in Section 18.2.

**TABLE 3208.3  
REQUIRED FLUE SPACES FOR RACK STORAGE**

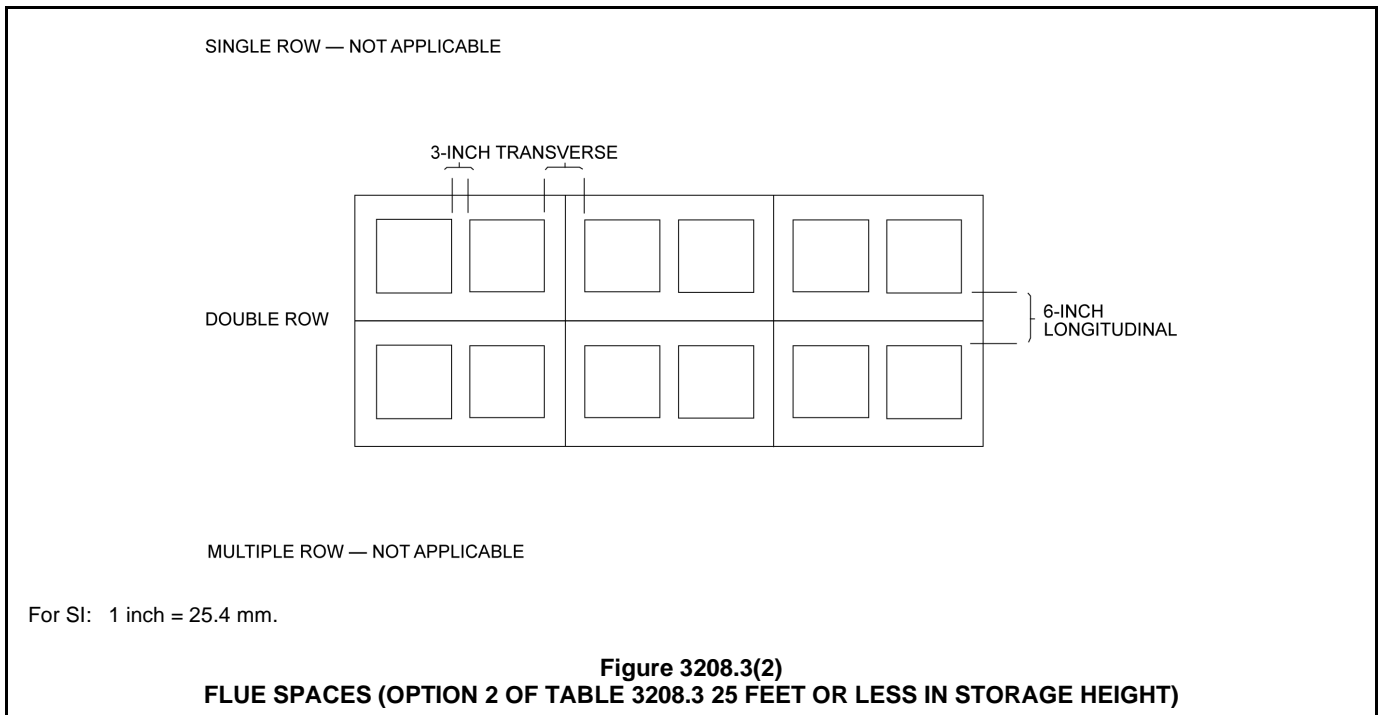
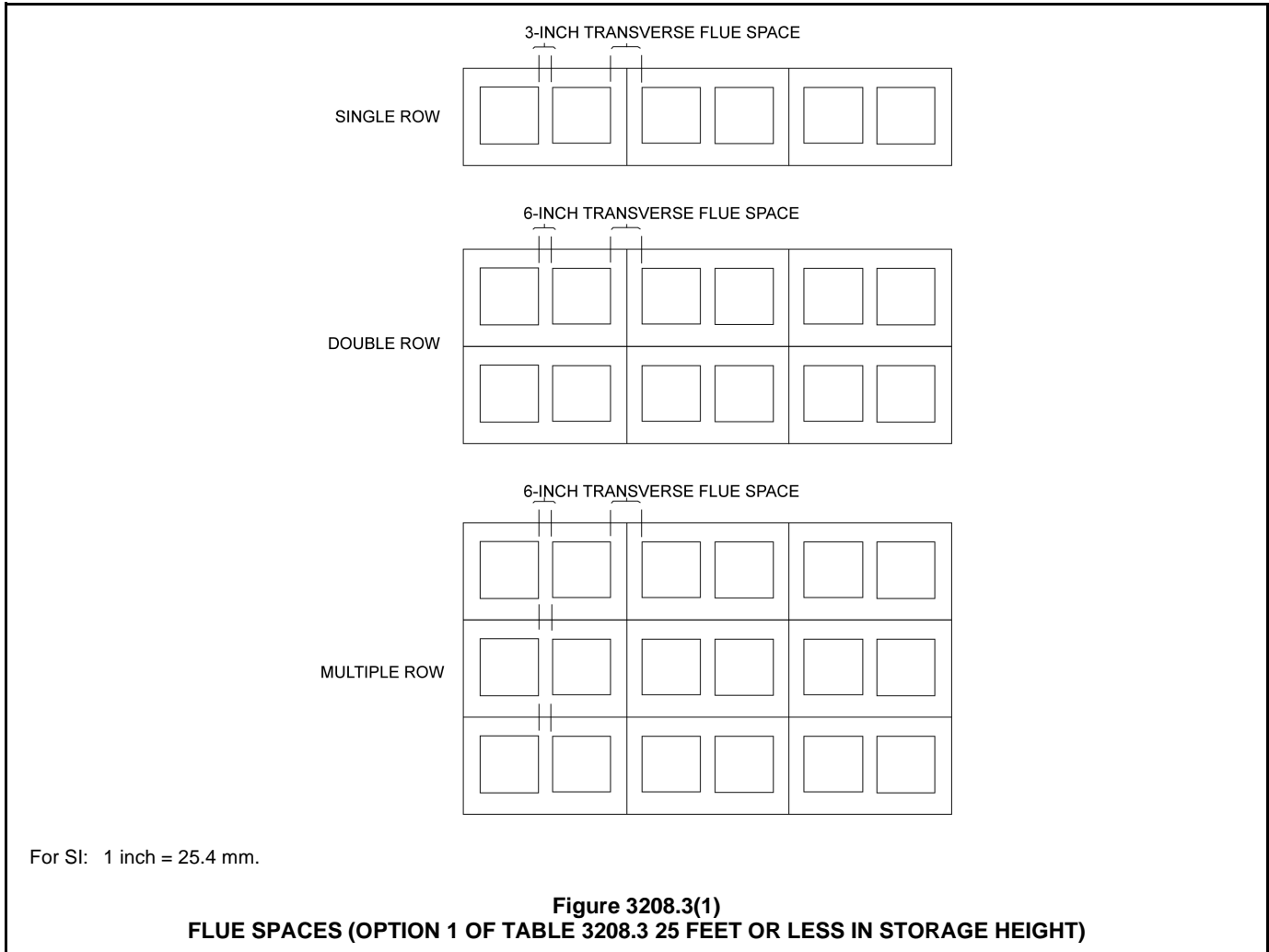
RACK CONFIGURATION	AUTOMATIC SPRINKLER PROTECTION		SPRINKLER AT THE CEILING WITH OR WITHOUT MINIMUM IN-RACK SPRINKLERS			IN-RACK SPRINKLERS AT EVERY TIER	NONSPRINKLERED
			≤ 25 feet		> 25 feet		
			Option 1	Option 2			
Single-row rack	Transverse flue space	Size <sup>b</sup>	3 inches	Not Applicable	3 inches	Not Required	Not Required
		Vertically aligned	Not Required	Not Applicable	Yes	Not Applicable	Not Required
	Longitudinal flue space		Not Required	Not Applicable	Not Required	Not Required	Not Required
Double-row rack	Transverse flue space	Size <sup>b</sup>	6 inches <sup>a</sup>	3 inches	3 inches	Not Required	Not Required
		Vertically aligned	Not Required	Not Required	Yes	Not Applicable	Not Required
	Longitudinal flue space		Not Required	6 inches	6 inches	Not Required	Not Required
Multirow rack	Transverse flue space	Size <sup>b</sup>	6 inches	Not Applicable	6 inches	Not Required	Not Required
		Vertically aligned	Not Required	Not Applicable	Yes	Not Applicable	Not Required
	Longitudinal flue space		Not Required	Not Applicable	Not Required	Not Required	Not Required

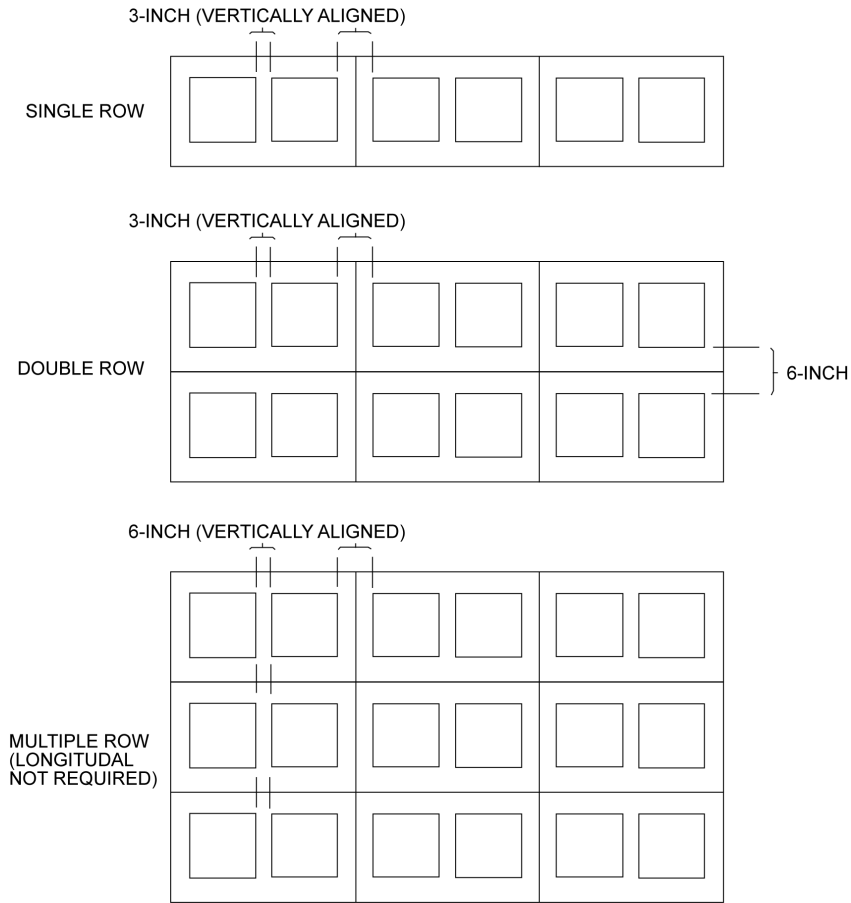
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Three-inch transverse flue spaces shall be provided not less than every 10 feet where ESFR sprinkler protection is provided.

b. Random variations are allowed, provided that the configuration does not obstruct water penetration.

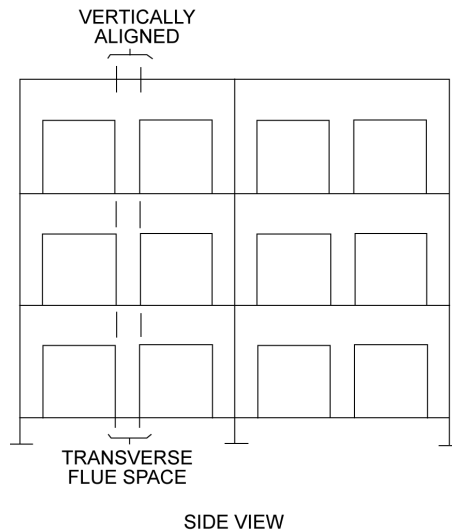
**HIGH-PILED COMBUSTIBLE STORAGE**





For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**Figure 3208.3(3)  
FLUE SPACES GREATER THAN 25 FEET IN STORAGE HEIGHT**



**Figure 3208.3(4)  
VERTICAL ALIGNMENT OF FLUE SPACES**

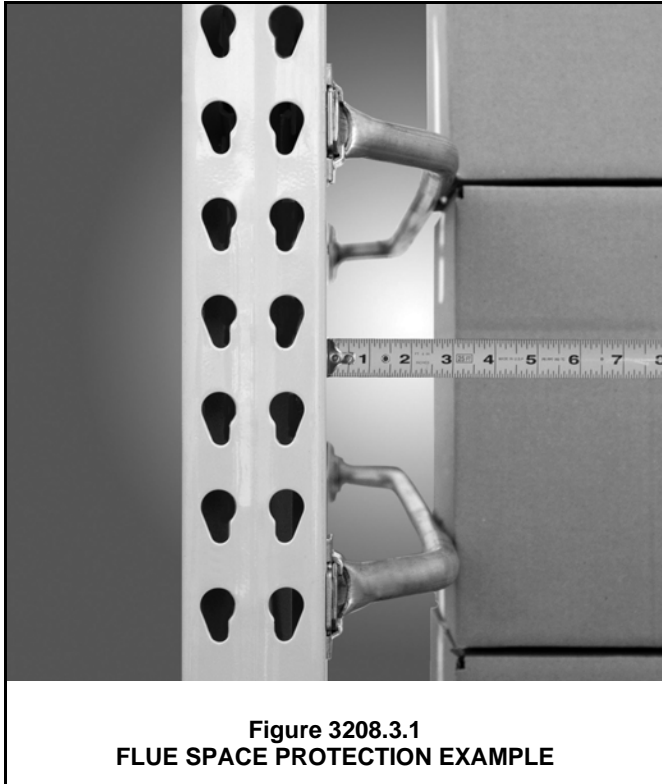


Figure 3208.3.1  
FLUE SPACE PROTECTION EXAMPLE

**3208.5 Extra-high-rack storage systems.** Approval of the *fire code official* shall be obtained prior to installing extra-high-rack combustible storage.

❖ In addition to the permit requirements contained in Section 105, the building owner, tenant or lessee is required to seek permission from the fire code official to construct an extra-high-rack storage system because of the higher challenge fire that such storage presents (see the commentary to Section 202 for the definition of “Extra-high-rack combustible storage”).

**3208.5.1 Fire protection.** Buildings with extra-high-rack combustible storage shall be protected with a specially engineered *automatic sprinkler system*. Extra-high-rack combustible storage shall be provided with additional special fire protection, such as separation from other buildings and additional built-in fire protection features and fire department access, where required by the *fire code official*.

❖ Extra-high-rack storage is considered to have additional risks that warrant the requirement for an automatic sprinkler system engineered with additional protection features. These features could include additional heads along the vertical axis, change in the type of sprinkler heads and the use of high-expansion foam systems. To further protect the building and neighboring buildings, the fire code official may require that additional fire protection measures be taken to increase the likelihood that, if a fire does occur, it will be contained to that building. These measures can include greater building separation requirements than required in Table 602 of the IBC, enhanced fire apparatus access, additional fire

hydrants and building openings. All additional fire protection and life safety systems require the approval of the fire code official.

## SECTION 3209 AUTOMATED STORAGE

**3209.1 General.** Automated storage shall be in accordance with this section.

❖ Automated storage is generally designed for operations in which the commodity storage necessary to serve the operation is large and where that facility may operate 24 hours a day, seven days a week. This type of storage is generally programmed for commodity stocking and retrieving, and contains a sufficient amount of commodity for the operation to continue working even if restocking may experience a slow period. Operations that commonly employ such facilities are automotive parts manufacturers, electronic parts manufacturers and even the food industry. One of the primary fire concerns with automated storage is the potential for the fire to be carried by the mechanism that transports the commodity. If such a fire were to occur while the commodity is in motion, it could reduce, if not overwhelm, the effectiveness of the automatic fire suppression system. As a result, additional measures are required in an attempt to compensate for that potential fire hazard.

**3209.2 Automatic sprinklers.** Where automatic sprinklers are required by Table 3206.2, the building shall be equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1.

❖ The provisions requiring an automatic sprinkler system throughout the building housing the automatic storage system is an additional fire protection feature based on the concept that the area may be difficult for the fire service to suppress a fire manually. The reference to the provisions of Chapter 9 covers generally all types of sprinkler systems beyond those specific to high-piled storage. Not all areas would need a sprinkler system that is designed to protect high-piled storage commodities.

**3209.3 Carousel storage.** *High-piled storage areas* having greater than 500 square feet (46 m<sup>2</sup>) of carousel storage shall be provided with automatic shutdown in accordance with one of the following:

1. An automatic smoke detection system installed in accordance with Section 907, with coverage extending 15 feet (4575 mm) in all directions beyond unenclosed carousel storage systems and that sounds a local alarm at the operator’s station and stops the carousel storage system upon the activation of a single detector.
2. An automatic smoke detection system installed in accordance with Section 907 and within enclosed carousel storage systems, that sounds a local alarm at the operator’s station and stops the carousel storage system upon the activation of a single detector.

3. A single dead-man-type control switch that allows the operation of the carousel storage system only when the operator is present. The switch shall be in the same room as the carousel storage system and located to provide for observation of the carousel system.

❖ Carousel storage is used in large storage operations when the commodity must be protected (security), when the commodity requires strict environmental control or both. In addition, carousel storage is selected because it may provide an economic advantage to an operation or business by having the commodity come directly to the employee rather than the employee stocking and retrieving the commodity. The carousel area is normally not occupied. An exception to this may be when the carousel system is undergoing maintenance or repair or during an annual inspection of the fire protection features. Examples of commodities within carousel storage may include distribution centers that distribute pharmaceutical or refrigerated/frozen foods and beverages. The additional fire safety requirements are precautionary, directly resulting from the limited access to these types of storage areas and addressing the potential of a moving fire via the carousel mechanism. Because the area of the carousel is controlled by a mechanized, generally computer-controlled system, immediate access to the actual storage area is normally limited. These limits serve to protect both personnel and the commodity. The additional fire safety measures include provisions for an elaborate automatic detection system, which upon activation stops the carousel from operating (moving). This precaution prevents the fire from spreading throughout the entire storage area.

**3209.4 Automated rack storage.** *High-piled storage areas* with automated rack storage shall be provided with a manually activated emergency shutdown switch for use by emergency personnel. The switch shall be clearly identified and shall be in a location *approved* by the fire chief.

❖ This section requires that if an emergency occurs in an automated rack storage facility, the remotely controlled pallet moving equipment be manually shut down. This shutdown accomplishes two objectives. First, the potential to either move additional product into the fire or move burning product through the storage area is removed. Second, it is not safe to place emergency personnel within the automated storage area when the system is still active. Many of these automated devices move much faster than personnel can get out of the way, and there is a physical danger to personnel. This shutdown will eliminate danger to personnel and reduce property damage. Since the shutdown of such systems is a tactical maneuver, the fire chief is required to approve the location for the switch and ensure that it is properly identified. The switch should be in a readily accessible location outside of the boundaries of the automated rack storage area. See also the commentary to Section 202 for the definition of “Automated rack storage.”

## SECTION 3210 SPECIALTY STORAGE

**3210.1 General.** Records storage facilities used for the rack or shelf storage of combustible paper records greater than 12 feet (3658 mm) in height shall be in accordance with Sections 3206 and 3208 and NFPA 13. Palletized storage of records shall be in accordance with Section 3207.

❖ The storage of various types of records can have a relatively high intrinsic value. This is where protection of the actual documents is essential to any business to retrieve information or to reconstruct records. The provisions of this section specifically identify the fire and life safety requirements for records stored on pallets and in-rack or shelf storage systems. Although the provisions of this section set the minimum safeguards from the hazards of fire and explosion, it is up to the owners of the records to determine the actual protection that must be provided. NFPA 13, as with other high-piled storage, is the minimum referenced standard. NFPA 13 specifically deals with carton record storage in Section 20.5 and high-bay record storage in Section 20.7.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

*2012 International Code Interpretations.* Washington, DC: International Code Council, 2011.

*High-piled Combustible Storage Application Guide, 2009 IFC.* Washington, DC: International Code Council, 2011.



# Chapter 33: Fire Safety During Construction and Demolition

## General Comments

This chapter outlines general fire safety precautions for all structures and all occupancies during construction and demolition operations. In general, these requirements seek to maintain required fire protection, limit fire spread, establish the appropriate operation of equipment and promote prompt response to fire emergencies.

There are 17 sections in Chapter 33. Section 3301 gives the general scope of the chapter and provides the basis for enforcement of its provisions. Section 3302 defines terms specifically relevant to the chapter. The listing, arrangement, fueling and supervision of temporary heating equipment is described in Section 3303. Section 3304 deals with precautions against fire that involve the control of smoking, waste disposal, open burning, spontaneous ignition and temporary electrical wiring. The storage, handling and classification of flammable and combustible liquids, flammable gases and explosive materials are addressed in Sections 3305, 3306 and 3307, respectively.

Sections 3308 and 3309 regulate the need for prefire planning, training and maintenance of fire protection systems and emergency notification means. Access for fire fighting is discussed in Section 3310. Escape by on-site personnel is covered under means of egress in Section 3311. The provision and maintenance of specific fire protection devices such as standpipes, automatic sprinkler systems and portable fire extinguishers is explained in Sections 3313, 3314 and 3315, respectively. The need to regulate heat sources, such as internal combustion engines and fuel-fired asphalt and tar kettles, is addressed in Sections 3316 and 3317.

## Purpose

This chapter contains requirements that are intended to safeguard people from injury or illness and protect property from damage during the construction or demolition processes.

## SECTION 3301 GENERAL

**3301.1 Scope.** This chapter shall apply to structures in the course of construction, *alteration* or demolition, including those in underground locations. Compliance with NFPA 241 is required for items not specifically addressed herein.

❖ Buildings are most vulnerable to fire when undergoing construction, demolition or alteration. Special measures are required to either minimize the potential for a fire or aid in fire control and suppression. These requirements amplify those of other sections of the code and prescribe maintenance of adequate means of egress and on-site incipient fire-fighting equipment. Temporary heating appliances are regulated to prevent ignition of combustible debris and structural elements. Fire apparatus access and maintenance of standpipes are also addressed [see also Chapter 33 of the *International Building Code*® (IBC®), NFPA 241 and the *NFPA Fire Protection Handbook*]. Note that, in accordance with Section 102.7.2 of the code, where both Chapter 33 of the code and NFPA 241 regulate a topic, the provisions of the code take precedence.

**3301.2 Purpose.** This chapter prescribes minimum safeguards for construction, *alteration* and demolition operations to provide reasonable safety to life and property from fire during such operations.

❖ This chapter is intended to regulate access by the responding fire department, fire protection systems, operations and maintenance of structures for precautions against fire and spread of fire during construction and demolition.

## SECTION 3302 DEFINITIONS

**3302.1 Terms defined in Chapter 2.** Words and terms used in this chapter and defined in Chapter 2 shall have the meanings ascribed to them as defined therein.

❖ This section directs the code user to Chapter 2 for the proper application of the terms used in this chapter. These terms may be defined in Chapter 2 or in another *International Code*® (I-Code®) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentaries, Sections 201.1 through 201.4).

**SECTION 3303  
TEMPORARY HEATING EQUIPMENT**

**3303.1 Listed.** Temporary heating devices shall be *listed* and *labeled* in accordance with the *International Mechanical Code* or the *International Fuel Gas Code*. Installation, maintenance and use of temporary heating devices shall be in accordance with the terms of the listing.

❖ Listing and labeling are used to identify materials, assemblies and devices that are required to bear the identification of the manufacturer, as well as a third-party quality-control agency. The quality-control agency allows the use of its listing or label based on periodic audits and inspections of the manufacturer's facility. Not all testing laboratories, inspection agencies and other organizations concerned with product or program evaluation use the same means for identifying listed equipment, materials or agencies. Some do not recognize equipment or materials as listed unless they are also labeled. The fire code official must use the same system as the listing organization to identify listed equipment, materials or agencies.

**3303.2 Oil-fired heaters.** Oil-fired heaters shall comply with Section 603.

❖ The regulations for the devices that are likely to be used for temporary heat are delineated in Section 603.

**3303.3 LP-gas heaters.** Fuel supplies for liquefied-petroleum gas-fired heaters shall comply with Chapter 61 and the *International Fuel Gas Code*.

❖ Because propane gas is heavier than air, special attention must be given to the way the fuel tank is arranged and connected to the heating device. Tank location and protection are just two of the concerns addressed in the *International Fuel Gas Code*® (IFGC®).

**3303.4 Refueling.** Refueling operations for liquid-fueled equipment or appliances shall be conducted in accordance with Section 5705. The equipment or appliance shall be allowed to cool prior to refueling.

❖ This section addresses the refueling of liquid-fueled equipment, but Section 5705 addresses proper liquid transfer, container filling operations, filling locations, quantity limits and more. Because hot surfaces can cause ignition of flammable vapors and spills, the appliance must be allowed to cool before refueling.

**3303.5 Installation.** Clearance to combustibles from temporary heating devices shall be maintained in accordance with the *labeled* equipment. When in operation, temporary heating devices shall be fixed in place and protected from damage, dislodgement or overturning in accordance with the manufacturer's instructions.

❖ Because conditions change during construction or demolition, temporary heating devices must be monitored and maintained. Materials are constantly being moved, which may reduce the clearances to the device. It may be advantageous for the owner to hire

a fire watch to check operating conditions while work is in progress and at the end of work shifts. The fire code official may need to decide what is required.

**3303.6 Supervision.** The use of temporary heating devices shall be supervised and maintained only by competent personnel.

❖ Temporary installations must be as safe as permanent ones. Having qualified people do these installations is important.

**SECTION 3304  
PRECAUTIONS AGAINST FIRE**

**3304.1 Smoking.** Smoking shall be prohibited except in *approved* areas. Signs shall be posted in accordance with Section 310. In *approved* areas where smoking is permitted, *approved* ashtrays shall be provided in accordance with Section 310.

❖ This smoking prohibition is out of concern for fire safety, not health or the environment. Every effort must be made to keep hot smoking materials from igniting building materials or debris. Smoking in occupancies subject to ignition hazards from smoking materials should be approved by the fire code official, confined to spaces without significant amounts of combustibles and where approved ash trays or receptacles are provided. Signage indicating "smoking permitted in this area" will encourage the use of the limited area. "No Smoking" signs similar to Commentary Figure 3304.1 may be used.



**3304.2 Combustible debris, rubbish and waste.** Combustible debris, rubbish and waste material shall comply with the requirements of Sections 3304.2.1 through 3304.2.4.

❖ As a basic fire safety measure, work site housekeeping is often overlooked. This section introduces an orderly progression of procedures for managing the accumulation of combustible rubbish on construction and demolition sites. The subsections were formerly contained in a single paragraph but have been placed in separate sections to emphasize their importance in fire safety planning.

**3304.2.1 Combustible waste material accumulation.** Combustible debris, rubbish and waste material shall not be accumulated within buildings.

❖ Construction jobs must be kept reasonably free of accumulations of combustible waste inside of buildings undergoing construction or demolition where any number of ignition sources may exist.

**3304.2.2 Combustible waste material removal.** Combustible debris, rubbish and waste material shall be removed from buildings at the end of each shift of work.

❖ To help mitigate the hazards of accumulating combustible rubbish inside of buildings, this section requires that such materials be removed to outside of the building at the end of each work shift.

**3304.2.3 Rubbish containers.** Where rubbish containers with a capacity exceeding 5.33 cubic feet (40 gallons) (0.15 m<sup>3</sup>) are used for temporary storage of combustible debris, rubbish and waste material, they shall have tight-fitting or self-closing lids. Such rubbish containers shall be constructed entirely of materials that comply with either of the following:

1. Noncombustible materials.
2. Materials that meet a peak rate of heat release not exceeding 300 kW/m<sup>2</sup> when tested in accordance with ASTM E1354 at an incident heat flux of 50 kW/m<sup>2</sup> in the horizontal orientation.

❖ Large rubbish containers must be provided for temporary storage of combustible construction or demolition rubbish. The specific container size is consistent with the size criteria in Section 304.3 and the fire safety requirements are consistent with those for large rubbish containers found throughout the code. The use of containers with tight-fitting or self-closing lids provides a method to reduce the possibility that a fire can be started in the container by accident and prevent continued burning if ignition does occur. Such containers need not be constructed of metal but can be constructed of other noncombustible materials, including materials that have been shown to be safe by meeting a very severe fire test, similar to those required by Section 808 for Group I-1, I-2 and I-3 occupancies and Section 304.3.4 for general rubbish control. A key requirement is that the lids must be tight-fitting or self-closing. Note that this does not address materials susceptible to spontaneous ignition, such as oily rags, that are covered by Section 3304.2.4. The use of the phrase “combustible debris,

rubbish and waste” makes this section consistent with other sections of the code.

**3304.2.4 Spontaneous ignition.** Materials susceptible to spontaneous ignition, such as oily rags, shall be stored in a listed disposal container.

❖ Spontaneous ignition, also known as autoignition or self-ignition, is defined by Burklin and Purington as “ignition due to chemical reaction or bacterial action in which there is slow oxidation of organic compounds until the material ignites; usually there is sufficient air for oxidation but insufficient ventilation to carry heat away as it is generated.” A detailed treatment of the subject appears in the *NFPA Fire Protection Handbook*. The One Meridian Plaza office building fire in 1991 was allegedly started by spontaneous ignition of oil-soaked rags that were improperly stored during a remodeling operation. This high-rise building in the heart of Philadelphia was so seriously damaged in the fire that it was razed in 1999. A listed container for the storage of the oily rags was not used. The fire code official should determine the kinds of oils or solvents used and research their potential for spontaneous ignition (see commentary, Section 304.3.1).

**3304.3 Burning of combustible debris, rubbish and waste.** Combustible debris, rubbish and waste material shall not be disposed of by burning on the site unless approved.

❖ Combustible rubbish and construction waste must not be burned, unless local environmental and fire authorities are consulted on local open burning regulations.

**3304.4 Open burning.** *Open burning* shall comply with Section 307.

❖ Section 307 requires that a permit be obtained for open burning. Other areas of concern are burning location and monitoring. The owner should make documentation of the event available to the fire code official.

**3304.5 Fire watch.** Where required by the *fire code official* for building demolition, or building construction during working hours that is hazardous in nature, qualified personnel shall be provided to serve as an on-site fire watch. Fire watch personnel shall be provided with not less than one approved means for notification of the fire department and their sole duty shall be to perform constant patrols and watch for the occurrence of fire.

❖ Hazardous demolition or construction operations may need the services of qualified emergency response personnel, such as hazmat technicians or fire fighters, to stand by or actually patrol the area, especially when hazardous construction operations are being conducted in an occupied building. When such persons are needed, it is essential that they focus on that task only and have no other assignments. A lay person should not be used; it is within the authority of the fire code official to require that professionals be on site. It is critical that such watch personnel be able to contact the fire department immediately in case of an

emergency through a reliable means of communication approved by the fire code official. See the commentary to Sections 403.12.1 through and 403.12.1.2 for additional information on fire watch personnel and their duties.

**3304.6 Cutting and welding.** Operations involving the use of cutting and welding shall be done in accordance with Chapter 35.

❖ Cutting and welding operations account for 9 percent of fires in industrial operations. With accumulations of combustible materials that are common during construction and demolition, additional precautions must be taken. One of the most effective ways to prevent or promptly respond to fires caused by cutting and welding is to have a vigorous “hot work” permit system. Chapter 35 presents these precautions.

**3304.7 Electrical.** Temporary wiring for electrical power and lighting installations used in connection with the construction, *alteration* or demolition of buildings, structures, equipment or similar activities shall comply with NFPA 70.

❖ Temporary wiring used during construction is, by its very nature, of a lesser class or quality than that which would be installed as permanent building wiring and must, therefore, be monitored for damage, unfinished work or exposed connections. Demolition operations may leave exposed live wiring, so coordination between the on-site electrician and the power company is important. Section 590 of NFPA 70 contains requirements for temporary wiring in buildings, including provisions for overcurrent protection, lamp protection, wiring quality and installation, disconnects and time limitations, to name but a few (see also commentary, Section 605).

## SECTION 3305

### FLAMMABLE AND COMBUSTIBLE LIQUIDS

**3305.1 Storage of flammable and combustible liquids.** Storage of flammable and *combustible liquids* shall be in accordance with Section 5704.

❖ Storage and use of flammable and combustible liquids require the approval of the fire code official for the control of hazards and to provide the fire department with vital hazard data for preplanning for incidents involving such materials. A permit is required for storage. See Section 105.6.17 and the accompanying commentary for more information on permit requirements.

**3305.2 Class I and Class II liquids.** The storage, use and handling of flammable and *combustible liquids* at construction sites shall be in accordance with Section 5706.2. Ventilation shall be provided for operations involving the application of materials containing flammable solvents.

❖ Sections 5706.2 through 5706.2.8.1 contain comprehensive regulations on the proper storage, use and

handling of Class I and II liquids on construction sites. Areas of particular concern are: signage, storage location, ventilation, sources of ignition and dispensing. Class I liquids are more hazardous than Class II because of their lower flash points [less than 100°F (38°C)] (see commentaries, Sections 5706.2 through 5706.2.8.1).

**3305.3 Housekeeping.** Flammable and combustible liquid storage areas shall be maintained clear of combustible vegetation and waste materials. Such storage areas shall not be used for the storage of combustible materials.

❖ Housekeeping, in this case, concerns ignition sources and added fuel load in the liquid storage area. Easily ignited dry weeds, grass and paper are prohibited in the area. Access to the area by fire fighters can be hampered when combustibles in the storage area ignite.

**3305.4 Precautions against fire.** Sources of ignition and smoking shall be prohibited in flammable and *combustible liquid* storage areas. Signs shall be posted in accordance with Section 310.

❖ Sources of ignition, such as electric arcing, open-flame heating devices and static electricity, must be controlled. Smoking must also be controlled by posting “no smoking” signs, providing safe smoking areas and promoting on-the-job awareness of the smoking prohibition as stipulated in Section 310.

**3305.5 Handling at point of final use.** Class I and II liquids shall be kept in *approved* safety containers.

❖ This section mandates that only approved safety cans (as defined in Section 202) of not more than a 5-gallon (19 L) capacity with a spring-loaded, self-closing lid and spout covers, designed to safely relieve internal pressure under fire conditions, be used for the storage of Class I and II liquids at construction and demolition sites.

The key to the proper storage and handling of flammable and combustible liquids is to keep liquids and vapors away from ignition sources. Restrictions on flammable liquid container sizes, separation distances and active and passive fire protection are based on the extent of the hazard presented should an uncontrolled release occur.

**3305.6 Leakage and spills.** Leaking vessels shall be immediately repaired or taken out of service and spills shall be cleaned up and disposed of properly.

❖ Accidental liquid spills create a vapor release that can quickly travel from the spill point to an ignition source. Because spills need immediate attention to neutralize and remove the hazard, the local fire department should be notified; it is the agency best prepared to deal with the immediate hazards of a spill.

Leaks can indicate a developing problem with equipment or piping needing immediate repair. Until repairs are made, the equipment or piping must be

taken out of service. If the leak or spill is expected to spread beyond the property lines or contaminate water or air, environmental authorities should also be notified.

### SECTION 3306 FLAMMABLE GASES

**3306.1 Storage and handling.** The storage, use and handling of flammable gases shall comply with Chapter 58.

❖ Chapter 58 deals with quantity limits for indoor storage, storage containers, ignition sources and limits for the outdoor storage of flammable gases. Also refer to Chapter 53 for general requirements for compressed gases.

**3306.2 Cleaning with flammable gas.** Flammable gases shall not be used to clean or remove debris from piping open to the atmosphere.

❖ In the past several years, two explosions that killed a combined 10 people were attributed to workers using natural gas flowing at high velocities to clean/clear fuel gas piping during the commissioning of fuel gas piping at industrial plants. The flammable gas and debris from the piping were vented to the atmosphere and ignited by sparks, one of which was suspected to be caused by static electricity. For details on the incidents see the U.S. Chemical Safety Board report at: <http://www.csb.gov/assets/1/19/KleenUrgentRec.pdf>.

The dangerous practice of using flammable gases to clean or remove debris from fuel piping that is open to the atmosphere is prohibited by this section.

**3306.2.1 Pipe cleaning and purging.** The cleaning and purging of flammable gas piping systems, including cleaning new or existing piping systems, purging piping systems into service and purging piping systems out of service, shall comply with NFPA 56.

#### Exceptions:

1. Compressed gas piping systems other than fuel gas piping systems where in accordance with Chapter 53.
  2. Piping systems regulated by the *International Fuel Gas Code*.
  3. Liquefied petroleum gas systems in accordance with Chapter 61.
- ❖ The intent of this section is to address the fire and explosion hazards associated with the purging of flammable gas piping typically found in electric generating plants and in industrial, institutional, and commercial applications. NFPA 56 provides minimum safety requirements for the cleaning and purging of flammable gas piping systems, including cleaning new or existing piping systems, purging piping systems into service, and purging piping systems out of service. It includes the appropriate managerial and

operational requirements necessary to foster safe outcomes. NFPA 56 compliments this section and also does not allow flammable gases to be used for internal cleaning of piping open to the atmosphere.

As indicated by the exceptions, it is not the intent of this section to cover cleaning or purging of the three listed systems.

### SECTION 3307 EXPLOSIVE MATERIALS

**3307.1 Storage and handling.** *Explosive* materials shall be stored, used and handled in accordance with Chapter 56.

❖ Chapter 56 prescribes minimum requirements for the safe storage, handling and use of explosives, ammunition and blasting agents for commercial and industrial occupancies. Its provisions are intended to protect the general public, emergency responders and individuals who handle explosives in connection with construction or demolition operations.

**3307.2 Supervision.** Blasting operations shall be conducted in accordance with Chapter 56.

❖ Specific requirements dealing with local physical and governmental controls, blasting area security and post-blast procedures are found in Section 5607.

Security precautions for explosive materials must conform to the requirements of this chapter and the referenced standards. Any discrepancy that suggests the loss or theft of explosives must be reported to local law enforcement authorities and the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) within 24 hours of discovery (see DOTy 27 CFR, Part 55.30). The ATF hotline may be contacted 24 hours a day at (800) 800-3855. Abandoned explosives, including those not claimed by the consignee within 48 hours of their arrival at a terminal, should be returned to the control of the last licensee (manufacturer or distributor) to possess them before they were abandoned. Local law enforcement authorities and the ATF should be contacted if this is not possible.

**3307.3 Demolition using explosives.** *Approved* fire hoses for use by demolition personnel shall be maintained at the demolition site whenever *explosives* are used for demolition. Such fire hoses shall be connected to an *approved* water supply and shall be capable of being brought to bear on post-*detonation* fires anywhere on the site of the demolition operation.

❖ The code text does not stipulate the number, size or length of hoses needed; therefore, the involvement of the fire code official is essential to anticipate an incident. The competence of the demolition crew to properly use the hose for fire fighting is not addressed, which suggests that fire brigade training may be in order. Periodic inspections by the fire code official are imperative. As is the case throughout the code, fire protection methods and procedures must be acceptable to the fire code official.

## SECTION 3308 OWNER'S RESPONSIBILITY FOR FIRE PROTECTION

**3308.1 Program superintendent.** The *owner* shall designate a person to be the fire prevention program superintendent who shall be responsible for the fire prevention program and ensure that it is carried out through completion of the project. The fire prevention program superintendent shall have the authority to enforce the provisions of this chapter and other provisions as necessary to secure the intent of this chapter. Where guard service is provided, the superintendent shall be responsible for the guard service.

- ❖ Each project must have a fire prevention program superintendent who is in charge of all fire safety efforts, such as prefire planning, on-the-job training of personnel, guard service and the other areas covered in Sections 3308.1 through 3308.7. This person acts on behalf of the fire code official and can enforce the provisions of Chapter 33.

**3308.2 Prefire plans.** The fire prevention program superintendent shall develop and maintain an *approved* prefire plan in cooperation with the fire chief. The fire chief and the *fire code official* shall be notified of changes affecting the utilization of information contained in such prefire plans.

- ❖ Prefire plans are developed by the fire prevention program superintendent to assist the site personnel responding to a fire. This plan must be coordinated with the local fire chief and the fire code official. Changes in building operations or equipment that could affect the fire department's ground attack of a fire must be reported to the fire department responder immediately. For example, if an additional 1,000-gallon (3785 L) propane tank is located alongside an existing tank, the responder needs to know about this situation.

**3308.3 Training.** Training of responsible personnel in the use of fire protection equipment shall be the responsibility of the fire prevention program superintendent.

- ❖ The fire responder is expected to know what fire-fighting and fire protection equipment is on the site and how to operate it. The fire prevention program superintendent is responsible for training the job-site personnel in the proper use of hand-held fire extinguishers, hose lines, fire alarms and sprinkler systems.

**3308.4 Fire protection devices.** The fire prevention program superintendent shall determine that all fire protection equipment is maintained and serviced in accordance with this code. The quantity and type of fire protection equipment shall be *approved*.

- ❖ Fire protection and detection equipment must be maintained during construction and demolition. The fire prevention program superintendent must decide what is necessary to enforce maintenance as required by the code. Approval of the equipment and its maintenance is not, however, transferred to the

fire prevention program superintendent, but remains with the fire code official.

**3308.5 Hot work operations.** The fire prevention program superintendent shall be responsible for supervising the permit system for hot work operations in accordance with Chapter 35.

- ❖ This issue is also discussed in the commentary to Section 3304.6. Chapter 35 contains an in-depth treatment of hot work, especially Section 3503.3, which deals with hot work permits. The fire prevention program superintendent issues the permits to coordinate a response if a fire should occur in the known hot work permit area.

**3308.6 Impairment of fire protection systems.** Impairments to any *fire protection system* shall be in accordance with Section 901.

- ❖ Section 901.7 specifically deals with systems out of service because of planned, emergency or accidental impairment. During demolition, portions of the equipment must be kept in service as long as possible. Likewise, equipment on a construction site must keep pace with the new work and be kept in service as much as possible, especially at the end of the work day.

**3308.7 Temporary covering of fire protection devices.** Coverings placed on or over fire protection devices to protect them from damage during construction processes shall be immediately removed upon the completion of the construction processes in the room or area in which the devices are installed.

- ❖ Fire protection devices must be kept in service as much as possible during construction. An example would be that paper or plastic bags must be removed from the sprinkler heads as soon as the painting of the sprinkler piping or the adjacent ceiling is completed. Additional information can be obtained from standards, such as NFPA 13 and NFPA 72.

## SECTION 3309 FIRE REPORTING

**3309.1 Emergency telephone.** Readily accessible emergency telephone facilities shall be provided in an *approved* location at the construction site. The street address of the construction site and the emergency telephone number of the fire department shall be posted adjacent to the telephone.

- ❖ The construction site must have an emergency phone located in an approved location. Workers on the site are not expected to know the street address of the site or the fire department emergency number if it is a number other than 9-1-1. Therefore, the site address and fire department emergency number must be prominently posted. Typical customized signs are available from safety equipment suppliers or sign companies.

### SECTION 3310 ACCESS FOR FIRE FIGHTING

**3310.1 Required access.** *Approved* vehicle access for fire fighting shall be provided to all construction or demolition sites. Vehicle access shall be provided to within 100 feet (30 480 mm) of temporary or permanent fire department connections. Vehicle access shall be provided by either temporary or permanent roads, capable of supporting vehicle loading under all weather conditions. Vehicle access shall be maintained until permanent fire apparatus access roads are available.

❖ Fire-fighting vehicle access is the means by which fire fighters gain access to the construction or demolition site and building for fire suppression and rescue operations until the permanent fire apparatus access roads are constructed. Such access is an integral component of the fire prevention program. The site superintendent or other person responsible for construction and demolition operations is responsible for maintaining and policing fire-fighter access routes, as provided in Section 3308. Fire apparatus must be able to get within 100 feet (30 480 mm) of any installed fire department connection supplying water to temporary or permanent fire protection systems. Access roads must support the weight of the heaviest vehicle that might respond. The weight requirements are available from the local fire department. All-weather surfaces are required because the responding fire department should not waste time moving snow or trying to get out of mud (see also commentary, Section 503).

**3310.2 Key boxes.** Key boxes shall be provided as required by Chapter 5.

❖ As construction nears completion, some areas may not be accessible to the fire department without the use of a key. In those cases, the fire code official may require a key box as stipulated in Section 506.

### SECTION 3311 MEANS OF EGRESS

**[B] 3311.1 Stairways required.** Where a building has been constructed to a *building height* of 50 feet (15 240 mm) or four stories, or where an existing building exceeding 50 feet (15 240 mm) in *building height* is altered, not less than one temporary lighted *stairway* shall be provided unless one or more of the permanent *stairways* are erected as the construction progresses.

❖ Work crews will necessarily be in, and the fire department will need access to, buildings under construction or demolition at the same time that the means-of-egress elements are being built or destroyed. This situation requires diligence on the part of the fire code official and the construction managers to make sure a means of escape for workers and access for emergency forces is available at all times, and that construction of occupiable areas does not unnecessarily extend beyond the construction of the means of egress. By the time the building is substantially

enclosed, all required means of egress should be fully constructed and functional. For a building under construction, these precautions are triggered when the building exceeds 50 feet (15 240 mm) in height or four stories. Any temporary stairways must be lighted.

Similarly, the destruction of the means of egress should not precede the demolition of areas occupied by workers.

**3311.2 Maintenance.** Required *means of egress* shall be maintained during construction and demolition, remodeling or *alterations* and additions to any building.

**Exception:** *Approved* temporary *means of egress* systems and facilities.

❖ As in any building where people must egress, the required means of egress must be kept clear of construction materials and demolition debris so occupants can exit in an emergency.

Temporary means of egress may be provided when the permanent egress system cannot be maintained in accordance with this section.

### SECTION 3312 WATER SUPPLY FOR FIRE PROTECTION

**3312.1 When required.** An *approved* water supply for fire protection, either temporary or permanent, shall be made available as soon as combustible material arrives on the site.

❖ A water supply must be connected to the wet standpipe, and underground water supply and hydrants must be available for the dry standpipes as soon as combustible materials are on the job site. As previously stated in this commentary, the unfinished building is most vulnerable to fire and must be protected as much as possible.

### SECTION 3313 STANDPIPES

**3313.1 Where required.** In buildings required to have standpipes by Section 905.3.1, not less than one standpipe shall be provided for use during construction. Such standpipes shall be installed prior to construction exceeding 40 feet (12 192 mm) in height above the lowest level of fire department vehicle access. Such standpipe shall be provided with fire department hose connections at accessible locations adjacent to usable stairways. Such standpipes shall be extended as construction progresses to within one floor of the highest point of construction having secured decking or flooring.

❖ This section requires the installation of standpipes during construction for any building required by Chapter 9 and the IBC to be equipped with a standpipe system. The requirement for standpipe and hose connections is triggered when construction progresses to a height of not more than 40 feet (12 192 mm) above the lowest level of fire department access. While hoses need not be provided, the hose connection must be located adjacent to a stairway.

Although thread requirements are not stated here, the hose threads must be compatible with those of the responding fire department as required by Section 905.1. Standpipe hose connections must be ready for use on each floor before the installation of the floor deck on the story or level above in order to provide fire fighters with a means of bringing hose lines to bear on a fire on the highest floor level having access.

**3313.2 Buildings being demolished.** Where a building is being demolished and a standpipe is existing within such a building, such standpipe shall be maintained in an operable condition so as to be available for use by the fire department. Such standpipe shall be demolished with the building but shall not be demolished more than one floor below the floor being demolished.

❖ When a structure is being demolished and a standpipe system exists within that structure, the standpipe system must be operable and be available for use by the fire department. When a structure or a floor is to be demolished, its standpipe system must also be demolished with the structure; however, the system may not be demolished more than one floor below the floor being demolished.

The abundance of avenues for vertical fire spread make buildings undergoing partial or total demolition highly susceptible to damage from fire. Even more so than construction sites, demolition projects attract vandals and vagrants who may set fires on the property for warmth or criminal purposes. Further, cutting equipment and portable heating appliances may easily ignite combustible debris created during demolition. Once started, fire will spread rapidly through voids and vertical openings created to remove building service equipment. Standpipes provide fire fighters with a means of deploying hose lines quickly against these rapidly spreading fires.

**3313.3 Detailed requirements.** Standpipes shall be installed in accordance with the provisions of Section 905.

**Exception:** Standpipes shall be either temporary or permanent in nature, and with or without a water supply, provided that such standpipes comply with the requirements of Section 905 as to capacity, outlets and materials.

❖ Section 905 deals with installation; maintenance and supervision; building height and area; special occupancy application and type as related to standpipe systems in buildings under construction (see commentary, Section 905).

Temporary standpipes, whether dry or wet, are subject to the same requirements of Section 905 as permanent standpipes.

### SECTION 3314 AUTOMATIC SPRINKLER SYSTEM

**3314.1 Completion before occupancy.** In buildings where an *automatic sprinkler system* is required by this code or the *International Building Code*, it shall be unlawful to occupy

any portion of a building or structure until the *automatic sprinkler system* installation has been tested and *approved*, except as provided in Section 105.3.4.

❖ Section 105.3.4 is very clear in that when the sprinkler system is not tested and approved, the building cannot be occupied by the owner or tenants. In other words “no protection; no people” as one fire code official has put it. This is especially important in a building that has been given construction alternatives (i.e., increased travel distances, increased height and area, or reduced fire-resistance ratings) based on the installation of a sprinkler system, because the building is not safe for people when the system is not functional. Since the issuance of a Certificate of Occupancy is regulated by Section 111.1 of the IBC, the administration of this section should be coordinated with the building official.

**3314.2 Operation of valves.** Operation of sprinkler control valves shall be allowed only by properly authorized personnel and shall be accompanied by notification of duly designated parties. Where the sprinkler protection is being regularly turned off and on to facilitate connection of newly completed segments, the sprinkler control valves shall be checked at the end of each work period to ascertain that protection is in service.

❖ Closed control valves at the time of a fire are a major cause of sprinkler system failure. Only properly trained personnel should be operating these valves under the supervision of the fire prevention program superintendent, if available. The systems must be kept in service as much as possible and especially overnight or at the time of shift changes. If a fire watch is employed, duties should include monitoring these valves. The fire department must be notified when the system is out of service for an extended period of time because it responds to a sprinklered building differently than it does to an unsprinklered building.

### SECTION 3315 PORTABLE FIRE EXTINGUISHERS

**3315.1 Where required.** Structures under construction, *alteration* or demolition shall be provided with not less than one *approved* portable fire extinguisher in accordance with Section 906 and sized for not less than ordinary hazard as follows:

1. At each *stairway* on all floor levels where combustible materials have accumulated.
2. In every storage and construction shed.
3. Additional portable fire extinguishers shall be provided where special hazards exist including, but not limited to, the storage and use of flammable and *combustible liquids*.

❖ Portable extinguishers must be rated for the hazards protected. Section 906 and NFPA 10, the applicable standard for portable fire extinguishers, contain infor-

mation on fire extinguisher ratings. Other circumstances under which the fire code official may require additional extinguishers include workers using: open-flame devices; flammable or combustible liquids; welding or cutting equipment; or painting equipment for applying flammable or combustible finishes during both construction and demolition.

### SECTION 3316 MOTORIZED CONSTRUCTION EQUIPMENT

**3316.1 Conditions of use.** Internal-combustion-powered construction equipment shall be used in accordance with all of the following conditions:

1. Equipment shall be located so that exhausts do not discharge against combustible material.
  2. Exhausts shall be piped to the outside of the building.
  3. Equipment shall not be refueled while in operation.
  4. Fuel for equipment shall be stored in an *approved* area outside of the building.
- ❖ Motorized equipment, particularly equipment powered by an internal combustion engine, must be kept clear of combustibles, must have exhaust arranged so as not to create an environmental hazard, must not be fueled while hot and have fuel stored properly. These issues are similarly addressed in Sections 3303, 3304 and 3305.

### SECTION 3317 SAFEGUARDING ROOFING OPERATIONS

**3317.1 General.** Roofing operations utilizing heat-producing systems or other ignition sources shall be conducted in accordance with Sections 3317.2 and 3317.3 and Chapter 35.

- ❖ Although licensed and bonded contractors are often required for roofing operations by state or local laws or ordinances, the jurisdiction must establish who is authorized to conduct such activities. In addition to the requirements of Section 3317, the applicable hot work requirements of Chapter 35 also apply to certain roofing operations. Since the definition of “Hot work” in Section 202 specifically includes the installation of torch-applied roofing systems, permits for roofing operations utilizing such heat-producing systems that are ignition sources are required by Section 105.6.24. Additional permits for the use of combustible liquids and compressed gas may be also appropriate. Roofing permits are typically required by the IBC, as well.

**3317.2 Asphalt and tar kettles.** Asphalt and tar kettles shall be operated in accordance with Section 303.

- ❖ Section 303 regulates transportation, location, fueling, supervision, construction and fire protection of asphalt and tar kettles (see commentary, Section 303).

**3317.3 Fire extinguishers for roofing operations.** Fire extinguishers shall comply with Section 906. There shall be not less than one multipurpose portable fire extinguisher with a minimum 3-A 40-B:C rating on the roof being covered or repaired.

- ❖ Section 906 generally covers the location and requirements of portable fire extinguishers with a particular reference to asphalt kettles in Table 906.1. Section 303 also has requirements for extinguishers on the kettle, in the proximity of the kettle and on the roof. Fire extinguishers are to be fully charged and ready for service. Many construction sites are littered with building materials and debris. The kettle operator is responsible for maintaining an appropriate distance between the hot kettle and combustible materials.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

- Burklin, Ralph W. and Robert G. Purington. *Fire Terms: A Guide to Their Meaning and Use*. Quincy, MA: National Fire Protection Association, 1980.
- Code Changes Resource Collection—2015 International Fire Code*. Washington, DC: International Code Council, 2014.
- NFPA Fire Protection Handbook*. Quincy, MA: National Fire Protection Association, 2008.
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# Chapter 34: Tire Rebuilding and Tire Storage

## General Comments

Each year, over 270 million vehicle tires are disposed of in the United States. Recycling, reuse and energy recovery are having a major impact, but tire storage continues to present an environmental and fire safety hazard. The risk associated with tire fires demonstrates the need to address this problem. This chapter prescribes ways to prevent and control fires in tire rebuilding plants, tire storage and tire byproduct facilities.

Tire fires, although infrequent, are serious situations that are difficult to extinguish, expensive to clean up and often become major hazardous material incidents affecting entire communities, frequently requiring neighborhood evacuations and long, drawn-out fire-extinguishing operations. These fires threaten pollution of the air, soil and water. Federal and state agencies, municipalities and private companies have spent millions of dollars cleaning up tire fires across the country.

Scrap tires are not generally considered a hazardous waste; however, if a tire fire occurs, tires break down into hazardous compounds including gases, heavy metal and oil. The average passenger car tire is estimated to produce over 2 gallons (8 L) of oil when burned, according to the Rubber Manufacturers Association. Oil that exudes into ground and surface water as a result of tire fires is a significant environment pollutant. In some cases, this may trigger Environmental Protection Agency (EPA) Superfund cleanup status. For every million tires consumed by fire, about 55,000 gallons (208 175 L) of runoff oil can pollute the environment unless contained and collected. This oily material is also highly flammable.

Air pollution is also produced by tire fires. Air emissions may include polycyclic aromatic hydrocarbons (PAHs), benzene, styrene, phenols and butadiene. For more information on toxic air pollutants generated by tire fires, go to the U.S. EPA's Toxics Air Pollution website.

Notable tire fires include the following:

1. In 1983, 7 million tires burned in Rhinehart, Virginia, issuing a plume of smoke 3,000 feet (912 m) high and nearly 50 miles (80 km) long with air pollution emissions deposited in three states. The fire burned for nine months, polluting nearby water sources with lead and arsenic. The tire storage facility where the fire occurred is now being cleaned up as a Superfund site.
2. In 1999, a lightning strike ignited a tire fire in Westley, California. The tire dump contained millions of scrap tires located in a canyon in a coastal mountain range. The large smoke plume from the fire impacted nearby farming communities and caused widespread concern of potential health effects from exposure to the smoke emissions. The tire fire also produced large volumes of pyrolytic oil that flowed off the slope and into the drainage of an intermittent stream. This oil was ignited too, and the oil fire significantly increased the smoke emissions close to ground level. A response to the oil and tire fires was beyond the capabilities of local and state agencies. The EPA regional coordinator immediately responded using Oil Pollution Act of 1990 authority. It took 30 days to extinguish the fire. Total EPA response costs were \$3.5 million.

Waste tires are difficult to ignite, but once a tire fire starts, it is generally very hard to control and extinguish. Using water or foam to extinguish a tire fire is often futile. Water is best used to keep adjacent, unburned tires from igniting. Smothering a tire fire with dirt or sand is usually the best option for extinguishing fires. Typically, the sand or dirt is moved with heavy equipment to cover the burning tires. Putting out a tire fire can also be facilitated by removing unburned tires from the pile to lessen the fuel load.

## Purpose

The requirements of Chapter 34 are intended to prevent or control fires and explosions associated with the remanufacture and storage of tires. Additionally, these requirements are intended to minimize the impact of tire storage fires by segregating the various operations and controlling ignition sources. Although the finished product, the tire, is not an unusual hazard, once ignition occurs the fire is extremely difficult to extinguish. Facilities designed and constructed for tire remanufacture are regulated by the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>) to reduce the impact of potential fires on buildings and the environment.

### SECTION 3401 GENERAL

**3401.1 Scope.** Tire rebuilding plants, tire storage and tire byproduct facilities shall comply with this chapter, other applicable requirements of this code and NFPA 13. Tire storage in buildings shall also comply with Chapter 32.

❖ In addition to the provisions of this chapter, NFPA 13 is referenced for sprinkler system design. Annex A of NFPA 13 also contains illustrations of various tire storage arrays. Spray operations using flammable or combustible solvents must also comply with Chapter 24. Sprinkler requirements for the bulk storage of rubber tires (defined in Section 202) may be found in Section 903.2.9.2. See the commentary to the above noted section for further discussion of fire protection for tire storage.

**3401.2 Permit required.** Permits shall be required as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit and Section 105.6.46 for discussion of specific operational permits for tire rebuilding facilities and their operation and maintenance. The process also notifies the fire department of the need for pre-fire planning for the hazardous property.

### SECTION 3402 DEFINITIONS

**3402.1 Terms defined in Chapter 2.** Words and terms used in this chapter and defined in Chapter 2 shall have the meanings ascribed to them as defined therein.

❖ This section directs the code user to Chapter 2 for the proper application of the terms used in this chapter. Such terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (also see commentaries, Sections 201.1 through 201.4).

### SECTION 3403 TIRE REBUILDING

**3403.1 Construction.** Tire rebuilding plants shall comply with the requirements of the *International Building Code*, as to construction, separation from other buildings or other portions of the same building, and protection.

❖ This section requires that construction must comply with the IBC. At a minimum, tire rebuilding plants are

classified in Group F-1 (factory/industrial moderate hazard) in accordance with Section 306.2 of the IBC. Depending on an evaluation of the actual hazards presented by a given operation, which could include grinding, buffing or gluing of tires or tire components, the plant or portions of it might be classified in Group H.

**3403.2 Location.** Buffing operations shall be located in a room separated from the remainder of the building housing the tire rebuilding or tire recapping operations by a 1-hour *fire barrier*.

**Exception:** Buffing operations are not required to be separated where all of the following conditions are met:

1. Buffing operations are equipped with an *approved* continuous automatic water-spray system directed at the point of cutting action.
2. Buffing machines are connected to particle-collecting systems providing a minimum air movement of 1,500 cubic feet per minute (cfm) (0.71 m<sup>3</sup>/s) in volume and 4,500 feet per minute (fpm) (23 m/s) in-line velocity.
3. The collecting system shall discharge the rubber particles to an *approved* outdoor noncombustible or fire-resistant container that is emptied at frequent intervals to prevent overflow.

❖ This section specifies that the buffing operations must be separated from the other operations by a 1-hour fire barrier. The intent is identical to the intent regarding construction: to keep the higher hazard operations separate, thereby reducing the potential for a rapidly spreading fire.

The exception recognizes that meeting the three outlined conditions will afford protection equivalent to the 1-hour fire barrier required by this section.

**3403.3 Cleaning.** The buffing area shall be cleaned at frequent intervals to prevent the accumulation of rubber particles.

❖ This section recognizes the importance of keeping the buffing area clean to reduce the possibility of igniting waste material. A maintenance schedule should be developed for particle removal. Cleaning frequency should be determined by the amount of equipment in operation.

**3403.4 Spray rooms and booths.** Each spray room or spray booth where flammable or combustible solvents are applied, shall comply with Chapter 24.

❖ When flammable or combustible solvents are used, the room or spray booth must comply with the requirements of Chapter 24. This provision is intended to reduce the likelihood of igniting solvents used in this process and to keep the incident within manageable proportions if ignition should occur.

## SECTION 3404 PRECAUTIONS AGAINST FIRE

**3404.1 Open burning.** *Open burning* is prohibited in tire storage yards.

❖ Due to the stubborn nature of tire fires once they are ignited, this section prohibits open burning in tire storage areas where ignition of tires is a hazard.

**3404.2 Sources of heat.** Cutting, welding or heating devices shall not be operated in tire storage yards.

❖ Like the previous section, this section prohibits additional sources of ignition from welding or heating devices.

**3404.3 Smoking prohibited.** Smoking is prohibited in tire storage yards, except in designated areas.

❖ Except in smoking locations designated by the owner and approved by the fire code official, smoking is prohibited in tire storage yards. “No smoking” signs should be posted prominently in the yards and rigorously enforced. See the commentary to Section 310 for further information on smoking regulations.

**3404.4 Power lines.** Tire storage piles shall not be located beneath electrical power lines having a voltage in excess of 750 volts or that supply power to fire emergency systems.

❖ Should a fire occur in a tire storage yard, it could burn for some time before it is extinguished. Because these fires can be quite extensive and burn very hot, this precaution reduces the possibility that large electrical grids or emergency power supplies will be disabled for extended periods.

**3404.5 Fire safety plan.** The *owner* or individual in charge of the tire storage yard shall be required to prepare and submit to the *fire code official* a fire safety plan for review and approval. The fire safety plan shall include provisions for fire department vehicle access. Not less than one copy of the fire safety plan shall be prominently posted and maintained at the storage yard.

❖ This section requires that the owner develop a fire safety plan and submit it to the fire code official for approval. This plan should be as detailed as necessary, depending on the size and layout of the yard. This plan should also be coordinated with fire department pre-incident plans. The plan should include the size and composition of the storage material; layout of access and egress routes; the physical infrastructure of the roads and other possible access routes. Maps should include hydrant and water sources, interior access lanes, fuel load configurations and the location of utilities on the site. The composition of the storage pile should be indicated because shredded scrap or chip piles require a different fire-fighting approach than a pile of whole tires.

**3404.6 Telephone number.** The telephone number of the fire department and location of the nearest telephone shall be posted conspicuously in attended locations.

❖ This section requires posting of the fire department telephone number along with the location of the telephone in conspicuous locations.

## SECTION 3405 OUTDOOR STORAGE

**3405.1 Individual piles.** Tire storage shall be restricted to individual piles not exceeding 5,000 square feet (464.5 m<sup>2</sup>) of continuous area. Piles shall not exceed 50,000 cubic feet (1416 m<sup>3</sup>) in volume or 10 feet (3048 mm) in height.

❖ Whole tires (new, used or awaiting recycling), shredded tires or tire chip piles represent a fuel package of considerable volume and heat potential. To manage this hazard, the code places limitations on pile heights and sizes as a means of controlling the size of potential fires and facilitating fire-fighting operations.

**3405.2 Separation of piles.** Individual tire storage piles shall be separated from other piles by a clear space of not less than 40 feet (12 192 mm).

❖ The intent of this section is to create 40-foot (12 192 mm) clear firebreaks between piles of tire storage in all directions.

**3405.3 Distance between piles of other stored products.** Tire storage piles shall be separated by a clear space of not less than 40 feet (12 192 mm) from piles of other stored product.

❖ This section also requires a 40-foot (12 192 mm) clear firebreak from piles of other materials, not just other tire storage piles.

**3405.4 Distance from lot lines and buildings.** Tire storage piles shall be located not less than 50 feet (15 240 mm) from *lot lines* and buildings.

❖ This section requires increasing the firebreak to 50 feet (15 240 mm) from lot lines and buildings due to the potential exposure to buildings on the same property or on adjacent property.

**3405.5 Fire breaks.** Storage yards shall be maintained free from combustible ground vegetation for a distance of 40 feet (12 192 mm) from the stored material to grass and weeds; and for a distance of 100 feet (30 480 mm) from the stored product to brush and forested areas.

❖ Because dry grass and weeds represent a significant fuel accumulation and fire hazard, this section requires that all combustible vegetation (grasses and weeds) be kept at least 40 feet (12 192 mm) from storage piles. The distance is increased to 100 feet (30 480 mm) when next to brush or forested areas,

not only to protect the brush and forested area from a fire in a storage yard but also to protect the storage yard from a brush or forest fire. For additional information on the protection of such areas, see the *International Wildland-Urban Interface Code*<sup>®</sup> (IWUIC<sup>®</sup>). The clearances required by this section require a vegetation control program to reduce the hazards.

**3405.6 Volume more than 150,000 cubic feet.** Where the bulk volume of stored product is more than 150,000 cubic feet (4248 m<sup>3</sup>), storage arrangement shall be in accordance with the following:

1. Individual storage piles shall comply with size and separation requirements in Sections 3405.1 through 3405.5.
2. Adjacent storage piles shall be considered a group, and the aggregate volume of storage piles in a group shall not exceed 150,000 cubic feet (4248 m<sup>3</sup>).

Separation between groups shall be not less than 75 feet (22 860 mm) wide.

❖ This section correlates with the requirements in Section 3405.1, which allow storage piles up to 50,000 cubic feet (1416 m<sup>3</sup>) in volume. There is really no reason to limit the number of piles but rather to limit the volume of storage. This section limits the group volume to 150,000 cubic feet (4248 m<sup>3</sup>) and clarifies that the piles must still comply with Sections 3405.1 through 3405.5 on pile size and separations. Basically, with the 75-foot (22 860 mm) separation requirement between groups, unlimited amounts of storage would be allowed.

**3405.7 Location of storage.** Outdoor waste tire storage shall not be located under bridges, elevated trestles, elevated roadways or elevated railroads.

❖ This section restricts where waste tire storage may be located. As a result of past fire experiences that created extended disruption in transportation, storage is prohibited under elevated roadways and bridges.

### SECTION 3406 FIRE DEPARTMENT ACCESS

**3406.1 Required access.** New tire storage yards shall be provided with fire apparatus access roads in accordance with Section 503 and Section 3406.2. Existing tire storage yards shall be provided with fire apparatus access roads where required in Chapter 11.

❖ Fire apparatus access roads must be arranged to provide clear, unobstructed access to required yard hydrants, if provided, and all points of the yard storage area. Turn-arounds and turning radii must be sized so that the fire apparatus can maneuver to protect exposures as well as fire fighters. Access roads must also comply with Section 503. Fire department access for existing tire storage yards must comply with Sections 1106.1 through 1106.1.2. Appendix D, where adopted by the jurisdiction, covers design

guidelines for access roads. Note that the appendices are not considered as part of the code unless specifically adopted. See Section 1 of the sample adopting ordinance on page xxi of the code book.

**3406.2 Location.** Fire apparatus access roads shall be located within all pile clearances identified in Section 3405.4 and within all fire breaks required in Section 3405.5. Access roadways shall be within 150 feet (45 720 mm) of any point in the storage yard where storage piles are located, not less than 20 feet (6096 mm) from any storage pile.

❖ In order to provide adequate access for fire suppression operations in tire storage yard fires, fire apparatus access roads must be located within all pile clearances and within all firebreaks. No portion of a pile is to be more than 150 feet (45 720 mm) from an access road and no less than 20 feet (6096 mm) from any storage pile. Maintaining a 20-foot (6096 mm) clearance between storage piles and the edge of the fire apparatus access road reduces the likelihood that the collapse of a pile [limited to 10 feet (3048 mm) in height by Section 3405.1] will totally obstruct access.

### SECTION 3407 FENCING

**3407.1 Where required.** Where the bulk volume of stored material is more than 20,000 cubic feet (566 m<sup>3</sup>), a firmly anchored fence or other *approved* method of security that controls unauthorized access to the storage yard shall surround the storage yard.

❖ Perimeter fences for site security are required to limit access to stored materials and deter theft, vandalism and arson in storage yards where the volume of tire material stored exceeds 20,000 cubic feet (566 m<sup>3</sup>).

**3407.2 Construction.** The fence shall be constructed of *approved* materials and shall be not less than 6 feet (1829 mm) high and provided with gates at least 20 feet (6096 mm) wide.

❖ Owners should be encouraged to construct noncombustible fences. Chain-link fencing is an excellent choice because it can be firmly anchored and requires little maintenance. To accommodate fire apparatus, all gates must be at least 20 feet (6096 mm) wide. Depending on local security concerns, fences may be topped with barbed wire for intruder control to further enhance the level of security provided. Such an installation should be approved by the fire code official and the local administrative authority, since some communities have ordinances or a zoning code that prohibits the use of barbed wire on fences.

**3407.3 Locking.** Gates to the storage yard shall be locked when the storage yard is not staffed.

❖ This section states that access gates to the storage yard are to be locked when not staffed to deter unauthorized entry. Since the yard entrance is considered part of the fire apparatus road network required for

the yard, gates must also comply with the provisions of Section 503.6.

**3407.4 Unobstructed.** Gateways shall be kept clear of obstructions and be fully openable at all times.

- ❖ This section requires that gates be accessible and be fully openable at all times, which will allow full and quick access for fire apparatus.

### SECTION 3408 FIRE PROTECTION

**3408.1 Water supply.** A public or private fire protection water supply shall be provided in accordance with Section 508. The water supply shall be arranged such that any part of the storage yard can be reached by using not more than 500 feet (152 m) of hose.

- ❖ This section requires that a fire protection water supply, in accordance with Section 508, be provided to the storage yard. Open storage yards are often located substantial distances from public fire mains, which may mean that water must be delivered to the scene by fire department tankers. This requirement should be included in both the prefire plan and the facility fire safety plan required by Section 3404.5. Alternative water supplies, such as a stream, lake or other body of water in the vicinity, should be explored.

**3408.2 Fire extinguishers.** Buildings or structures shall be provided with portable fire extinguishers in accordance with Section 906. Fuel-fired vehicles operating in the storage yard shall be equipped with a minimum 2-A:20-B:C-rated portable fire extinguisher.

- ❖ This section and Section 906 require that fire extinguishers be available. Portable fire extinguishers are provided for incipient fire control. These appliances should be located where they are readily available. They are also required on fuel-fired vehicles operating in the yard.

### SECTION 3409 INDOOR STORAGE ARRANGEMENT

**3409.1 Pile dimensions.** Where tires are stored on-tread, the dimension of the pile in the direction of the wheel hole shall be not more than 50 feet (15 240 mm). Tires stored adjacent to or along one wall shall not extend more than 25 feet (7620 mm) from that wall. Other piles shall be not more than 50 feet (15 240 mm) in width.

- ❖ This section places further restrictions on tire storage to maintain fire-fighting access to the stored tires in case of a fire. When the tires are stored on their tread, storage piled against a wall (i.e., closed on one end) must not extend more than 25 feet (7620 mm) from the wall. Where the on-tread piles are open on both ends, the length of the pile must not exceed 50 feet (15 240 mm), measured in the direction of the wheel hole. These limitations enhance hose stream

access to the interior of the pile. Piles of any other configuration cannot exceed 50 feet in any dimension. Annex A to Chapter 3 of NFPA 13 includes example illustrations of tire storage arrays.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

FM Global Property Loss Prevention Data Sheet 8-7, *Rubber Tire Storage*. Johnson, RI: Factory Mutual Global Research, 2009.

*Prevention and Management of Scrap Tire Fires*. Washington, DC: Rubber Manufacturers Association.



# Chapter 35: Welding and Other Hot Work

## General Comments

Welding and other hot work are frequent ignition sources. Statistics from a major property insurance company for a recent 5-year period showed 290 hot-work-related ignitions that led to losses of \$407 million, or an average of \$1.4 million per incident. Of these 290 losses, 42 percent were caused by employees and 58 percent were caused by outside contractors. To compare the magnitude of these losses, this same insurance company saw 395 fires associated with housekeeping and 262 losses associated with smoking. The average poor housekeeping loss was \$902,000; the average smoking loss was about \$440,000.

Both hot work operations themselves and the equipment and materials associated with such work can create significant ignition and fire hazards. Hot work creates sparks and slag and gives off heat. Materials, such as acetylene and oxygen, are used in gas welding and an electrical current is used for arc welding. Additionally, these activities tend to occur in buildings that are not designed for these materials and hazards. Hot work often occurs within buildings undergoing renovations, which are even more susceptible to ignition. Hot work can be either temporary or ongoing. Permanent installations generally have the ability to address ignition hazards more consistently.

Several different types of hot work would fall under the requirements found in Chapter 35, including both gas and electric arc methods and any open-torch operations.

The important factor in avoiding ignition hazards is preparing for and monitoring hot-work activities. Primarily these precautions relate to basic fire prevention and fire control. Chapter 35 details a program that allows a facility to assign an employee to be the administrator of a hot-work program as defined in Section 202 of the code. This administrator would be allowed to issue permits for work on site, would be required to perform pre-work inspections and would be responsible for ensuring that the correct safety measures are taken. The fire code official has the authority to make periodic checks of these records, so they must be made available for at least 48 hours after the work ends. This chapter provides specific requirements for the protection of combustibles and for fire watches.

Personnel undertaking hot work will have varying levels of familiarity with the building or facility where the work is being done. Often, the person undertaking hot work is not an employee at the facility and may not be under the direct control of the hot work program manager. The qualifications of the hot work operator are discussed in Section 3503.4.

## Purpose

This chapter covers requirements for safety in welding and other types of hot work by reducing the potential for fire ignitions. Many of the activities of this chapter focus on the actions of occupants. As noted, welding and other hot work are responsible for a large percentage of fire ignitions that usually result in large losses.

## SECTION 3501 GENERAL

**3501.1 Scope.** Welding, cutting, open torches and other hot work operations and equipment shall comply with this chapter.

❖ Welding and cutting operations, whether electric or gas, are methods for joining or separating metals. In either case, a strong heat energy source is applied to the material, commonly known as the workpiece, to perform the required operation. Specific hazards associated with each type of welding or cutting apparatus and process may vary greatly, but, in each case, two elements are always present that may cause or contribute to the spread of fire—a heat energy source and air or oxygen. As a result, efforts

to control fuels and reduce the impact of fires if they occur are the focuses of these requirements.

**3501.2 Permits.** Permits shall be required as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants must demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit. The process also notifies the fire department of the need for prefire planning for the hazardous property and helps to verify that proper procedures will be followed.

The actual permit requirements for hot work are in Section 105.6.24. This section lists several specific instances where a permit would be required for hot work operations. One of the items would allow a single permit to be issued to allow a hot work program. This program will be explained in more detail in this chapter, but essentially it allows a person on site to manage the hot work activities. This program has a number of safety requirements, including fire department review of documentation at the facility for a minimum of 48 hours after the work is completed. Generally, this type of permit provides much needed flexibility for facilities where hot work is a common occurrence.

**3501.3 Restricted areas.** Hot work shall only be conducted in areas designed or authorized for that purpose by the personnel responsible for a Hot Work Program. Hot work shall not be conducted in the following areas unless approval has been obtained from the *fire code official*:

1. Areas where the sprinkler system is impaired.
  2. Areas where there exists the potential of an explosive atmosphere, such as locations where flammable gases, liquids or vapors are present.
  3. Areas with readily ignitable materials, such as storage of large quantities of bulk sulfur, baled paper, cotton, lint, dust or loose combustible materials.
  4. On board ships at dock or ships under construction or repair.
  5. At other locations as specified by the *fire code official*.
- ❖ This section describes restrictions on the areas where hot work can take place. Normally hot work activities are restricted to designated areas; however, there are times when hot work may be needed in specific locations, such as in a building undergoing renovation. This section presents this list as a way to verify that when hot work is needed, notification of the activity is made and special precautions are taken. In addition, this section also authorizes the fire code official to add other areas where special approval would be necessary. The code cannot anticipate all potentially hazardous situations. For this reason, this section does not explicitly prohibit hot work in these areas; it simply requires special approval.

**3501.4 Cylinders and containers.** *Compressed gas* cylinders and fuel containers shall comply with this chapter and Chapter 53.

- ❖ This section is focused on any cylinders or containers used to store gases used in hot work operations, primarily oxygen and acetylene. Oxygen is an oxidizing gas and acetylene is a highly flammable gas and an unstable reactive Class 2. This section requires that any specific requirements within Chapter 35 be addressed along with the general requirements found in Chapter 53 regarding compressed gases.

**3501.5 Design and installation of oxygen-fuel gas systems.** An oxygen-fuel gas system with two or more manifolded cylinders of oxygen shall be in accordance with NFPA 51.

- ❖ This section references NFPA 51 for any oxygen-fuel gas systems where any number of oxygen containers are manifolded. The scope of this standard specifically states that it addresses only situations where two or more cylinders are manifolded.

## SECTION 3502 DEFINITIONS

**3502.1 Definitions.** The following terms are defined in Chapter 2:

**HOT WORK.**

**HOT WORK AREA.**

**HOT WORK EQUIPMENT.**

**HOT WORK PERMITS.**

**HOT WORK PROGRAM.**

**RESPONSIBLE PERSON.**

**TORCH-APPLIED ROOF SYSTEM.**

- ❖ Definitions of terms can help in the understanding and application of code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

## SECTION 3503 GENERAL REQUIREMENTS

**3503.1 General.** Hot work conditions and operations shall comply with this chapter.

- ❖ This section is generally applicable to all hot work activities, which would include welding and cutting, but also includes activities such as torch-applied roof systems. The requirements are primarily related to the hot work permit program, qualifications and general administrative provisions related to fire safety procedures.

**3503.2 Temporary and fixed hot work areas.** Temporary and fixed hot work areas shall comply with this section.

- ❖ These provisions are applicable to both temporary and permanent activities because the same fire hazard exists in both cases. Temporary situations generally pose a greater hazard, however, because they typically occur in areas not designed for such ignition hazards. For example, hot work is fairly common in buildings undergoing renovation.

**3503.3 Hot work program permit.** Hot work permits, issued by an *approved* responsible person under a hot work program, shall be available for review by the *fire code official* at the time the work is conducted and for 48 hours after work is complete.

❖ Because individual facilities are allowed to manage the process of issuing permits, permit information must be available to the fire code official for periodic review. As noted in the definition for “Hot work permits,” the records must be available for at least 48 hours following completion of work. The 48-hour period gives the fire code official the time necessary to verify that permitting was done according to established procedures if a fire should occur.

This section does not require that the permits be submitted to the fire code official; it asks only that they be available for review. This section, along with Section 3503.5, is part of the package that allows a periodic random check of the permitting and hot work administrative procedures.

**3503.4 Qualifications of operators.** A permit for hot work operations shall not be issued unless the individuals in charge of performing such operations are capable of performing such operations safely. Demonstration of a working knowledge of the provisions of this chapter shall constitute acceptable evidence of compliance with this requirement.

❖ The definitions for “Hot work program” and “Responsible person” in Section 202 are specifically aimed at the individual who coordinates issuing and managing permits. The qualifications of the operator and administrative follow-through are critical aspects in preventing hot work fires and are the subjects of this section.

Operators of welding and cutting apparatus must demonstrate understanding of, competence in and responsibility for their activities. A thorough understanding of proper welding and cutting safety precautions as outlined in this chapter and NFPA 51 is a minimum requirement. Operators should also be familiar with general industry standards, as well as federal and state Occupational Safety and Health Administration (OSHA) regulations, manufacturers’ recommendations regarding equipment being operated and standards of good practice as detailed by the American Welding Society (AWS), National Fire Protection Association (NFPA) or other professional safety organization. Operators must be capable of physically demonstrating their knowledge of proper safety practices when required by the fire code official. Written competency examinations are not required by this section.

**3503.5 Records.** The individual responsible for the hot work area shall maintain “prework check” reports in accordance with Section 3504.3.1. Such reports shall be maintained on the premises for not less than 48 hours after work is complete.

❖ This section is specific to the hot work program administrator and requires that the prework checks be available for review for at least 48 hours. This allows periodic checks by the fire code official and

would allow reasonable time for review of documentation after a fire to determine if welding or cutting was implicated in any fire situation during the previous permit period.

**3503.6 Signage.** Visible hazard identification signs shall be provided where required by Chapter 50. Where the hot work area is accessible to persons other than the operator of the hot work equipment, conspicuous signs shall be posted to warn others before they enter the hot work area. Such signs shall display the following warning:

CAUTION  
HOT WORK IN PROGRESS  
STAY CLEAR

❖ Signage, as with many other code applications, is used as a method to warn of hazards. This is especially critical in areas where people unfamiliar with the hazards may be present. For example, this may be more important during renovations in an occupied office building. The signage requirements apply to both temporary and fixed situations, and the visibility of the signs must be consistent with the requirements of Chapter 50.

## SECTION 3504 FIRE SAFETY REQUIREMENTS

**3504.1 Protection of combustibles.** Protection of combustibles shall be in accordance with Sections 3504.1.1 through 3504.1.9.

❖ This section deals with basic fire safety activities that should be addressed when undertaking hot work. Some of the requirements may be more applicable to certain types of hot work than others because of the specific hazards presented. The three specific issues addressed include the protection of the area and fire protection systems located in the vicinity of the hot work; requirements for fire watches during and after the hot work is undertaken; and the administrative procedures used to confirm that all the applicable safety steps have been taken. This section focuses primarily on the protection of combustibles through both passive and active means. More specifically, combustibles must either be removed or protected by fire protection systems that remain operational during hot work activities.

**3504.1.1 Combustibles.** Hot work areas shall not contain combustibles or shall be provided with appropriate shielding to prevent sparks, slag or heat from igniting exposed combustibles.

❖ This section requires that combustibles either be removed from the area or properly shielded from sparks or excessive heat that could ignite a fire. A shield may need to be both noncombustible and insulating. In the case of sparks that provide little heat, a metal shield may be allowable. If the hot work operation gives off large amounts of heat, such as the use

of a torch, the shield would also need to resist the transmission of heat.

**3504.1.2 Openings.** Openings or cracks in walls, floors, ducts or shafts within the hot work area shall be tightly covered to prevent the passage of sparks to adjacent combustible areas, or shielded by metal fire-resistant guards, or curtains shall be provided to prevent passage of sparks or slag.

❖ Openings or cracks in walls, floors, ducts or shafts within the hot work area shall be tightly covered to prevent the passage of sparks to adjacent combustible areas; shields constructed of metal fire-resistant guards or curtains shall be provided to prevent passage of sparks or slag.

Openings or cracks in walls are potential travel paths for sparks or slag from hot work operations. It is very common for a partition in an existing building to have penetrations for pipes or other utilities. Sparks that penetrate a partition or wall have the potential of starting a fire in adjoining rooms or areas.

**3504.1.3 Housekeeping.** Floors shall be kept clean within the hot work area.

❖ This section addresses a basic fire safety issue of keeping the floors in the hot work area clean. Accumulations of dust and other high-surface-area materials are highly susceptible to ignition, flash fires and explosions. This kind of housekeeping is doubly important for welding and similar hot work in a building under renovation because such buildings tend to have higher concentrations of dusts and other hazardous combustibles.

**3504.1.4 Conveyor systems.** Conveyor systems that are capable of carrying sparks to distant combustibles shall be shielded or shut down.

❖ Conveyor systems, particularly in industrial applications, constitute a hazard. More specifically, if a welding operation ignites a fire on a conveyor system, the fire can move throughout the parts of the building served by the conveyor and possibly ignite multiple fires. Generally, most fire protection features are not designed for multiple-fire ignitions, but instead are designed for a single event. For instance, a sprinkler system has a specific design density for a specified area of operation. If the fire demand is higher than what the sprinkler system was designed to handle, the water supply and pressure could be inadequate and the sprinkler system will likely be overcome. Also, because the fire is moving, it is more difficult for the sprinklers to activate because the sprinkler might not heat sufficiently. This results in the fire growing larger before intervention from the fire protection systems. Even if a sprinkler does activate, it may not be addressing the origin of the fire.

**3504.1.5 Partitions.** Partitions segregating hot work areas from other areas of the building shall be noncombustible. In fixed hot work areas, the partitions shall be securely con-

nected to the floor such that no gap exists between the floor and the partition. Partitions shall prevent the passage of sparks, slag, and heat from the hot work area.

❖ The partitions discussed in this section act as shields, as described in Section 3504.1.1. The requirements state that partitions must be installed so that there is no room for sparks, slag or heat to pass beyond the hot work area. These requirements are primarily geared toward fixed hot work areas where the conditions can be more permanently controlled. Hot work operations in temporary locations will likely not have partitions installed solely for the purpose of protecting combustible materials. Section 3504.1.1 would be more applicable to temporary hot work.

**3504.1.6 Floors.** Fixed hot work areas shall have floors with noncombustible surfaces.

❖ The requirement for noncombustible floor surfaces is specific to fixed hot work operations because a fixed location situation can be more easily controlled than a temporary hot work operation. In many cases, program administrators will have little control over the type of floor and the location of combustibles in the areas where temporary hot work occurs.

**3504.1.7 Precautions in hot work.** Hot work shall not be performed on containers or equipment that contain or have contained flammable liquids, gases or solids until the containers and equipment have been thoroughly cleaned, inerted or purged; except that "hot tapping" shall be allowed on tanks and pipe lines where such work is to be conducted by *approved* personnel. Hot work on flammable and *combustible liquid* storage tanks shall be conducted in accordance with Section 3510.

❖ The title of this section is somewhat misleading because the section pertains specifically to hot work on containers or equipment that may contain flammable or combustible liquids. Simply because a container is empty does not mean that it is safe to conduct hot work. In fact, the vapors are usually much more susceptible to ignition than the liquid itself; therefore, before any hot work can occur, the vapors and liquids must be purged.

This section does allow hot work on containers or piping without the specific removal of liquids. This is termed "hot tapping" and must be done by an experienced individual. Hot tapping is extremely dangerous since the piping or tank still contains flammable or combustible liquids and, therefore, the personnel performing this work must be aware of the hazards and be able to safeguard the operation. This section also points the user to Section 3510, which contains specific safeguards for hot work on flammable and combustible liquid storage tanks and references NFPA 326 for these hot work operations. Note that NFPA 326 does not cover hot tapping, therefore other industry standards and safeguards must be used.

**3504.1.8 Sprinkler protection.** Automatic sprinkler protection shall not be shut off while hot work is performed. Where hot work is performed close to automatic sprinklers, noncombustible barriers or damp cloth guards shall shield the individual sprinkler heads and shall be removed when the work is completed. If the work extends over several days, the shields shall be removed at the end of each workday. The *fire code official* shall approve hot work where sprinkler protection is impaired.

❖ One of the major sources of losses related to hot work occurs either at buildings under construction or under renovation where an installed automatic sprinkler system has been shut off. In many cases, there is a concern that the automatic sprinkler system will be damaged or will accidentally activate during construction so the system is temporarily shut off. Unfortunately, this is the most likely time for an ignition to occur. Frequently, large manufacturing, storage and institutional occupancies intentionally perform much of their heavy maintenance work during slow periods to reduce service disruptions. Under such circumstances, care must be exercised so that sprinkler outages do not coincide with welding or cutting operations.

To reduce the likelihood of accidental operation of sprinklers if welding or cutting operations must be performed in close proximity to sprinklers or sprinkler piping, this section includes some methods of protecting the sprinkler without shutting the system down. It is important to note that any protection placed onto or near the sprinklers is to be removed at the end of each workday. Field welding or cutting operations performed on sprinkler piping is prohibited by NFPA 13.

**3504.1.9 Fire detection systems.** *Approved* special precautions shall be taken to avoid accidental operation of automatic fire detection systems.

❖ As with sprinkler systems, there is a concern for false alarms. This section does not give a methodology for protecting against false alarms but does state that precautions must be taken. There are many different technologies and approaches for fire detection systems in addition to the building-specific applications. Each situation should be looked at individually. One possible scenario would be to shut down smoke detectors in a hot work area and put a fire watch in place. As soon as the hot work is complete, those detectors are placed back on line.

**3504.2 Fire watch.** Fire watches shall be established and conducted in accordance with Sections 3504.2.1 through 3504.2.6.

❖ This section is critical to avoiding ignition as a result of hot work operations. The six subsections list criteria for establishing and conducting a fire watch.

**3504.2.1 When required.** A fire watch shall be provided during hot work activities and shall continue for not less than 30 minutes after the conclusion of the work. The *fire code official*, or the responsible manager under a hot work pro-

gram, is authorized to extend the fire watch based on the hazards or work being performed.

**Exception:** Where the hot work area has no fire hazards or combustible exposures.

❖ Fire watches are required any time hot work is undertaken and are to extend a minimum of 30 minutes beyond completion of the work. The time may need to be extended, depending on the specific hazards present, such as a large amount of combustibles or the facility being open to the public. There is an exception for those situations when combustibles are simply not present. The combustibility of the floor should also be considered.

**3504.2.2 Location.** The fire watch shall include the entire hot work area. Hot work conducted in areas with vertical or horizontal fire exposures that are not observable by a single individual shall have additional personnel assigned to fire watches to ensure that exposed areas are monitored.

❖ This section states that a fire watch is required in all hot work areas. The term “hot work area” is defined but is necessarily a general definition because many things will affect the extent of the area. These factors include the type and application of hot work, the configuration and layout of the space and the types of materials in the area. Also, where, for example, many pieces of equipment act as obstructions or the shape of the room or placement of partitions blocks a line of sight, the fire watch may need to consist of more than one person.

**3504.2.3 Duties.** Individuals designated to fire watch duty shall have fire-extinguishing equipment readily available and shall be trained in the use of such equipment. Individuals assigned to fire watch duty shall be responsible for extinguishing spot fires and communicating an alarm.

❖ The individuals who undertake a fire watch have specific duties. They not only need to watch for and notify of an ignition of combustibles, they also need to be prepared to extinguish spot fires with portable extinguishers. Intervention when fires are small is the best line of defense in extinguishing and controlling fires. Waiting until the fire department or fire brigade arrives will allow a fire to increase dramatically in size and intensity.

**3504.2.4 Fire training.** The individuals responsible for performing the hot work and individuals responsible for providing the fire watch shall be trained in the use of portable fire extinguishers.

❖ A person conducting a fire watch must be trained to operate fire extinguishers located in the watch area. As noted previously, intervention in the incipient stages of a fire is extremely effective.

**3504.2.5 Fire hoses.** Where hoselines are required, they shall be connected, charged and ready for operation.

❖ This section states that when a hoseline is required, it should be properly charged and ready for use during a fire watch. Otherwise, the effectiveness is much lower. As already noted, fires are more likely to be

extinguished or controlled when intervention occurs early. An uncharged hoseline will defeat the purpose of the equipment.

**3504.2.6 Fire extinguisher.** Not less than one portable fire extinguisher complying with Section 906 and with a minimum 2-A:20-B:C rating shall be readily accessible within 30 feet (9144 mm) of the location where hot work is performed.

❖ This section specifies that the fire extinguishers required for a fire watch must be all-purpose extinguishers for all fire types; the potential fire type will vary with the type of hot work and the surrounding combustibles. The 30-foot (9144 mm) travel distance specified here is more restrictive than what is required for similar ratings of extinguishers in Section 906. Table 906.3(2) would allow a maximum travel distance of 50 feet (15 240 mm) for other applications with the same rating of extinguisher.

**3504.3 Area reviews.** Before hot work is permitted and not less than once per day while the permit is in effect, the area shall be inspected by the individual responsible for authorizing hot work operations to ensure that it is a fire safe area. Information shown on the permit shall be verified prior to signing the permit in accordance with Section 105.6.

❖ This section is part of the hot work program. It requires the person administering the program to check the area where hot work has been permitted. A specific checklist is contained within Section 3504.3.1 to provide guidance as to what is to be inspected. Because the authority is given to those other than the fire department to issue permits and manage the safety of hot work operations, documentation of the inspections is a mechanism for review by the fire department to verify that operations are proceeding safely.

**3504.3.1 Pre-hot-work check.** A pre-hot-work check shall be conducted prior to work to ensure that all equipment is safe and hazards are recognized and protected. A report of the check shall be kept at the work site during the work and available upon request. The pre-hot-work check shall determine all of the following:

1. Hot work equipment to be used shall be in satisfactory operating condition and in good repair.
2. Hot work site is clear of combustibles or combustibles are protected.
3. Exposed construction is of noncombustible materials or, if combustible, then protected.
4. Openings are protected.
5. Floors are kept clean.
6. No exposed combustibles are located on the opposite side of partitions, walls, ceilings or floors.
7. Fire watches, where required, are assigned.
8. *Approved* actions have been taken to prevent accidental activation of suppression and detection equipment in accordance with Sections 3504.1.8 and 3504.1.9.

9. Fire extinguishers and fire hoses (where provided) are operable and available.

❖ As noted in Section 3504.3, this section includes a list of items to be reviewed in hot work areas. These checks confirm that the requirements in Sections 3504.1 and 3504.2 are actually being met.

## SECTION 3505 GAS WELDING AND CUTTING

**3505.1 General.** Devices or attachments mixing air or oxygen with combustible gases prior to consumption, except at the burner or in a standard torch or blow pipe, shall not be allowed unless *approved*.

❖ The materials used for gas cutting and welding are generally materials such as acetylene and oxygen. Acetylene is a flammable gas and oxygen is an oxidizer. Together, these gases produce an intense high-temperature flame. The high temperature of combustion is excellent for welding and cutting and, at the same time, is a significant ignition hazard. Acetylene is the preferred gas because it burns at high temperatures, but other flammable gases, such as methyl acetylene-propadiene and propylene, are also sometimes used. The other major type of welding is electric arc welding, which is discussed in Section 3506.

Because of the enriched combustion process created by pure oxygen, this section prohibits mixing oxygen and air prior to use with the flammable gas of choice for welding or cutting.

**3505.2 Cylinder and container storage, handling and use.** Storage, handling and use of *compressed gas* cylinders, containers and tanks shall be in accordance with this section and Chapter 53.

❖ A major hazard with gas welding and cutting is not necessarily the hot work operation itself, but instead the materials used in the operation. These gases are stored in cylinders and manifolded into systems for use. The storage, handling and use of such gases is specifically regulated by Chapter 53, which addresses issues such as security, valve protection, separation from hazardous materials and container and cylinder marking (see commentary, Chapter 53). Note that oxygen-fuel gas systems where two or more cylinders of oxygen are manifolded must meet the requirements of NFPA 51.

**3505.2.1 Cylinders connected for use.** The storage or use of a single cylinder of oxygen and a single cylinder of fuel gas located on a cart shall be allowed without requiring the cylinders to be separated in accordance with Section 5003.9.8 or 5003.10.3.6 when the cylinders are connected to regulators, ready for service, equipped with apparatus designed for cutting or welding and all of the following:

1. Carts shall be kept away from the cutting or welding operation in accordance with Section 3505.5 or fire-resistant shields shall be provided.

2. Cylinders shall be secured to the cart to resist movement.
  3. Carts shall be in accordance with Section 5003.10.3.
  4. Cylinder valves not having fixed hand wheels shall have keys, handles or nonadjustable wrenches on valve stems while the cylinders are in service.
  5. Cylinder valve outlet connections shall conform to the requirements of CGA V-1.
  6. Cylinder valves shall be closed when work is finished.
  7. Cylinder valves shall be closed before moving the cart.
- ❖ The use of “welding carts” has been common practice as a means to secure cylinders of oxygen and fuel-gas used in cutting and welding operations. The carts serve as a means to safely secure cylinders, as well as a means to hold flexible hose, torches and, in some cases, safety equipment such as goggles or eye shields and welding rods (see Commentary Figure 3505.2.1).

This section was added to the code because a number of fire code officials were considering a compressed gas cylinder containing a fuel gas located adjacent to a cylinder of compressed or cryogenic oxygen on a cart to be incompatible hazardous materials based on the definition of “Incompatible materials” in Section 202.

The requirements for separation of incompatible materials under Sections 5003.9.8 and 5003.10.3.6 present a practical difficulty when the quantity of materials is limited. Allowing single cylinders of oxygen and fuel-gas, with additional controls to address the typical use condition, provides a more rational and comprehensive approach to safe use than outright prohibition that is out of convention with a common practice.

This section correctly treats a single cylinder of fuel gas adjacent to a cylinder of oxygen as being available for service as a closed use system rather than being considered storage. It requires that both the oxygen and fuel gas cylinder be equipped with a pressure regulator, which is a valve that reduces the pressure of a gas to safe levels for use and consumption. Section 3505.4 requires acetylene gas cylinders be equipped with a pressure regulator that limits the pressure to 15 pounds per square inch gauge (psig) (103 kPa) or less. For other fuel gases such as liquefied petroleum gas (LP-gas) and MAPP gas (an LP-gas mixed with methylacetylene-propadiene to yield a higher combustion temperature in oxygen), Section 3509.1 requires that fuel gas hose systems comply with NFPA 51, which has requirements for pressure regulators. Regulators for oxygen and fuel gas are required by NFPA 51 to be listed for use with the particular gases being used.

In addition to the requirements in NFPA 51, this section also specifies requirements for the protection of the cylinders and their contents. Cylinders must be adequately secured on the cart to limit their movement. Prior to moving the cart, the cylinder valves

must be closed. Fuel gas cylinder valves that utilize square-head keys or similar valves that are not equipped with fixed hand wheels are required to be provided with their operating device on the cylinder to facilitate prompt and easy operation of the cylinder valve during use. Cylinders must also be protected from hot slag and sparks by being located away from the hot work activity or by protection using fire-resistant shields.

As an additional safety feature to prevent the connection of a fuel gas pressure regulator to an oxygen cylinder (or vice-versa), Item 5 requires that cylinder fittings comply with Compressed Gas Association (CGA) Standard V-1. Flammable gas cylinder valves are normally constructed using left-handed threaded connections and the outlet diameter is sized so a pressure regulator designed for oxygen cannot be accidentally connected to a cylinder containing a fuel gas.

In further substantiation of this new section, it should be pointed out that the CGA performed an extensive survey of its member companies who reported that in 75 years of experience, no regulator failures, hose fires or other incidents were attributable to single cylinders of oxygen and acetylene located next to each other and that most accidents associated with the use of oxygen regulators are failures and explosions caused by contamination.

It should also be noted that nothing in this section exempts or waives the requirements of Chapter 50 for maximum allowable quantities (MAQs), and the storage, handling and use of hazardous materials, or the requirements in Chapters 53, 58 and 63 for compressed gases, flammable gases and oxidizing



**Figure 3505.2.1**  
**TYPICAL WELDING CART**

gases, respectively. A building in which oxygen and fuel gas supplies are stored and used must maintain quantities below the MAQs for indoor control areas. If the amount in storage and closed use exceeds the MAQ in one or more control areas the building must be constructed as a Group H-2 occupancy.

**3505.2.1.1 Individual cart separation.** Individual carts shall be separated from each other in accordance with Section 5003.9.8.

❖ In buildings housing more than one cart containing oxygen and fuel gas used for cutting and welding, this section requires that individual carts be separated from one another in accordance with Section 5003.9.8. For cutting and welding carts, this requires a minimum 20-foot (6096 mm) separation between each cart or the construction of noncombustible line-of-sight barriers that extend a minimum of 18 inches (457.2 mm) above and to the sides of each cart.

This section also recognizes the allowance created by Section 3505.2.1 to allow a single cylinder of oxidizing gas and a single cylinder of fuel gas to be located on an individual cart, and addresses the possible concern over multiple carts stored in close proximity to one another. If the number of carts were to grow, the quantity controls imposed by the MAQs per control area would trigger the use of a Group H occupancy when the MAQ of 1,000 cubic feet (23.32 m<sup>3</sup>) of flammable gas was exceeded (three or four carts, depending on the fuel gas). However, using MAQ as a quantity control was not the intent of Section 3505.2.1.

**3505.3 Precautions.** Cylinders, valves, regulators, hose and other apparatus and fittings for oxygen shall be kept free from oil or grease. Oxygen cylinders, apparatus and fittings shall not be handled with oily hands, oily gloves, or greasy tools or equipment.

❖ Oxygen, which is an oxidizer, will increase the intensity of combustion; therefore, traces of combustibles, such as oils or greases, that normally pose a moderate hazard will be a higher hazard when found on cylinders of oxygen. Keeping gas cylinders free of grease and oil is especially important because gas-welding operations use flammable gases in combination with oxygen.

**3505.4 Acetylene gas.** Acetylene gas shall not be piped except in *approved* cylinder manifolds and cylinder manifold connections, or utilized at a pressure exceeding 15 pounds per square inch gauge (psig) (103 kPa) unless dissolved in a suitable solvent in cylinders manufactured in accordance with DOTn 49 CFR Part 178. Acetylene gas shall not be brought in contact with unalloyed copper, except in a blowpipe or torch.

❖ Acetylene is the preferred gas for welding because it burns at very high temperatures, which is more conducive to welding and cutting operations. This also creates a high fire hazard. Therefore, this section limits the piping of acetylene to approved cylinder manifolds and manifold connections, which can be

accomplished in a variety of ways. The pressure of piped acetylene is limited to 15 pounds per square inch gauge (psig) (103 kPa) to avoid large releases of acetylene. There is an exception when acetylene is dissolved in a solvent, such as acetone, which reduces its volatility hazard.

Acetylene (CH = CH) is an extremely volatile compressed gas that is usually dissolved in a solvent, such as acetone or dimethylformamide, because of its volatility, and is normally stored and shipped in cylinders at a pressure of 250 pounds per square inch (psi) (1724 kPa). These solvents are Class IB flammable and Class II combustible liquids, respectively. However, in practice it is the flammable gas hazard that is regulated; the solvent into which the gas is absorbed has not been independently assessed. The established reason for doing this is that the control strategy for the compressed gas hazard is suitable for that of the solvent hazard. Acetone will dissolve approximately 425 times its volume of acetylene at 250 psi (1724 kPa).

Acetylene gas reacts vigorously with some metals, including copper and some copper alloys, to produce metallic acetylides that are shock-sensitive explosive compounds. Copper acetylide is an extremely shock-sensitive explosive and, if detonated, even in very small quantities, can initiate acetylene decomposition, cause hose or tank rupture and potentially cause catastrophic detonations or deflagrations, especially when tanks are manifolded.

**3505.5 Remote locations.** Oxygen and fuel-gas cylinders and acetylene generators shall be located away from the hot work area to prevent such cylinders or generators from being heated by radiation from heated materials, sparks or slag, or misdirection of the torch flame.

❖ Because of the hazards of using gases for welding and cutting, the cylinders and generators must be located away from the hot work operation itself. This means that the connection must be a sufficient length to allow locating the cylinders a safe distance from the hot work. Generally, only a short distance is required; a distance of only a few feet may be sufficient under ordinary conditions. A greater distance may be more prudent when welding or cutting operations involve a highly reflective surface or material. Where space is limited, a suitable barrier may be erected to protect cylinders from heat, provided such a barrier does not impair the operation of regulating equipment.

**3505.6 Cylinders shutoff.** The torch valve shall be closed and the gas supply to the torch completely shut off when gas welding or cutting operations are discontinued for a period of 1 hour or more.

❖ Good practice dictates shutting off gas cylinders when equipment is not in use; however, it is common practice for welding and cutting operators who must use a torch intermittently to shut off only the torch. Care must be taken in these instances to check the system to see that it has been properly shut down when work

is discontinued for a longer duration and at the end of the work period. This limits the amount of flammable or oxidizing gases that can be emitted to the atmosphere if the torch or hose is damaged in any way or if a valve at the torch head is not tightly closed.

**3505.7 Prohibited operation.** Welding or cutting work shall not be held or supported on *compressed gas* cylinders or containers.

❖ Section 3505.5 addresses physical separation of the welding and cutting gas cylinders from the hot work. This section goes a step further and prohibits welding operations on top of compressed gas containers or cylinders. This requirement would apply to any compressed gas cylinders or containers, whether they contain flammable gases or not. The concern is explosion caused by overpressure in the compressed gas cylinders when they are heated.

**3505.8 Tests.** Tests for leaks in piping systems and equipment shall be made with soapy water. The use of flames shall be prohibited for leak testing.

❖ This section requires that piping and equipment subjected to hot work be tested using soapy water rather than a flame to recognize any leaks. This is important because the piping may contain some residual flammable or oxidizing materials. Soapy water will produce harmless bubbles at the leak site even at very low pressures.

## SECTION 3506 ELECTRIC ARC HOT WORK

**3506.1 General.** The frame or case of electric hot work machines, except internal-combustion-engine-driven machines, shall be grounded. Ground connections shall be mechanically strong and electrically adequate for the required current.

❖ The following sections are specific to welding and cutting using an electrical arc. This process produces enough heat to join metals together or cut metals. There are several variations of arc welding and cutting. More specifically, in some arc welding processes a shielding gas is used to protect the weld from contaminants and prevent metal oxidation. Also, the electrode is either nonconsumable or consumable, which dictates whether additional materials are needed in the process.

Electric arc hot work poses some potential hazards because the process is working with electric power and current. Therefore, unless the welder is powered using an internal combustion engine, the frame or case of the welding piece must be grounded.

**3506.2 Return circuits.** Welding current return circuits from the work to the machine shall have proper electrical contact at joints. The electrical contact shall be periodically inspected.

❖ The current for welding must be able to loop back to the power source from the item being welded or cut. Cable movement may loosen contacts, causing poor conduction and interruption of ground continuity. At

the high voltages used in welding and cutting operations, high-resistance arcs may occur at loose contacts, resulting in a fire. Similarly, loose contacts may create a ground path, exposing the operator or others in the vicinity to the danger of electrocution.

**3506.3 Disconnecting.** Electrodes shall be removed from the holders when electric arc welding or cutting is discontinued for any period of 1 hour or more. The holders shall be located to prevent accidental contact and the machines shall be disconnected from the power source.

❖ The intent of this section is to prevent materials and machinery used as part of the electric arc-welding process from becoming a source of ignition after the hot work operations have been discontinued for 1 hour or more by requiring the disconnection of the electrodes and the power supply. Poorly supervised arc-welding machines may be subject to tampering or misuse even when properly maintained, and could become a fire hazard if left unattended and energized for long durations. Accidental contact with unsupervised welding electrodes or machine contacts may result in electrocution. This is similar to the intent of Section 3505.6 for gas hot work, which requires the supply gas valves to be shut off when an extended interruption occurs.

**3506.4 Emergency disconnect.** A switch or circuit breaker shall be provided so that fixed electric welders and control equipment can be disconnected from the supply circuit. The disconnect shall be installed in accordance with NFPA 70.

❖ When an electric arc-welding or cutting operation is in a permanent location, it is important that the particular operation be isolated onto a single disconnect switch. This makes it easier to verify that operations are in fact disconnected from the power supply during an emergency. NFPA 70 will have the specific requirements for this disconnect.

**3506.5 Damaged cable.** Damaged cable shall be removed from service until properly repaired or replaced.

❖ Damaged cable increases the likelihood of ignition hazards because wires may be exposed, resulting in resistance heating or potential electric shock hazards.

## SECTION 3507 CALCIUM CARBIDE SYSTEMS

**3507.1 Calcium carbide storage.** Storage and handling of calcium carbide shall comply with Chapter 50 of this code and Chapter 9 of NFPA 51.

❖ Calcium carbide gas is used for the creation of acetylene gas used in gas welding and cutting. Acetylene gas, as discussed earlier in this commentary, is extremely flammable and burns at very high temperatures. Calcium carbide itself is considered water reactive and will form acetylene upon contact with moisture. This section increases the likelihood that the gas is handled to avoid a hazardous situation.

Compliance with Chapter 50 of the code and Chapter 9 of NFPA 51 is required. Chapter 9 of NFPA 51 specifically relates to storage requirements for calcium carbide gas. These requirements focus on keeping the calcium carbide dry and separated from other areas when it is stored in large quantities.

### SECTION 3508 ACETYLENE GENERATORS

**3508.1 Use of acetylene generators.** The use of acetylene generators shall comply with this section and Chapter 6 of NFPA 51A.

❖ Acetylene generators essentially use calcium carbide gas and moisture to generate acetylene. Because acetylene is extremely flammable, the equipment must be handled with care.

Detailed requirements for acetylene generators are left to Chapter 4 of NFPA 51A, which is specific to such generators. These provisions deal with issues such as the construction requirements of generator rooms or houses and detailed installation requirements for the generators themselves.

There are several types of generators, including those with automatic water feed and manual water feed.

**3508.2 Portable generators.** The minimum volume of rooms containing portable generators shall be 35 times the total gas-generating capacity per charge of all generators in the room. The gas-generating capacity in cubic feet per charge shall be assumed to be 4.5 times the weight of carbide per charge in pounds. The minimum ceiling height of rooms containing generators shall be 10 feet (3048 mm). An acetylene generator shall not be moved by derrick, crane or hoist while charged.

❖ When generators are portable, they are generally at a greater risk for damage and are more likely to be in a location that may not have been specifically designed for this equipment. Therefore, this section provides some minimum volume requirements to make sure that a particular space can handle the volume of gases produced. The 35-to-1 volume requirement is intended to prevent formation of an explosive atmosphere in rooms or spaces where portable acetylene generators are employed. Assuming there is no leakage from the compartment, and that perfect efficiency in the generation of acetylene is achieved, this volume produces an atmosphere only slightly above the lower explosive limit (LEL). These provisions will reduce the likelihood of the formation of an explosive acetylene-air mixture if the required ventilation is maintained and acetylene production is not vented directly to the atmosphere in the room. To assist the code user in determining how much acetylene could be generated, this section includes a conservative approach to calculating the generation capacity.

Because acetylene is slightly lighter than air, the high ceiling is intended to provide space above the top of wall openings for containment of any combusti-

ble mixture that may form. The high ceiling is also important because acetylene is considered an asphyxiant, and having the high ceiling will allow the gas to rise, giving any occupants a longer escape time without being exposed to the gas.

Finally, this section prohibits the relocation of charged acetylene generators. Moving an acetylene generator while charged is likely to cause an uncontrolled gas release if it is dropped or damaged.

**3508.3 Protection against freezing.** Generators shall be located where water will not freeze. Common salt such as sodium chloride or other corrosive chemicals shall not be utilized for protection against freezing.

❖ Because acetylene generators use calcium carbide and moisture to create acetylene, freezing temperatures may cause water in the system to expand, thus damaging generator components. Additionally, corrosive materials, such as salt used to thaw ice on walkways, should not be used near the generators since they may have a damaging effect on generator components and potentially lead to failure.

### SECTION 3509 PIPING MANIFOLDS AND HOSE SYSTEMS FOR FUEL GASES AND OXYGEN

**3509.1 General.** The use of piping manifolds and hose systems shall be in accordance with Section 3509.2 through 3509.7, Chapter 53 and Chapter 5 of NFPA 51.

❖ Quite often, manifolding of several cylinders is desirable to decrease the amount of time taken to disconnect spent cylinders and reconnect new ones. When cylinders are manifolded, the potential hazard increases because the amount of material that can be released in one event is much larger. Special care and specific requirements are necessary to address these hazards. Compliance with Chapter 5 of NFPA 51 and Chapter 53 of the code for compressed gases is referenced. Although manifolded cylinders may create a higher risk for a large release, numerous disconnections and connections using a single cylinder may increase the likelihood of a failure.

**3509.2 Protection.** Piping shall be protected against physical damage.

❖ When cylinders are manifolded, the potential size of a gas release increases. Manifold piping is more likely to be damaged than the cylinders themselves. This section requires that piping associated with manifolded cylinders be installed in a manner minimizing the likelihood of mechanical and physical damage from collision or abrasion. When piping must be run in an area where mechanical and physical hazards cannot be eliminated, barriers or other suitable protection must be provided to absorb or deflect the impact of such damage without affecting the compressed gas piping.

Though not specifically listed in this section, physical damage resulting from corrosion should be con-

sidered when providing piping protection. Corrosion is the enemy of any piping system and can be caused by weather exposure, burial in the soil or construction materials that are in contact with the pipe. Protection is usually provided by a factory-applied coating or by field-wrapping the pipe with a protective covering, such as a coal-tar-based or plastic wrapping. Where possible, a piping material should be chosen that is not subject to the type of corrosion of the application. Acceptable fuel gas piping materials are regulated by Chapter 4 of the *International Fuel Gas Code*® (IFGC®).

Corrosion can also be caused by galvanic action that takes place where dissimilar metals are joined together in a current-carrying medium, such as soil or water. For example, if steel and copper pipe are joined in a medium that conducts electrical current, the steel pipe will corrode at an accelerated rate because of the electrochemical process between the dissimilar metals. To protect against galvanic corrosion, dielectric fittings and couplings are used to join the piping.

**3509.3 Signage.** Signage shall be provided for piping and hose systems as follows:

1. Above-ground piping systems shall be marked in accordance with ASME A13.1.
  2. Station outlets shall be marked to indicate their intended usage.
  3. Signs shall be posted, indicating clearly the location and identity of section shutoff valves.
- ❖ Signage for piping and hosing associated with manifolded cylinders must indicate the content of the system, gas flow direction, intended use of the gas outlets and location of shutoff valves. This information helps to quickly assess emergencies and take corrective action.

**3509.4 Manifolding of cylinders.** Oxygen manifolds shall not be located in an acetylene generator room. Oxygen manifolds shall be located not less than 20 feet (6096 mm) away from combustible material such as oil or grease, and gas cylinders containing flammable gases, unless the gas cylinders are separated by a *fire partition*.

❖ Manifolds are groups of cylinders connected to one another in a series in a gas supply system. As a general rule throughout the code, oxidizing and flammable materials must be kept physically separated from each other, either by space or fire-resistance-rated construction. Acetylene is a flammable gas with an explosive range of 2.5 to 100 percent and needs very little oxygen to burn. Excess oxygen may only make an explosion worse; therefore, separation is required. Other materials found in shop areas, such as solvents, oils and lubricants, must be kept clear of oxygen cylinders for similar reasons and may either be separated by distance or fire-resistive shielding. The fire partitions required by this section must be constructed in accordance with Section 708 of the *International Building Code*® (IBC®).

**3509.5 Identification of manifolds.** Signs shall be posted for oxygen manifolds with service pressures not exceeding 200 psig (1379 kPa). Such signs shall include the words:

LOW-PRESSURE MANIFOLD

DO NOT CONNECT HIGH-PRESSURE CYLINDERS

MAXIMUM PRESSURE 250 PSIG

❖ The signage required by this section is intended to prevent high-pressure oxygen cylinders from being connected to a low-pressure manifold. A high-pressure cylinder may cause a rupture of the system, resulting in an instantaneous release of large volumes of oxygen. The maximum 250-psig (1723 kPa) working pressure is approximately one-half the customary minimum safety margin of  $1\frac{1}{2}$  times the working pressure.

**3509.6 Clamps.** Hose connections shall be clamped or otherwise securely fastened.

❖ Hoses are potentially less reliable than a pipe if they do not receive proper care. This section requires clamps or other methods of securing to provide stability and prevent an inadvertent disconnection during use. Hose connections may fail because of an improper connection, damage or overpressurization. An unrestrained hose can become a deadly weapon if it becomes disconnected.

**3509.7 Inspection.** Hoses shall be inspected frequently for leaks, burns, wear, loose connections or other defects rendering the hose unfit for service.

❖ Many places where welding or cutting operations are performed pose distinct hazards to welding and cutting hoses. Excessive abrasions, cuts, dry rot, cracking or discoloration are all signs that a hose needs to be replaced. Any hose sustaining burn damage or having a damaged or deformed connection should be replaced immediately. When in doubt about the condition of a hose, it should be taken out of service and hydrostatically tested by qualified personnel in accordance with the manufacturer's recommendations before being returned to service or replaced. Discarding defective lengths of hose improves the likelihood that it will not be reused.

## SECTION 3510 HOT WORK ON FLAMMABLE AND COMBUSTIBLE LIQUID STORAGE TANKS

**3510.1 General.** Hot work performed on the interior or exterior of tanks that hold or have held flammable or *combustible liquids* shall be in accordance with Section 3510.2 and Chapters 4, 5, 6, 7 and 10 of NFPA 326.

❖ Annually, there are numerous documented incidents involving loss of life, injury and property damage where hot work was conducted on tanks containing or that had contained flammable or combustible liquids and industry-specific precautions were not followed or personnel did not understand the hazard or risk.

## WELDING AND OTHER HOT WORK

This section improves the general guidelines in the code and references the appropriate standard to safely conduct hot work on tanks that contain or had contained flammable or combustible liquids. Other references to hot work on flammable and combustible tanks are in Section 3504.1.7 and in 5704.2.7.6 of the code, as well as Section 6.5.3 of NFPA 30.

**3510.2 Prevention.** The following steps shall be taken to minimize hazards where hot work must be performed on a flammable or *combustible liquid* storage container:

1. Use alternative methods to avoid hot work where possible.
  2. Analyze the hazards prior to performing hot work, identify the potential hazards and the methods of hazard control.
  3. Hot work shall conform to the requirements of the code or standard to which the container was originally fabricated.
  4. Test the immediate and surrounding work area with a combustible gas detector and provide for a means of continuing monitoring while conducting the hot work.
  5. Qualified employees and contractors performing hot work shall use an industry-approved hot work permit system to control the work.
  6. Personnel shall be properly trained on hot work policies and procedures regarding equipment, safety, hazard controls and job-specific requirements.
  7. On-site safety supervision shall be present where hot work is in progress to protect the personnel conducting the hot work and provide additional overview of site-specific hazards.
- ❖ The United States Chemical Safety Board (CSB) has published general guidelines applicable to almost every situation where welding or cutting on flammable, combustible or toxic chemical tanks occurs. Those general safety guidelines are listed in this section.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

*Complete Revision History to the 2015 I-Codes.* Washington, DC: International Code Council, 2014.

Manz, A. "Welding, Cutting and Other Hotwork," Section 6, Chapter 14. *Fire Protection Handbook*, 19<sup>th</sup> ed. Quincy, MA: National Fire Protection Association, 2003.

# Chapter 36: Marinas

## General Comments

Chapter 36 addresses fire protection and prevention requirements for marinas. This chapter was developed in response to complications encountered by a number of fire departments responsible for protecting marinas, as well as fire loss history in marinas that lacked fire protection. Fire-fighting operations at marinas are more of a challenge from the perspectives of access, hose stream deployment and the proximity of exposures. These factors are compounded because personal marine craft are typically constructed of rigid thermoplastics or wood, do not burn as shielded fires when compared to fires involving passenger vehicles, and have flammable and combustible liquids on board in varying amounts.

Part of the basis for the approval of these requirements was the United States' fire loss history for marina fires from 2003 through 2006, wherein marina fires

caused the complete loss of 272 boats and houseboats for a total loss of more than \$67 million. Excluding the scoping section, Chapter 36 is divided into four sections:

Section 3602—Definitions

Section 3603—General Precautions

Section 3604—Fire Protection Equipment

Section 3605—Marine Motor Fuel-dispensing Stations

## Purpose

Compliance with this chapter is to establish safe practices in marina areas, provide an identification method for mooring spaces in the marina, provide fire fighters with safe operational areas and provide fire protection methods to extend hose lines in a safe manner.

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## SECTION 3601 SCOPE

**3601.1 Scope.** Marina facilities shall be in accordance with this chapter.

❖ This section identifies that marina facilities are covered in this chapter. It is possible to find and utilize the provisions found in this chapter among other sections of the code. However, it was felt that, for ease of use, a chapter specific to this special use would be beneficial to those fire code officials with marinas in their jurisdictions.

**3601.2 Plans and approvals.** Plans for marina fire protection facilities shall be *approved* prior to installation. The work shall be subject to final inspection and approval after installation.

❖ Plan approval prior to installation enables the jurisdiction to review the marina layout, the required fire protection features and general safety precautions for the public, property and fire fighters. The inspection process verifies that the general safety precautions are met and that the required fire protection features are practiced.

## SECTION 3602 DEFINITIONS

**3602.1 Definitions.** The following terms are defined in Chapter 2:

FLOAT.

MARINA.

PIER.

VESSEL.

WHARF.

❖ Definitions of terms can help in the understanding and application of code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*® (I-Code®) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentaries, Sections 201.1 through 201.4).

## SECTION 3603 GENERAL PRECAUTIONS

**3603.1 Combustible debris.** Combustible debris and rubbish shall not be deposited or accumulated on land beneath marina structures, piers or wharves.

❖ Due to the combustible nature of most piers and wharves, the code requires that combustible debris not be deposited or allowed to accumulate under them. Consistent with the provisions found in Section 304.1.1, this section prohibits disorderly, unkempt storage or accumulation of trash, waste rags, waste-paper, litter and other combustible materials. Litter and trash represent serious fire hazards because of their ease of ignition and rapid heat release once

ignited. The importance of maintaining property and buildings in good order seems obvious, but sloppy housekeeping still occurs and can be the cause of serious fires.

**3603.2 Sources of ignition.** Open-flame devices used for lighting or decoration on the exterior of a vessel, float, pier or wharf shall be *approved*.

- ❖ Similar to Section 308.1.1, this section requires that open-flame devices used in marina areas—including the wharf, pier, float or aboard a vessel—be approved. Fire code official approval ensures the device is appropriate for the intended use and that any needed precautions will be followed.

**3603.3 Flammable or combustible liquid spills.** Spills of flammable or *combustible liquids* at or upon the water shall be reported immediately to the fire department or jurisdictional authorities.

- ❖ Spills of flammable and combustible liquids in a marina create significant hazards due to the fact that these materials have a specific gravity less than that of water and will float on the water, spreading the liquid quickly around the many combustible materials found in vessels, floats, piers and wharves. The vapors that are released from these materials may easily find an ignition source with the resulting fire covering a large area. In addition to the fire problem, rapid response can help mitigate issues that affect the environment, marine animals and birds.

**3603.4 Rubbish containers.** Containers with tight-fitting or self-closing lids shall be provided for temporary storage of combustible debris, rubbish and waste material. The rubbish containers shall be constructed entirely of materials that comply with any one of the following:

1. Noncombustible materials.
  2. Materials that meet a peak rate of heat release not exceeding 300 kW/m<sup>2</sup> where tested in accordance with ASTM E 1354 at an incident heat flux of 50 kW/m<sup>2</sup> in the horizontal orientation.
- ❖ The use of containers with tight-fitting or self-closing lids reduces the possibility that an accidental container fire can be started and prevents continued burning if ignition does occur. Rubbish containers need not be constructed of metal or other noncombustible material. Other materials, including materials that have been shown to be safe by meeting a very severe fire test similar to those required by Section 808 for Group I-1, I-2 and I-3 occupancies and Section 304.3.4 for general rubbish control, may be used. Note that the requirement covers all types of rubbish and is not intended to address spills of combustible or flammable liquids. The use of the phrase “combustible debris, rubbish and waste material” makes this section consistent with other sections of the code. This section should be applied in conjunction with Section 304.3.

**3603.5 Electrical equipment.** Electrical equipment shall be installed and used in accordance with its listing, Section 605 of this code and Chapter 5 of NFPA 303 as required for wet, damp and hazardous locations.

- ❖ Section 605 provides the basic requirements for the use of electrical cords, appliances, motors and space heaters. Chapter 5 of NFPA 303 covers the same information and specifies requirements for new installations. It also requires an annual inspection of the marina’s electrical wiring and equipment. The inspection must include all electrical grounds, verification of the polarity of circuits and an inspection of all flexible cords and cables, including shore power cable sets that supply electricity to docked marine craft. Other elements include requirements that address the introduction of hazards or uses that are greater than those for which the electrical system was originally designed.

**3603.6 Berthing and storage.** Berthing and storage shall be in accordance with Chapter 7 of NFPA 303.

- ❖ When vessels are either berthed or stored on land, this section requires these activities be performed in accordance with the requirements in NFPA 303. The requirements are based on whether the storage is wet or dry, indoor or outdoor and rack storage. Berthing involves locating a marine craft or vessel in a space between piers, wharves or docks. The berth is the area that is occupied by the water.

When wet berthed, the boat must be stored so that it can be removed in an emergency without moving other boats, and fire department access is required around piers, wharves and floats. When dry storage is used, the standard has extensive requirements for the use of heaters and open flame-producing devices, such as torches, on-board batteries, fuel tanks and types of equipment to access and remove the vessels, in an emergency.

**3603.7 Slip identification.** Slips and mooring spaces shall be individually identified by an *approved* numeric or alphabetic designator. Space designators shall be posted at the space. Signs indicating the space designators located on finger piers and floats shall be posted at the base of all piers, finger piers, floats and finger floats.

- ❖ A slip is a berthing space located between two adjacent piers. The term “mooring space” can also refer to a slip or an anchored space where the vessel is simply secured to a mooring buoy. Large marinas can have many hundreds of slips or mooring spaces on site.

Similar to the premises identification provisions in Section 505, this section provides for an approved system of signs indicating how the marina is laid out to enable emergency responders to quickly identify the location of a fire or other emergency. The provision not only provides for a marina layout, but also requires that individual float and slip identification be provided.

## SECTION 3604 FIRE PROTECTION EQUIPMENT

**3604.1 General.** Piers, marinas and wharves with facilities for mooring or servicing five or more vessels, and marine motor fuel-dispensing facilities shall be equipped with fire protection equipment in accordance with Sections 3604.2 through 3604.6.

❖ Marinas have a significant potential for a fire emergency. Therefore, the fire protection to be provided must be properly established, installed and identified for use in an emergency.

**3604.2 Standpipes.** Marinas and boatyards shall be equipped throughout with standpipe systems in accordance with NFPA 303. Systems shall be provided with hose connections located such that no point on the marina pier or float system exceeds 150 feet (15 240 mm) from a standpipe hose connection.

❖ Standpipe systems in marinas are basically a horizontal standpipe to reach all parts of the float system, piers and buildings with no more than 150 feet (15 240 mm) of travel distance from a fire hose connection. This section requires a Class I standpipe system that provides 2½-inch (64 mm) hose connections for fire department use. The system is allowed to be a manual dry system in accordance with Section 6.4 of NFPA 303, meaning that the only required water supply is a connection for fire apparatus and that piping is not required to contain water at all times. In addition, NFPA 303 permits the omission of hose racks, hoses and standpipe cabinets at marinas and boatyards, recognizing that these would be subject to misuse in such venues.

**3604.2.1 Identification of standpipe outlets.** Standpipe hose connection locations shall be clearly identified by a flag or other *approved* means designed to be readily visible from the pier accessing the float system.

❖ To provide emergency responders with a visual cue in locating standpipe hose connections, each connection must have an approved identification marker readily visible from the wharf or pier to which the floats are attached.

**3604.3 Access and water supply.** Piers and wharves shall be provided with fire apparatus access roads and water-supply systems with on-site fire hydrants where required by the *fire code official*. Such roads and water systems shall be provided and maintained in accordance with Sections 503 and 507.

❖ So that emergency responders can quickly access the floats, fire apparatus access roads are to be provided in close proximity to the gangways and standpipe inlets that serve the marina. The access roads may be part of the parking lot system for the marina; however, they must meet the minimum width, load-bearing capability and turning radius criteria for the responding apparatus set forth in Section 503. In addition to the access roads, a fire hydrant system complying with the requirements of Section 508 may be required. Note that such systems are to be pro-

vided when it is determined by the fire code official that they are needed to properly protect the marina.

**3604.4 Portable fire extinguishers.** One portable fire extinguisher of the ordinary (moderate) hazard type shall be provided at each required standpipe hose connection. Additional portable fire extinguishers, suitable for the hazards involved, shall be provided and maintained in accordance with Section 906.

❖ A 2-A:10-B-C-rated portable fire extinguisher placed adjacent to each standpipe hose connection would meet the general requirement for this section. In addition, to meet the requirements of Table 906.3(1), a sufficient number of extinguishers must be provided throughout the marina with a maximum travel distance of 75 feet (22 860 mm) from any point along the piers, wharves or floats to an extinguisher.

**3604.5 Communications.** A telephone not requiring a coin to operate or other *approved*, clearly identified means to notify the fire department shall be provided on the site in a location *approved* by the *fire code official*.

❖ This section requires a public telephone to be provided at locations approved by the fire code official. The phone is to have the capability of coinlessly dialing 911 or other means of notifying the fire department. A sign identifying the location of the emergency phone must be provided. When a telephone is provided, NFPA 303 requires a sign at the telephone indicating the address of the marina so that callers may clearly and promptly communicate the location of any emergency.

**3604.6 Emergency operations staging areas.** Space shall be provided on all float systems for the staging of emergency equipment. Emergency operation staging areas shall provide a minimum of 4 feet wide by 10 feet long (1219 mm by 3048 mm) clear area exclusive of walkways and shall be located at each standpipe hose connection. Emergency operation staging areas shall be provided with a curb or barrier having a minimum height of 4 inches (102 mm) and maximum space between the bottom edge and the surface of the staging area of 2 inches (51 mm) on the outboard sides of the staging area.

An *approved* sign reading FIRE EQUIPMENT STAGING AREA—KEEP CLEAR shall be provided at each staging area.

❖ Adjacent to each standpipe there is to be an open space at least 4 feet wide by 10 feet long (1219 mm by 3048 mm) in addition to the walkway width. This area is for the purpose of providing storage and working space around the standpipe for equipment that must be transported to the area for operational needs. To ensure the equipment does not slide, roll or otherwise fall into the water, a minimum 4-inch-high (102 mm) curb or barrier is to be provided. A maximum 2-inch (51 mm) space between the surface of the float deck and the bottom of the 4-inch-high (102 mm) barrier is permitted on the water side of the staging area to allow for drainage of the surface of

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the pier, float or dock. A sign is required to identify the area as a dedicated fire department staging area and to keep it clear of other items that may be placed there by those who use the floats.

### SECTION 3605 MARINE MOTOR FUEL-DISPENSING FACILITIES

**3605.1 Fuel dispensing.** Marine motor fuel-dispensing facilities shall be in accordance with Chapter 23.

- ❖ Fuel-dispensing facilities in marinas are required to be in accordance with Sections 2303 and 2310. Section 2303 provides general requirements for all fuel-dispensing facilities. Section 2310 contains the specific requirements for the marine fuel-dispensing facilities, which are similar to other fuel-dispensing facilities. Section 2310.1 also references the *International Building Code*® (IBC®) and NFPA 30A for construction requirements of these fueling facilities and Chapter 57 for fuel storage requirements.

#### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

*Complete Revision History to the 2015 I-Codes.* Washington, DC: International Code Council, 2014.

*Fire Protection Handbook,* 20<sup>th</sup> ed. Quincy, MA: National Fire Protection Association, 2008.

# Chapter 37: Combustible Fibers

## General Comments

Operations involving combustible fibers are typically associated with salvage, paper milling, recycling, cloth manufacturing, carpet and textile mills and agricultural operations, among others.

The primary hazard associated with these operations is the abundance of materials and their ready ignitability. These so-called “rag districts,” where cloth scrap and clippings are collected and separated for reuse in paper manufacturing, have been associated with catastrophic conflagrations as recently as the 1970s.

Because of these hazards, occupancies storing or handling more than 100 cubic feet (3 m<sup>3</sup>) of loose, or 1,000 cubic feet (28 m<sup>3</sup>) of baled, combustible fibers are classified as Group H-3 (high hazard) by the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>).

## Purpose

Chapter 37 establishes the requirements for the storage and handling of combustible fibers, including animal, vegetable and synthetic fibers, whether woven into textiles, baled, packaged or loose.

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## SECTION 3701 GENERAL

**3701.1 Scope.** The equipment, processes and operations involving *combustible fibers* shall comply with this chapter.

❖ Fibers and textiles are an integral part of our daily lives. Almost all fibers are combustible. This characteristic is a problem when the fibers are manufactured, made into fabrics and collected as waste.

**3701.2 Applicability.** Storage of *combustible fibers* in any quantity shall comply with this section.

❖ Fibers stored as raw material or finished product must comply with this section.

**3701.3 Permits.** Permits shall be required as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit, Section 105.6.8 for a discussion of specific quantity-based operational permits for the materials regulated in this chapter and Section 105.7 for a general discussion of activities requiring a construction permit. The permit process also notifies the fire department of the need for prefire planning for hazardous properties.

## SECTION 3702 DEFINITIONS

**3702.1 Definitions.** The following terms are defined in Chapter 2:

**BALED COTTON.**

**BALED COTTON, DENSELY PACKED.**

**COMBUSTIBLE FIBERS.**

**SEED COTTON.**

❖ Definitions of terms can help in the understanding and application of code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4).

## SECTION 3703 GENERAL PRECAUTIONS

**3703.1 Use of combustible receptacles.** Ashes, waste, rubbish or sweepings shall not be placed in wood or other combustible receptacles and shall be removed daily from the structure.

❖ The regular and proper disposal of ashes, waste, rubbish and sweepings is of the utmost importance. Not giving a fire a place of origin is the main objective.

## COMBUSTIBLE FIBERS

The waste containers cannot be combustible. Routine and regular handling and disposal of waste products are integral parts of housekeeping.

**3703.2 Vegetation.** Grass or weeds shall not be allowed to accumulate at any point on the premises.

❖ Tall grass, dry weeds and bushes around buildings and on and alongside roadways, highways and streets present a definite fire hazard. Controlling or clearing grass, weeds and bushes reduces this hazard.

**3703.3 Clearances.** A minimum clearance of 3 feet (914 mm) shall be maintained between automatic sprinklers and the top of piles.

❖ Although a 3-foot (914 mm) clearance is required by this section, other sections of the code and NFPA 13 allow less clearance. Sprinkler clearances are intended to provide room for the fire plume to develop, thus ensuring sprinkler activation and preventing obstruction of the sprinkler spray pattern.

**3703.4 Agricultural products.** Hay, straw, seed cotton or similar agricultural products shall not be stored adjacent to structures or combustible materials unless a clear horizontal distance equal to the height of a pile is maintained between such storage and structures or combustible materials. Storage shall be limited to stacks of 100 tons (91 metric tons) each. Stacks shall be separated by not less than 20 feet (6096 mm) of clear space. Quantities of hay, straw, seed cotton and other agricultural products shall not be limited where stored in or near farm structures located outside closely built areas. A permit shall not be required for agricultural storage.

❖ Farm and other agricultural buildings are exempt from the requirements of this section. Agricultural outbuildings probably represent the single largest class of buildings used for combustible fiber storage; however, despite the hazards associated with the spontaneous combustion of green hay, these occupancies generally pose little threat to life or adjacent property.

**3703.5 Dust collection.** Where located within a building, equipment or machinery that generates or emits *combustible fibers* shall be provided with an *approved* dust-collecting and exhaust system. Such systems shall comply with Chapter 22 of this code and Section 511 of the *International Mechanical Code*.

❖ Dust may create a considerable explosion when displaced from a surface on which it rests, and it may also be ignited by static sparks. For this reason, a dust-collecting hood and exhaust system is required.

**3703.6 Portable fire extinguishers.** Portable fire extinguishers shall be provided in accordance with Section 906 as required for extra-hazard occupancy protection as indicated in Table 906.3(1).

❖ Section 906 gives the requirements for portable fire extinguishers. Such extinguishers must be selected and installed for an extra-hazard occupancy because of the high possibility of ignition of combustible fibers or dust.

**3703.7 Sources of ignition.** Sources of ignition shall comply with Sections 3703.7.1 and 3703.7.2.

❖ This section introduces the provisions for ignition control. A form of heat is required to ignite combustible fibers. By limiting the sources of ignition in the storage or use area, one can reduce the possibility of a fire.

**3703.7.1 Smoking.** Smoking shall be prohibited and “No Smoking” signs provided as follows:

1. In rooms or areas where materials are stored or dispensed or used in open systems.
2. Within 25 feet (7620 mm) of outdoor storage or open use areas.
3. Facilities or areas within facilities that have been designated as totally “no smoking” shall have “No Smoking” signs placed at all entrances to the facility or area. Designated areas within such facilities where smoking is permitted either permanently or temporarily shall be identified with signs designating that smoking is permitted in these areas only.

Signs required by this section shall be in English as a primary language or in symbols allowed by this code and shall comply with Section 310.

❖ The three areas listed in this section, because of their hazard characteristics, have been designated to receive “No Smoking” signs, in accordance with Section 310 of the code.

**3703.7.2 Open flames.** Open flames and high-temperature devices shall not be used in a manner that creates a hazardous condition and shall be listed for use with the materials stored or used. High-temperature devices and those devices utilizing an open flame shall be listed for use with the materials stored or used.

❖ Processes that use open flames must be installed and safeguarded in accordance with the manufacturer’s specifications. Safety is further enhanced by the requirement for certain devices to be listed for use in proximity to hazardous materials.

## SECTION 3704 LOOSE FIBER STORAGE

**3704.1 General.** Loose combustible fibers, not in suitable bales or packages and stored outdoors in the open, shall comply with Section 2808 of this code. Occupancies involving the indoor storage of loose combustible fibers in amounts exceeding the *maximum allowable quantity per control area* as set forth in Section 5003.1 shall comply with Sections 3704.2 through 3704.6.

❖ This section identifies Section 2808 of the code as the appropriate standard for the exterior storage of combustible fibers. The material hazards presented by combustible fibers are similar to the wood chips, hogged materials, fines, compost, raw materials and solid biomass feedstock regulated by Section 2808. This section further indicates that the more restrictive

indoor storage of combustible fibers regulated by Sections 3704.2 through 3704.6 is for those facilities that have amounts exceeding the maximum allowable quantity per control area (MAQ) as set forth in Section 5003.1. If the hazards are controlled so as to eliminate the application of Table 5003.1.1 of the code [IBC Table [F]307.1(1)] and IBC Section 307.5, the increased protection levels for a Group H-3 occupancy would not be necessary.

**3704.2 Storage of 100 cubic feet or less.** Loose *combustible fibers* in quantities of not more than 100 cubic feet (3 m<sup>3</sup>) located in a structure shall be stored in a metal or metal-lined bin equipped with a self-closing cover.

- ❖ Small amounts of material may be stored inside a building in approved containers. Acceptable receptacles include metal or metal-lined containers with self-closing lids that help prevent the loose fibers from being ignited by outside sources such as cigarettes, candles, friction, sparks, etc. The term “self-closing” means that the lid is equipped with an approved device or is otherwise arranged to operate in a manner that will ensure its closing after having been opened. In many cases, these types of bins are top-opening and need nothing more than gravity to meet this requirement. See the commentary to the definition of “Self-closing” in Chapter 2.

**3704.3 Storage of more than 100 cubic feet to 500 cubic feet.** Loose *combustible fibers* in quantities exceeding 100 cubic feet (3 m<sup>3</sup>) but not exceeding 500 cubic feet (14 m<sup>3</sup>) shall be stored in rooms enclosed with 1-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both, with openings protected by an *approved* opening protective assembly having a *fire protection rating* of  $\frac{3}{4}$  hour in accordance with the *International Building Code*.

- ❖ Moderate quantities of material must be stored in 1-hour fire-resistance-rated rooms. Openings in floors, walls and ceilings must be protected with self-closing or automatic-closing  $\frac{3}{4}$ -hour fire doors or windows in approved frames. Section 707 of the IBC deals with the construction of and fire-resistance ratings for fire barriers and with fire barriers used for separation of incidental use areas.

**3704.4 Storage of more than 500 cubic feet to 1,000 cubic feet.** Loose *combustible fibers* in quantities exceeding 500 cubic feet (14 m<sup>3</sup>) but not exceeding 1,000 cubic feet (28 m<sup>3</sup>) shall be stored in rooms enclosed with 2-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both, with openings protected by an *approved* opening protective assembly having a *fire protection rating* of 1½ hours in accordance with the *International Building Code*.

- ❖ Large amounts of material require a 2-hour fire-resistance-rated enclosure. Openings in floors, walls and ceilings require self-closing or automatic-closing, 1½-

hour fire doors or windows in approved frames. Again, the IBC establishes the requirements for the construction of fire barriers and required opening protectives.

**3704.5 Storage of more than 1,000 cubic feet.** Loose *combustible fibers* in quantities exceeding 1,000 cubic feet (28 m<sup>3</sup>) shall be stored in rooms enclosed with 2-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both, with openings protected by an *approved* opening protective assembly having a *fire protection rating* of 1½ hours in accordance with the *International Building Code*. The storage room shall be protected by an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.

- ❖ The enclosure requirements in this section are the same as in Section 3704.4; however, if the storage quantity exceeds 1,000 cubic feet (28 m<sup>3</sup>), the storage room must be sprinklered for extra protection.

**3704.6 Detached storage structure.** Not more than 2,500 cubic feet (70 m<sup>3</sup>) of loose *combustible fibers* shall be stored in a detached structure suitably located, with openings protected against entrance of sparks. The structure shall not be occupied for any other purpose.

- ❖ Separate, special-purpose structures are required for the storage of extremely large volumes of loose material. Only loose fiber material may be stored in the structure, and openings must restrict the entrance of sparks. These occupancies must be classified in Group H-3, and must be constructed and protected in accordance with the IBC.

## SECTION 3705 BALED STORAGE

**3705.1 Bale size and separation.** Baled *combustible fibers* shall be limited to single blocks or piles not more than 25,000 cubic feet (700 m<sup>3</sup>) in volume, not including aisles or clearances. Blocks or piles of baled fiber shall be separated from adjacent storage by aisles not less than 5 feet (1524 mm) wide, or by flash-fire barriers constructed of continuous sheets of noncombustible material extending from the floor to a minimum height of 1 foot (305 mm) above the highest point of the piles and projecting not less than 1 foot (305 mm) beyond the sides of the piles.

- ❖ Bulk restrictions and aisle requirements for piles or blocks of combustible fibers are established in this section. These restrictions provide access for fire fighting and limit the fuel load of piles and blocks. Aisles or flash-fire barriers must be provided between piles and blocks. Aisles must be a minimum of 5 feet (1524 mm) wide to reduce the likelihood of horizontal fire spread between blocks or piles of stored material; and to provide fire fighters access to fires. In place of aisles, protection in the form of flash-fire barriers constructed of noncombustible materials is considered equivalent and may be used as specified in this sec-

## COMBUSTIBLE FIBERS

tion. Depending upon the height and array of the baled storage, the provisions of Chapter 32 may also apply to these materials.

Note that these provisions do not apply to densely packed baled cotton based on its exclusion from the definition of "Combustible fibers" in Section 202. See the commentary to the various cotton definitions in Section 202 for a discussion of the hazards of various cotton processing and storage operations.

**3705.2 Special baling conditions.** Sisal and other fibers in bales bound with combustible tie ropes, jute and other fibers that swell when wet, shall be stored to allow for expansion in any direction without affecting building walls, ceilings or columns. A minimum clearance of 3 feet (914 mm) shall be required between walls and sides of piles, except that where the storage compartment is not more than 30 feet (9144 mm) wide, the minimum clearance at side walls shall be 1 foot (305 mm), provided that a center aisle not less than 5 feet (1524 mm) wide is maintained.

❖ Allowances or clearances must be provided for the expansion of combustible fibers susceptible to swelling when wet. In addition to the lateral forces that these piles may create if placed against structural elements, their contribution to the building live load should be considered. This section prescribes clearances from building elements. Structural loading concerns should be referred to the building official or to a qualified structural engineer. As an example of special baling conditions, rolled paper is commonly stored on its side rather than on its end to promote water runoff. Structural damage has resulted from the expansion of wet paper rolls or bales of rags when minimum clearances were not provided.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

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**CHAPTERS 38 through 49  
RESERVED**



## Part V—Hazardous Materials

# Chapter 50: Hazardous Materials—General Provisions

### General Comments

The requirements of this chapter apply to all hazardous chemicals. Hazardous chemicals are defined as those that pose an unreasonable risk to the health and safety of operating or emergency personnel, the public and the environment if not properly controlled during handling, storage, manufacture, processing, packaging, use, disposal or transportation. The requirements of this chapter and associated chapters are considered the

minimum safety requirements for the use, production and storage of hazardous chemicals.

### Purpose

This chapter contains the general requirements for hazardous chemicals in all occupancies. The general provisions of this chapter are intended to be companion provisions with the specific requirements of Chapters 51 and 53 through 67 regarding a given hazardous material.

### SECTION 5001 GENERAL

**5001.1 Scope.** Prevention, control and mitigation of dangerous conditions related to storage, dispensing, use and handling of hazardous materials shall be in accordance with this chapter.

This chapter shall apply to all hazardous materials, including those materials regulated elsewhere in this code, except that where specific requirements are provided in other chapters, those specific requirements shall apply in accordance with the applicable chapter. Where a material has multiple hazards, all hazards shall be addressed.

#### Exceptions:

1. In retail or wholesale sales occupancies, the quantities of medicines, foodstuff or consumer products and cosmetics containing not more than 50 percent by volume of water-miscible liquids and with the remainder of the solutions not being flammable shall not be limited, provided such materials are packaged in individual containers not exceeding 1.3 gallons (5 L).
2. Quantities of alcoholic beverages in retail or wholesale sales occupancies shall not be limited providing the liquids are packaged in individual containers not exceeding 1.3 gallons (5 L).
3. Application and release of pesticide and agricultural products and materials intended for use in weed abatement, erosion control, soil amendment or similar applications where applied in accordance with the manufacturers' instructions and label directions.

4. The off-site transportation of hazardous materials where in accordance with Department of Transportation (DOTn) regulations.
5. Building materials not otherwise regulated by this code.
6. Refrigeration systems (see Section 606).
7. Stationary storage battery systems regulated by Section 608.
8. The display, storage, sale or use of fireworks and *explosives* in accordance with Chapter 56.
9. *Corrosives* utilized in personal and household products in the manufacturers' original consumer packaging in Group M occupancies.
10. The storage of distilled spirits and wines in wooden barrels and casks.
11. The use of wall-mounted dispensers containing alcohol-based hand rubs classified as Class I or II liquids where in accordance with Section 5705.5.

❖ The purpose of Exception 1 is to address consumer products, foodstuffs and cosmetics that are not formulated with flammable constituents and are stored and displayed in Group M occupancies, provided the individual package is limited to a volume of 1.3 gallons (5 L) or less. In the event of a leak or broken package, the amount of hazardous material lost would be small and present a smaller spill cleanup problem. This is limited to products containing no more than 50 percent by volume of water-miscible liquids and with the remaining content not being flammable, based on the code's definition of "Flammable liquid." This percentage limitation further reduces the

hazard of a material spill due to the difficult ignitability of such materials. This exception would not apply to any Level 2 or 3 aerosol as defined in Chapter 2, because these consumer products are formulated with either a flammable propellant or a flammable base product. It also would not apply to many paints, coatings, adhesives or lubricants formulated with flammable or combustible liquids. Consumer products, such as household bleach (which is typically a mixture of less than 12.5-percent sodium hypochlorite by volume and water) or window cleaners (typically formulated with 3 to 6 percent by volume of ammonium hydroxide) would be exempted by this exception, as would a 1-gallon (3.9 L) bottle containing a solution of 37-percent hydrochloric acid and water used for disinfecting swimming pool water or for cleaning concrete surfaces.

Similar to Exception 1, Exception 2 deals with the amount of storage allowed in Group M occupancies where individual containers of alcoholic beverages do not exceed 1.3 gallons (5 L) in wholesale and retail stores. In the event of a leak or broken consumer package, the amount of flammable or combustible beverage lost would be small and present a smaller spill cleanup problem. This exception parallels Section 5701.2, Exception 3.

Exception 3 states that the application of pesticides and agricultural products is not considered a hazardous process if done in accordance with the manufacturer's instructions and label directions, since those products and pesticides have been tested in these application methods.

Exception 4 states that any time hazardous materials are transported over public highways or by public transportation, U.S. Department of Transportation (DOTn) requirements must be enforced. The code intends that when a material, good or commodity is transported off site, it is within the domain of the DOTn while the material is in transit. In the case of hazardous materials, DOTn has ruled that the activities associated with preparing the material for shipment, such as selection of the type of shipping container, placarding the container to identify its hazards and the preparation of shipping papers, are within the domain of DOTn and that local codes [e.g., the *International Fire Code*<sup>®</sup> (IFC<sup>®</sup>)] are preempted by the Hazardous Materials Transportation Act. Commonly, this includes storing goods and materials at a railroad siding for several months before they are consigned for shipment. The code has no authority when the material is in transit, including while shipping papers are being prepared or are in effect. Note, however, that while the code exempts hazardous materials in transportation, it does not exempt the facility where these materials are packaged and prepared for shipment.

Once the material reaches the point where it has been delivered and the shipping papers have been received by the consignee (e.g., the party responsible for the material), the goods or commodity are no longer

within the domain of DOTn and the applicable regulatory requirements are those adopted fire and building codes of the jurisdiction whose enforcement and interpretation is the responsibility of the fire code official.

Exception 5 exempts commonly used building materials that may exhibit some hazardous properties, but do not fall into the realm of a hazardous materials as defined in the code, from being regulated as hazardous material. Without this exception, the storage of certain building materials could result in a Group H occupancy classification.

Exception 6 states that refrigeration systems are governed by Section 606, which has specific requirements that would be enforced over any general requirements of the hazardous material chapters of the code.

Exception 7 notes that stationary storage battery systems are governed by Section 608, which has specific requirements that would be enforced over any general requirements of the hazardous material chapters of the code. Note that the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>) considers this an incidental storage area. See Table 509 of the IBC for incidental use area requirements.

Exception 8 refers to Chapter 56 for specific requirements concerning fireworks and explosives. Those specific requirements would be enforced over any general requirements of the hazardous material chapters of the code.

Exception 9 states that corrosives used in personal and household products, such as certain cleaners or detergents, are not considered hazardous when maintained in their original packaging in Group M areas. Note that this is specific to Group M use areas only. However, this exception does not apply to small containers of flammable aerosols or liquids in retail display areas where they are regulated in Chapter 51 or 57, respectively. Without this exception, many common products in mercantile display areas could be classified as hazardous materials resulting in grocery stores and other mercantile occupancies being inappropriately classified in occupancy classification Group H.

Exception 10 covers the storage of distilled spirits and wines in wooden barrels and casks. This statement may appear to exempt all requirements for these products from being a Group H occupancy. However, the IBC will still classify the storage area as a Group H occupancy if the amounts exceed the maximum allowable quantities (MAQs) per control area listed in Table 307.1(1) of that code for flammable or combustible liquids. All requirements for a Group H occupancy in the IBC are still applicable; however, any requirements from the code are not.

Exception 11 provides a necessary cross reference to provisions in Section 5705.5 to prevent alcohol-based hand rub dispensers from being considered the same as other flammable liquids and exempting them from the limitations of Table 5003.1.1(1).

**5001.1.1 Waiver.** The provisions of this chapter are waived where the *fire code official* determines that such enforcement is preempted by other codes, statutes or ordinances. The details of any action granting such a waiver shall be recorded and entered in the files of the code enforcement agency.

❖ If the fire code official determines that the requirements of this chapter are preempted by other codes, statutes or ordinances, he or she has the authority to waive the requirements of this chapter. Documentation must be placed into the files of the code enforcement agency stating the reasons for the waiver.

**5001.2 Material classification.** Hazardous materials are those chemicals or substances defined as such in this code. Definitions of hazardous materials shall apply to all hazardous materials, including those materials regulated elsewhere in this code.

❖ Hazardous materials are chemicals or substances defined in the code as such. Be sure to view the Material Safety Data Sheets (MSDS) for information on the properties of the material.

**5001.2.1 Mixtures.** Mixtures shall be classified in accordance with hazards of the mixture as a whole. Mixtures of hazardous materials shall be classified in accordance with nationally recognized reference standards; by an *approved* qualified organization, individual, or Material Safety Data Sheet (MSDS); or by other *approved* methods.

❖ Mixtures are to be classified to their specific blend of chemicals, i.e., as a whole, not as to their component ingredients. The MSDS are required sources of information on the properties of the chemical mixtures.

**5001.2.2 Hazard categories.** Hazardous materials shall be classified according to hazard categories. The categories include materials regulated by this chapter and materials regulated elsewhere in this code.

❖ The properties of the chemical will mandate the hazard categories under which the chemical is listed. These properties are found in the MSDS.

**5001.2.2.1 Physical hazards.** The material categories listed in this section are classified as *physical hazards*. A material with a primary classification as a *physical hazard* can also pose a *health hazard*.

1. *Explosives* and blasting agents.
2. *Combustible liquids*.
3. Flammable solids, liquids and gases.
4. Organic peroxide solids or liquids.
5. Oxidizer, solids or liquids.
6. Oxidizing gases.
7. Pyrophoric solids, liquids or gases.
8. Unstable (reactive) solids, liquids or gases.
9. Water-reactive materials solids or liquids.
10. *Cryogenic fluids*.

❖ This section lists those hazardous materials regulated in Chapters 51 and 53 through 67 that are clas-

sified as a physical hazard. The definition for the term “physical hazard” is located in Section 202. Because of their potential detonation or fire hazard, buildings containing more than the MAQ of hazardous materials listed in this section are classified as Group H-1, H-2 or H-3. Materials posing multiple hazards must be classified as both a health hazard and physical hazard, and meet the requirements of both classifications.

**5001.2.2.2 Health hazards.** The material categories listed in this section are classified as *health hazards*. A material with a primary classification as a *health hazard* can also pose a *physical hazard*.

1. Highly toxic and toxic materials.
2. *Corrosive* materials.

❖ This section lists those hazardous materials regulated in Chapters 51 and 53 through 67 that are classified as a health hazard. When hazardous chemicals pose more of a health problem than a fire, explosion or reactivity hazard, buildings containing more than the MAQ of hazardous materials listed in this section are classified as Group H-4. This section also notes that a hazardous material may pose multiple hazards and thus be considered both a physical hazard and health hazard. For example, a material classified as toxic or corrosive may also be a Class 2 or 3 oxidizer. Requirements for each material classification are applicable where a multiple hazard exists.

**5001.3 Performance-based design alternative.** Where *approved* by the *fire code official*, buildings and facilities where hazardous materials are stored, used or handled shall be permitted to comply with this section as an alternative to compliance with the other requirements set forth in this chapter and Chapters 51 through 67.

❖ The purpose of performance-based design criteria is to promote innovative, flexible and responsive solutions that optimize the expenditure and consumption of resources while preserving social and economic value. The model codes, including the *International Codes*® (I-Codes®), have traditionally incorporated alternative materials, designs and methods of construction provisions, such as those found in Section 104.9. This section provides a framework and opportunity to use new materials and methods when design equivalence to the prescriptive requirements of the code is demonstrated to and approved by the fire code official.

Large chemical manufacturing and production facilities are typically required to comply with federal risk management plans (RMP) and process safety management (PSM) requirements, which require a level of safety that generally exceeds current hazardous materials regulations in the code. This section is intended to be compatible with federal RMP and PSM programs, so it would reduce the burden on businesses in having to comply with duplicative or conflicting local and federal regulations. Yet, compliance with these provisions will yield a level of safety that

should equal or exceed the prescriptive code requirements.

Based on the fact that performance-based approaches are already in widespread use in federal laws regulating chemical storage and handling facilities, the topic of hazardous materials regulation stands out as a good place to start phasing performance-based concepts into the code. While a casual glance through the text of Section 5001.3 might lead one to conclude that the proposed section represents a huge loophole for the industry to jump through to avoid compliance with the code's prescriptive requirements, a closer investigation will reveal that this is not the case. This text, duplicated from Chapter 22 of the *ICC Performance Code® for Buildings and Facilities* (ICCPC®), was developed by trying to incorporate federal RMP and PSM regulations and then looking through the code's prescriptive hazardous materials regulations to pick up any topics that appeared to have been overlooked.

The text of this section was developed through a cooperative effort of fire officials and industry representatives in the IFC Performance Code Development Forum. Those who worked on the text believed that compliance with the proposed provisions would yield a facility that would be at least as safe, if not safer, than a facility constructed in accordance with the code's prescriptive requirements.

It is absolutely true that use of this approach would require a tremendous amount of time, money and effort on the part of a permit applicant to demonstrate code compliance to local fire code officials, and clearly, the approach will not be for everyone; however, even for those who might not use the approach in its entirety, the performance objectives would greatly assist code users and enforcers when dealing with alternative methods by better defining the intent of the code.

See the ICCPC and its "User's Guide" for a more comprehensive discussion of performance-based design concepts and philosophy.

**5001.3.1 Objective.** The objective of Section 5001.3 is to protect people and property from the consequences of unauthorized discharge, fires or explosions involving hazardous materials.

❖ The intent and scope of this section is to protect the occupants of the building, people in the surrounding area, emergency response personnel and property from acute consequences associated with unintended or unauthorized releases of hazardous materials. These performance-based design requirements encourage the use of both accident prevention and control measures to reduce risk.

It is not the intent of this section or the prescriptive requirements of the code to regulate all hazardous materials. Within the scopes of building and fire codes, hazardous materials are generally defined as those materials that are acutely dangerous to people or property. Building and fire codes in the United

States usually defer regulation of materials that present only a risk of chronic or environmental effects to other regulatory agencies, such as the Occupational Safety and Health Administration (OSHA) or the Environmental Protection Agency (EPA). Exposure of workers to hazardous materials in the normal course of their jobs is also beyond the scope of building and fire codes. Such workplace safety issues are instead regulated by occupational safety and health codes, which in the United States fall under the jurisdiction of OSHA.

When developing a performance-based design involving hazardous materials concerns, consideration should be given not only to the hazardous materials categories in Section 5001.2.2, but also to the quantity, state, situation (storage/use), arrangement and location of materials and processes.

**5001.3.2 Functional statements.** Performance-based design alternatives are based on the following functional statements:

1. Provide safeguards to minimize the risk of unwanted releases, fires or explosions involving hazardous materials.
2. Provide safeguards to minimize the consequences of an unsafe condition involving hazardous materials during normal operations and in the event of an abnormal condition.

❖ This section includes two functional statements that serve the overall objective of Section 5001.3. These two statements focus on reducing the probability of unsafe conditions involving hazardous materials and minimizing the consequences of an unsafe condition, if one occurs. The concepts can be summarized as prevention and control. Specific means by which these functional statements can be accommodated are listed in Section 5001.3.3.

**5001.3.3 Performance requirements.** Where safeguards, systems, documentation, written plans or procedures, audits, process hazards analysis, mitigation measures, engineering controls or construction features are required by Sections 5001.3.3.1 through 5001.3.3.18, the details of the design alternative shall be subject to approval by the *fire code official*. The details of actions granting the use of the design alternatives shall be recorded and entered in the files of the jurisdiction.

❖ Section 5001.3 allows the use of this section of the code based on the approval of the fire code official; however, the specifics of the design alternatives selected by designers, evaluators and operators should also be subject to review by a third party representing the public. The fire code official has the responsibility to verify that the performance alternatives provided by Section 5001.3 will protect from conditions hazardous to life, property or public welfare, as required by Section 101.2. When acceptance for the use of the design is granted, a record of the approval should be made in the public record to document acceptance of the design alternative.

**5001.3.3.1 Properties of hazardous materials.** The physical- and health-hazard properties of hazardous materials on site shall be known and shall be made readily available to employees, neighbors and the *fire code official*.

❖ This section correlates with the reporting requirements set forth in the Superfund Amendments and Reauthorization Act of 1986 (SARA Title III) and to some degree with the prescriptive reporting requirements set forth in the code. Compliance with these reporting requirements can be accomplished through the use of MSDS; inventory reports; SARA Title III reporting documents, which are typically mandatory under federal law; and Section 5001.5.2. This section ensures that interested parties will have access to information about the characteristics of hazardous materials that are located on site.

**5001.3.3.2 Reliability of equipment and operations.** Equipment and operations involving hazardous materials shall be designed, installed and maintained to ensure that they reliably operate as intended.

❖ Equipment and operations at facilities regulated by federal PSM rules should have little difficulty demonstrating compliance with the requirements of this section. The PSM rules generally address this topic area.

At facilities that are not required to comply with PSM rules, the selection of equipment and design of operations would have to go through a great deal of scrutiny by qualified individuals. In addition, equipment manuals and operational protocols would need to be developed and followed, as applicable.

**5001.3.3.3 Prevention of unintentional reaction or release.** Safeguards shall be provided to minimize the risk of an unintentional reaction or release that could endanger people or property.

❖ Facilities regulated by federal RMP rules are required to evaluate the potential consequences of various release scenarios on the surrounding area; therefore, many such facilities provide safety systems to reduce these potential consequences, recognizing that the consequence analysis information must be made available to the public.

Depending on the classification and state (solid, liquid or gas) of hazardous materials stored or used at a given site, a variety of mitigation measures may be provided to comply with this provision. Such measures might include process controls, spill control and containment systems, and ventilation controls.

**5001.3.3.4 Spill mitigation.** Spill containment systems or means to render a spill harmless to people or property shall be provided where a spill is determined to be a plausible event and where such an event would endanger people or property.

❖ This requirement is primarily derived from the prescriptive provisions in the code. As a general rule, storage facilities are regarded as less likely candidates for dangerous spills than facilities that involve dispensing or processing operations. In addition, dangerous spill conditions are probably more likely to occur in facilities with large quantity vessels or sys-

tems than those with only small containers. Information that may be useful in determining whether a spill is plausible and whether dangerous conditions would result includes the following:

- Specific material and process hazards involved.
- A block flow diagram for the facility.
- Piping and instrument drawings.
- A list of all safety devices showing their location, design basis and capacity, date of installation, etc.
- Equipment manufacturers' operational instructions, including safe operating limits for the equipment.
- Equipment drawings and specifications that reflect built and installed equipment.

**5001.3.3.5 Ignition hazards.** Safeguards shall be provided to minimize the risk of exposing combustible hazardous materials to unintended sources of ignition.

❖ The primary design and operating intent is to ensure that flammable and combustible materials are always completely controlled, in accordance with process design parameters; however, where flammable and combustible hazardous materials are present, a degree of redundancy is sometimes necessary to provide an additional level of safety. Where there is a plausible risk of spills or leaks, such as in loading and unloading or packaging operations, additional measures, such as ignition source controls, are prudent. To that end, process design and operation should ensure to the greatest degree possible that ignition sources are kept away from areas where flammable or combustible hazardous materials are present. Where separation is not feasible, ignition source controls may be warranted. Such controls may involve the following:

- Electrical classification of areas where flammable hazardous materials might be present.
- Classification of mobile equipment that might operate in areas where flammable hazardous materials might be present.
- The use of grounding systems and equipment to minimize the potential for sparking in areas where flammable hazardous materials might be present.

**5001.3.3.6 Protection of hazardous materials.** Safeguards shall be provided to minimize the risk of exposing hazardous materials to a fire or physical damage whereby such exposure could endanger or lead to the endangerment of people or property.

❖ This section directs the designer and operator to review and ensure that vessels or systems containing hazardous materials are not exposed to or are protected from damage by external fire. The design should focus, first, on reducing the possibility for fire or other hazards, such as vehicular impact, and, sec-

ond, on isolating hazardous materials from exposure to unsafe conditions, such as a fire.

All storage areas and systems should be formally reviewed to find and correct any sources of exposure to fire, including the following:

- Nearby storage of combustibles.
- Nearby hot work operation.
- Nearby vehicular operation.

All systems subject to fire exposure should be formally reviewed to ensure adequate protection, including the following:

- Sprinkler installation.
- Insulation of equipment.
- Fire-resistance-rated barriers.

**5001.3.3.7 Exposure hazards.** Safeguards shall be provided to minimize the risk of and limit damage from a fire or explosion involving explosive hazardous materials whereby such fire or explosion could endanger or lead to the endangerment of people or property.

❖ This section directs the designer and operator to review and ensure that vessels or systems containing hazardous materials are not subject to damage from internal fire, chemical reaction or explosion. The design criteria should be, first, to reduce the risk of an internal fire or explosion and, second, where the first is not feasible, to design vessels and systems in such a manner that loss of integrity will not occur in an overpressure situation.

All systems should be formally reviewed to identify and correct any sources of internal fire, explosion or overpressure. The review should include the following:

- The potential for inadvertent or improper mixing of reactive components.
- The potential for overheating of unstable materials.
- The potential for inadequate venting of unstable reaction byproducts.
- The potential for inadequate diluent material supply.

Where overpressure or explosion conditions cannot be reasonably ruled out, the design should consider overpressure protection, containment and explosion control systems.

**5001.3.3.8 Detection of gas or vapor release.** Where a release of hazardous materials gas or vapor would cause immediate harm to persons or property, means of mitigating the dangerous effects of a release shall be provided.

❖ This section increases the likelihood that hazardous vapor releases are detected and mitigated before they can harm individuals or property. In occupied areas, detection of a vapor release may be by sight, smell or an automatic detection system. For many hazardous materials, such as chlorine or ammonia, vapor releases are readily evident before concentra-

tions are truly hazardous based on the presence of vapor fog or a noxious odor. Where this is not the case, automatic detection systems and alarms may be warranted. Sensors can take the form of ambient sampling devices at strategic area locations, sampling devices in key vent streams or specially designed leak-detection systems, such as acoustic emission systems. The performance measurement is based on the ability of the sensing equipment or operators to provide adequate warning so that safety precautions can be taken before unsafe conditions are present.

Mitigation-based solutions can range from special process equipment designs to elaborate ventilation and air-scrubbing systems. Where practical, the simplest mitigation consists of overdesign of the process system so that the likelihood of release is extremely low. The performance measurement of a ventilation or treatment system is based on the reduction of the concentration of the hazardous materials in the workplace and nearby environment to levels that are not acutely hazardous.

**5001.3.3.9 Reliable power source.** Where a power supply is relied upon to prevent or control an emergency condition that could endanger people or property, the power supply shall be from a reliable source.

❖ This section is derived from the prescriptive requirements of the code. It is essential to ensure that a reliable power supply is provided for systems that are critical to safety. Some examples of systems that may require a reliable power supply include mechanical ventilation systems; treatment systems; gas detection and alarm systems; and emergency shutdown systems. The reliability needs of the system are related to the potential risks associated with system failure.

A reliable power source does not necessarily equate to a generator or battery system. The type of system to be used depends on the relative level of hazard that might result in the event of a power failure. In some cases, such as those where hazardous processes shut down upon loss of power, a connection ahead of the building's main disconnect switch may be adequate to qualify as a reliable source. Guidance on the selection and performance requirements for power supply systems providing an alternative source of electrical power can be found in NFPA 110.

**5001.3.3.10 Ventilation.** Where ventilation is necessary to limit the risk of creating an emergency condition resulting from normal or abnormal operations, means of ventilation shall be provided.

❖ In many cases involving hazardous materials, ventilation must be provided to limit the risk of creating an emergency condition. Ventilation might be necessary during both normal and abnormal operating conditions. Some examples of operations that may require ventilation are storage or processing of flammable and combustible liquids or gases inside buildings;

drum-filling operations inside buildings; laboratory use of chemicals and dust-handling systems. Ventilation may also be used as a means for reducing vapor concentrations below lower flammable limits (LFL) in areas where ignition sources are present or for pressurization of areas to isolate hazardous vapors.

Guidance on the performance requirements for ventilation systems can be found in a number of sources, including the OSHA Process Safety Management (PSM) regulations, DOL 29 CFR Part 1910.119; NFPA 30; NFPA 45; NFPA 69; and NFPA 497.

**5001.3.3.11 Process hazard analyses.** Process hazard analyses shall be conducted to ensure reasonably the protection of people and property from dangerous conditions involving hazardous materials.

❖ This section establishes an administrative safety control plan addressing process hazard analysis. Guidance on process hazard analysis techniques can be found in the OSHA PSM regulation, DOL 29 CFR, Part 1910.119. The process hazard analysis must be appropriate to the complexity of the process and must identify, evaluate and control the hazards involved in the process. The analysis can be accomplished through various methods. Some of these are “what-if” scenarios, process hazard analysis, fault tree, etc. A person trained in these and other hazard evaluation techniques should be employed to complete this analysis.

**5001.3.3.12 Pre-startup safety review.** Written documentation of pre-startup safety review procedures shall be developed and enforced to ensure that operations are initiated in a safe manner. The process of developing and updating such procedures shall involve the participation of affected employees.

❖ This section establishes an administrative safety control plan addressing prestartup safety review procedures. Guidance on techniques for written documentation of prestartup safety review procedures can be found in the OSHA PSM regulation, DOL 29 CFR, Part 1910.119. Prestartup safety reviews are typically necessary when new facilities are prepared for operation and where existing facilities are modified to a degree that is significant enough to require a change in the process safety information.

A prestartup safety review should confirm that, prior to the introduction of highly hazardous chemicals to a process, the following verifications have been accomplished at a minimum:

- Construction and equipment is in accordance with design specifications.
- Safety, operating, maintenance and emergency procedures are in place and are adequate.
- For new facilities, a process hazard analysis has been performed and recommendations have been resolved or implemented before startup; for modified facilities, requirements contained in

management of change documents have been met.

- Training of each employee involved in operating a process has been completed.

**5001.3.3.13 Operating and emergency procedures.** Written documentation of operating procedures and procedures for emergency shut down shall be developed and enforced to ensure that operations are conducted in a safe manner. The process of developing and updating such procedures shall involve the participation of affected employees.

❖ This section establishes an administrative safety control plan addressing written documentation of operating and emergency shutdown procedures. Guidance on developing written documentation for operating procedures and emergency shutdown techniques can be found in the OSHA PSM regulation, DOL 29 CFR, Part 1910.119. Overall, there are 14 elements that employers covered by PSM are required to complete to meet the federal PSM regulations. Two elements that relate to this section are as follows:

- DOL 29 CFR Part 1910.119(c): This element requires that employees and their representatives be consulted on the development and conduct of hazard assessments and the development of chemical accident prevention plans, and provide access to these and other records required under the federal law.
- DOL 29 CFR Part 1910.119(f): This element requires that written operating procedures for the chemical process, including procedures for each operating phase, operating limitations, and safety and health considerations, must be developed and implemented.

**5001.3.3.14 Management of change.** A written plan for management of change shall be developed and enforced. The process of developing and updating the plan shall involve the participation of affected employees.

❖ This section establishes an administrative safety control plan addressing management of change. Guidance on developing written documentation for management of change can be found in the OSHA PSM regulation, DOL 29 CFR, Part 1910.119. The PSM element that relates to this section is DOL 29 CFR, Part 1910.119 (l), which states that this element requires a review of the technical basis for the proposed change; the impact of change on safety and health; possible modifications to operating procedures and process safety information; the necessary time period for the change; and authorization requirements for the proposed change.

Employees involved in operating a process, and maintenance and contract employees whose job tasks will be affected by a change in the process, should be informed of and trained in the change prior to startup of the process or the affected part of the process.

**5001.3.3.15 Emergency plan.** A written emergency plan shall be developed to ensure that proper actions are taken in the event of an emergency, and the plan shall be followed if an emergency condition occurs. The process of developing and updating the plan shall involve the participation of affected employees.

❖ This section establishes an administrative safety control plan addressing emergency response planning. Guidance on developing written documentation for an emergency response plan can be found in the OSHA PSM regulation, DOL 29 CFR, Part 1910.119. The PSM element that relates to this section is 29 CFR, Part 1910.119(n), which references other portions of the federal regulations. Such plans may include identification of actions to be taken by employees in the event of an emergency and the assignment of a staff liaison who can assist emergency response personnel.

**5001.3.3.16 Accident procedures.** Written procedures for investigation and documentation of accidents shall be developed, and accidents shall be investigated and documented in accordance with these procedures.

❖ This section establishes an administrative safety control plan addressing accident investigation and reporting. Guidance on accident investigation and reporting can be found in the OSHA PSM regulation, DOL 29 CFR, Part 1910.119. The PSM element that relates to this section is DOL 29 CFR, Part 1910.119(m).

Some of the guidelines specified in the federal regulations include the following:

- The need for an incident investigation team to be established, consisting of at least one person knowledgeable in the process involved, a contract employee if the incident involved contractor work and other persons with appropriate knowledge and experience to thoroughly investigate and analyze the incident.
- The need for a report to be prepared at the conclusion of each investigation, including, at a minimum, the date of the incident and when the investigation began; description of the incident; factors that contributed to the incident and recommendations resulting from the investigation.
- The need for the establishment of a system to promptly address and resolve the incident report findings and recommendations, and to document resolutions and corrective actions.
- The need for accident investigation reports to be reviewed by all affected persons whose job tasks are relevant to the incident findings, including contract employees, where applicable.

**5001.3.3.17 Consequence analysis.** Where an accidental release of hazardous materials could endanger people or property, either on or off-site, an analysis of the expected consequences of a plausible release shall be performed and

utilized in the analysis and selection of active and passive hazard mitigation controls.

❖ This section establishes an administrative safety control plan addressing an analysis of off-site consequences. Guidance on accident investigation and reporting can be found in the EPA RMP regulation, 40 CFR, Part 68. These regulations amend the accident release prevention requirements under Section 112(r) of the Clean Air Act.

EPA's RMP rules are a good source of examples for alternative release scenarios for a particular site, and, through the identification and analysis of plausible release scenarios, changes can be implemented to minimize the probability and consequences of a release. A plausible release is one that has occurred in the past or could occur under reasonable single-system failures.

Devices that normally use some kind of motion or energy to prevent or minimize the release represent active mitigation controls. Active mitigation controls might include valves, switches, pumps and blowers. Passive mitigation controls include devices that are permanently in place and have an inherently safe design that allows them to be used at all times. Passive mitigation controls might include dikes, walls, ponds and sumps.

The off-site consequence analysis can be accomplished through various methods. Those methods include "what-if" scenarios, process hazard analysis, Hazard and Operability Analysis (HAZOP) and fault tree. A person trained in these and other hazard evaluation techniques should be used to complete this analysis.

**5001.3.3.18 Safety audits.** Safety audits shall be conducted on a periodic basis to verify compliance with the requirements of this section.

❖ This section establishes an administrative safety control plan addressing safety compliance audits. Guidance on safety audits can be found in the OSHA PSM regulation, DOL 29 CFR, Part 1910.119. The PSM element that relates to this section is DOL 29 CFR, Part 1910.119(o). On a routine basis, each facility must review its continuing compliance with each of the subsections in Section 5001.3 and other related provisions of the code. The word "periodic" reflects a need for adequate frequency to check that safety programs, features and systems will perform as intended. Recognizing that many code sections contain issues that change very little over time, compliance audit frequencies will not be the same for all programs, features and systems. Depending on the particular safety element, the audit frequency may range to as much as 5-year intervals under the PSM regulations.

**5001.4 Retail and wholesale storage and display.** For retail and wholesale storage and display of nonflammable solid and nonflammable or noncombustible liquid hazardous materials

in Group M occupancies and storage in Group S occupancies, see Section 5003.11.

- ❖ This section deals only with nonflammable solid and nonflammable or noncombustible liquid hazardous materials in Group M and S occupancies. For flammable or combustible liquids, see Section 5704.3.4 of the code.

**5001.5 Permits.** Permits shall be required as set forth in Sections 105.6 and 105.7.

When required by the *fire code official*, permittees shall apply for approval to permanently close a storage, use or handling facility. Such application shall be submitted not less than 30 days prior to the termination of the storage, use or handling of hazardous materials. The *fire code official* is authorized to require that the application be accompanied by an *approved* facility closure plan in accordance with Section 5001.6.3.

- ❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit and Section 105.7 for a general discussion of activities requiring a construction permit. The permit process also notifies the fire department of the need for prefire planning for the hazardous property.

**5001.5.1 Hazardous Materials Management Plan.** Where required by the *fire code official*, an application for a permit shall include a Hazardous Materials Management Plan (HMMP). The HMMP shall include a facility site plan designating the following:

1. Access to each storage and use area.
  2. Location of emergency equipment.
  3. Location where liaison will meet emergency responders.
  4. Facility evacuation meeting point locations.
  5. The general purpose of other areas within the building.
  6. Location of all above-ground and underground tanks and their appurtenances including, but not limited to, sumps, vaults, below-grade treatment systems and piping.
  7. The hazard classes in each area.
  8. Locations of all control areas and Group H occupancies.
  9. Emergency exits.
- ❖ This section requires information that allows emergency responders to understand the basic construction and access features of a building or premises to be presented. Such features include emergency exits that can be used for access; the physical and health hazards of hazardous materials stored and used

within particular areas; where emergency responders will meet the fire department liaison; and the location of all above-ground and underground tanks, sumps, vaults or any other below-grade processes. This information is extremely beneficial to emergency responders because it identifies locations where confined space entries may need to be performed. A Hazardous Materials Management Plan (HMMP) must also identify which areas are constructed as control areas and Group H occupancies.

HMMPs have commonly been used as tools to help facilitate tactical preplanning of Group H occupancies or facilities storing and handling large amounts of hazardous materials, such as petroleum storage terminals. HMMPs can be beneficial when preparing tactical preplans, but can be cumbersome if actually used as a tactical preplan. For example, consider a water treatment plant. Such a plant could have large amounts of anhydrous chlorine, sulfur dioxide, sodium hydroxide and hydrofluorosilic acid. To comply with all of the requirements of an HMMP for the various storage and process piping drawings, plant layout and process details could easily result in over 100 pages of information that would need to be read and understood. This level of information has not always been beneficial to emergency responders, especially given that Section 5003.9.1.1 requires the permit holder to designate responsible persons to serve as fire department liaisons in the event of an incident. It is expected that these responsible persons have a good understanding of the hazardous materials and the processes involving their storage and use.

All plans must be legible and should be drawn to scale or dimensioned and be kept updated. The fire code official may waive the requirement for an HMMP. By themselves, approvals of the building or site may suffice for the HMMP when dealing with small quantities of hazardous materials not posing a complex storage, use or maintenance problem.

Appendix H [Hazardous Materials Management Plan (HMMP) and Hazardous Materials Inventory Statement (HMIS) Instructions] was developed to provide a standard reporting format for businesses submitting an HMMP to the fire or building code official. Appendix H is not a mandatory appendix unless it is adopted by the jurisdiction. Some jurisdictions have already developed standard formats for submission of HMMPs, and Appendix H can be amended to provide this information to the regulated community.

**5001.5.2 Hazardous Materials Inventory Statement (HMIS).** Where required by the *fire code official*, an application for a permit shall include an HMIS, such as Superfund Amendments and Reauthorization Act of 1986 (SARA) Title III, Tier II Report or other *approved* statement. The HMIS shall include the following information:

1. Product name.
2. Component.
3. Chemical Abstract Service (CAS) number.

4. Location where stored or used.
  5. Container size.
  6. Hazard classification.
  7. Amount in storage.
  8. Amount in use-*closed systems*.
  9. Amount in use-*open systems*.
- ❖ HMIS requirements provide information that will prove beneficial to building and fire code officials, plans examiners and fire code inspectors who are attempting to determine that the amount of hazardous materials in storage and use complies with the applicable requirements of the code and the IBC. An HMIS must document the product's name, its chemical constituents along with its respective Chemical Abstract Service (CAS) numbers, the volume of containers or tanks, the product's hazard classification and the amount in storage, use-open systems and use-closed systems. This type of information is beneficial for plans examiners to confirm the correct occupancy classification, if the mechanical ventilation system should comply with Section 510 of the *International Mechanical Code*<sup>®</sup>, (IMC<sup>®</sup>), as well as to verify that the design of the process(es) complies with the applicable requirements of the code.

To provide the necessary information for proper occupancy classification, IBC Section 414.1.3 requires that information similar to the requirements for an HMIS be provided to the building code official. This section now requires that plans reflect where hazardous materials will be stored and used in multiple-story buildings, which is necessary to verify compliance with Table 5003.8.3.2 and IBC Table 414.2.2.

SARA Title III, known as the Emergency Planning and Right to Know Act, established requirements for emergency planning and reporting on hazardous materials. SARA Title III, Tier II reports are representative of a typical HMIS as required by this section. The exception, which is listed in SARA and is similar to Section 5001.4.1, leaves the requirement for submission of the HMIS up to the discretion of the fire code official for circumstances in which hazards can be managed without the need for HMIS.

A new Appendix H [Hazardous Materials Management Plan (HMMP) and Hazardous Materials Inventory Statement (HMIS) Instructions] was developed to provide a standard reporting format for businesses submitting an HMIS to the fire or building code official. Appendix H is not a mandatory appendix unless it is adopted by the jurisdiction. Some jurisdictions have already developed standard formats for submittal of HMISs, and Appendix H can be amended to provide this information to the regulated community.

**5001.6 Facility closure.** Facilities shall be placed out of service in accordance with Sections 5001.6.1 through 5001.6.3.

- ❖ This section contains requirements for handling and disposing of hazardous materials prior to a facility's closure. The 30-day notice prior to the facility's clo-

sure is intended to enable proper measures to be taken for disposing of or eliminating all hazardous materials before the building owner vacates the premises.

**5001.6.1 Temporarily out-of-service facilities.** Facilities that are temporarily out of service shall continue to maintain a permit and be monitored and inspected.

- ❖ Facilities warranting a closure plan are considered to be either temporarily or permanently out of service. Although a facility may not be closed permanently, this section recognizes the need to regulate hazardous materials in buildings that may be temporarily out of service. Because the out-of-service condition may be temporary, the storage or presence of any hazardous materials in a facility must be monitored and inspected, as required by the fire code official.

**5001.6.2 Permanently out-of-service facilities.** Facilities for which a permit is not kept current or is not monitored and inspected on a regular basis shall be deemed to be permanently out of service and shall be closed in an *approved* manner. Where required by the *fire code official*, permittees shall apply for approval to close permanently storage, use or handling facilities. The *fire code official* is authorized to require that such application be accompanied by an *approved* facility closure plan in accordance with Section 5001.6.3.

- ❖ Facilities warranting a closure plan are considered to be either temporarily or permanently out of service. A facility is to be classified as permanently out of service if approval is not kept current as required for a temporarily out-of-service facility or it is not properly monitored or inspected, as required by the fire code official.

**5001.6.3 Facility closure plan.** Where a facility closure plan is required in accordance with Section 5001.5 to terminate storage, dispensing, handling or use of hazardous materials, it shall be submitted to the *fire code official* not less than 30 days prior to facility closure. The plan shall demonstrate that hazardous materials that are stored, dispensed, handled or used in the facility will be transported, disposed of or reused in a manner that eliminates the need for further maintenance and any threat to public health and safety.

- ❖ This plan is used to document the timetable for the proper transportation, disposal or approved reuse of all chemicals that are on site. It is important to note that this could include any contaminated soils or dike facilities in the area.

## SECTION 5002 DEFINITIONS

**5002.1 Definitions.** The following terms are defined in Chapter 2:

**BOILING POINT.**

**CEILING LIMIT.**

**CHEMICAL.**

**CHEMICAL NAME.**

CLOSED CONTAINER.  
 CONTAINER.  
 CONTROL AREA.  
 CYLINDER.  
 DAY BOX.  
 DEFLAGRATION.  
 DESIGN PRESSURE.  
 DETACHED BUILDING.  
 DISPENSING.  
 EXCESS FLOW CONTROL.  
 EXHAUSTED ENCLOSURE.  
 EXPLOSION.  
 FLAMMABLE VAPORS OR FUMES.  
 GAS CABINET.  
 GAS ROOM.  
 HANDLING.  
 HAZARDOUS MATERIALS.  
 HEALTH HAZARD.  
 IMMEDIATELY DANGEROUS TO LIFE AND HEALTH (IDLH).  
 INCOMPATIBLE MATERIALS.  
 LIQUID.  
 LOWER EXPLOSIVE LIMIT (LEL).  
 LOWER FLAMMABLE LIMIT (LFL).  
 MATERIAL SAFETY DATA SHEET (MSDS).  
 MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA.  
 NORMAL TEMPERATURE AND PRESSURE (NTP).  
 OUTDOOR CONTROL AREA.  
 PERMISSIBLE EXPOSURE LIMIT (PEL).  
 PESTICIDE.  
 PHYSICAL HAZARD.  
 PRESSURE VESSEL.  
 SAFETY CAN.  
 SECONDARY CONTAINMENT.  
 SEGREGATED.  
 SOLID.  
 STORAGE, HAZARDOUS MATERIALS.  
 SYSTEM.  
 TANK, ATMOSPHERIC.  
 TANK, PORTABLE.  
 TANK, STATIONARY.  
 TANK VEHICLE.  
 UNAUTHORIZED DISCHARGE.  
 USE (MATERIAL).

## VAPOR PRESSURE.

- ❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

## SECTION 5003 GENERAL REQUIREMENTS

**5003.1 Scope.** The storage, use and handling of all hazardous materials shall be in accordance with this section.

- ❖ Once a chemical is considered a hazardous chemical that is not exempt under the exceptions of Section 5001.1, it is expected to meet the general requirements listed in Section 5003 and any of the referenced codes or standards.

**5003.1.1 Maximum allowable quantity per control area.** The *maximum allowable quantity per control area* shall be as specified in Tables 5003.1.1(1) through 5003.1.1(4).

For retail and wholesale storage and display in Group M occupancies and Group S storage, see Section 5003.11.

- ❖ This section references Tables 5003.1.1(1) through 5003.1.1(4) for the maximum quantities allowed in a control area (see Section 5003.8.2 for design and protection requirements). If the quantity of chemicals used in a building does not exceed the maximum allowed per control area and the number of control areas does not exceed the number and percentage of chemicals allowed by Table 5003.8.3.2, those areas are considered part of the main use and do not have to meet all of the requirements for a hazardous occupancy.

**TABLE 5003.1.1(1).** See page 50-17.

- ❖ Table 5003.1.1(1) is subdivided based on whether the material is in storage or in use in a closed or open system. Definitions of both “Closed” and “Open” systems are found in Section 202. Within these subdivisions, the appropriate MAQ is listed in accordance with the physical state (solid, liquid or gas) of the material. A column for gas in open systems is not indicated because gaseous hazardous materials should not be allowed in a system that is continuously open to the atmosphere. Note that the third column of the table, “Group When the Maximum Allowable Quantity Is Exceeded,” is informational only, since occupancy group determination is within the scope of the IBC, not the code.

Note also that the MAQ values for gases are indicated (at the head of each gas column) as being “at NTP,” i.e., at a “normal” temperature of 70°F (21°C) and a pressure of one atmosphere, or 14.7 pounds per square inch absolute (psia) (101 kPa). In other

words, the MAQs for gases are based on a certain volume of free gas, not gas under pressure in its cylinder.

This table and Table 5003.1.1(3) for outdoor storage include a row for inert gases and inert cryogenics, thus clarifying that the amount of inert gases and inert cryogenics in storage or use is unlimited. There is also a definition in Section 202 for “Inert gas” that provides a means of classifying gases considered inert under conditions most commonly encountered by fire code officials. This definition ensures that inert compressed gases, inert cryogenic fluids or gas mixtures containing cryogenic fluid are properly classified. See the commentary to that definition in Section 202.

Even though the quantity of inert gases and cryogenics is not limited inside of a building, they are still subject to regulation. For example, storage of inert gases and cryogenic fluids requires an operational permit in accordance with Sections 105.6.9 and 105.6.11, respectively. In addition, Section 5307 has requirements for a mechanical ventilation system designed and operated in accordance with Section 5004.3 for storage and Section 5005.1.9 for use when a room or building contains inert compressed gases. Rooms containing inert cryogenic compressed gases are required to comply with the construction and mechanical ventilation requirements in Section 5504.2.

The unit of measure for liquefied gases has historically been incorporated into the MAQ tables in terms of gallons (L) because that has been the conventional thinking. From a practical standpoint, the use of gallons (L) as a unit of measure for liquefied gases introduces an inconsistency into the concept due to the fact that, unlike most liquids, the density of liquefied gases varies widely.

In commerce, liquefied gases are packaged and distributed based on weight as the unit of measure. The table has been revised to reflect threshold quantities in terms of the units of measure that are readily available from the commercial market and greatly simplifies the use of the code, thereby making it more user friendly. The revision required that a model be used as the basis for comparison. This approach was taken when thresholds were revised to base certain health-hazard threshold levels using a “chlorine index” as the model. A similar approach was used as a means to simplify the use of the table.

In the case of liquefied flammable gases, probably the most commonly encountered liquefied gas is LP-gas (LPG). LPG as defined can consist of propane, butane, propylene or others either in a mixed or pure form. NFPA 58, Table B.1.2(a), lists the approximate densities of commercial propane and butane at 60°F (16°C) as 4.20 and 4.81 pounds per gallon, respectively. Converting the 30-gallon (114 L) quantity to pounds and rounding up to the closest 5 pounds (2.3 kg) yields a quantity of 150 pounds (68 kg) on a weight basis. The density of butane is greater than

that of propane, therefore representing the worst case where mixtures of propane and butane are involved. The result of converting the 30-gallon (114 L) threshold to a 150-pound (68 kg) threshold is in keeping with the philosophical approach used with gases, such as ammonia and chlorine, as they appear in Table 5003.1.1(2).

The threshold level of 15 gallons (57 L) for oxidizing gases is now expressed in terms of weight based on using any of a number of oxidizing gases as the baseline. However, given the fact that a single cylinder of chlorine (an oxidizing, corrosive and toxic gas) has been used as the baseline in Table 5003.1.1(2), it is reasonable to use a single cylinder of chlorine as the baseline for the establishment of quantity in Table 5003.1.1(1), as well. To test the assumption, a comparison was made to the 1,500-cubic-foot (42 m<sup>3</sup>) baseline maximum quantity for a nonliquefied gas using oxygen as the model. Using a specific volume for oxygen of 12.1 cubic feet per pound translates the 1,500 cubic feet (42 m<sup>3</sup>) allowed for the baseline MAQ to 125 pounds (57 kg) if this gas was considered on a weight basis. The use of 150 pounds (68 kg) as a baseline quantity for liquefied oxidizing gases resolves the problem where a single cylinder of chlorine would not trip the Group H-4 occupancy threshold, but would trip the Group H-3 occupancy threshold where arguably the inherent health hazards of the gas may represent a greater concern for public safety than do the physical hazards of the same gas.

It is recognized that this approach may appear to represent a major increase in the threshold for liquefied oxidizing gases; however, it brings the threshold levels into parity with those of liquefied flammable gases, which may represent the greater hazard given the potential for fire and/or explosion. The example using oxygen as the baseline shows that an increase is justified and establishes a clear rationale that is based on practical examples of materials commonly found in commerce, which have generally been accepted for use as the threshold for an increased level of control. In addition, the use of weight as a unit of measure brings the code into correlation with units typically used by the suppliers of these products, thereby mitigating the need for elaborate conversions into units of measure not found in common use.

Note a refers the user to Section 5003.8.3 to determine if a design strategy using the control area concept is needed for a building to avoid being classified in Group H.

Note b clearly indicates that the aggregate quantity of hazardous materials in use and storage, within a given control area, cannot exceed the quantity listed in the table for storage.

Without Note c, many common alcoholic beverages and household products containing a negligible amount of a hazardous material could result in a Group M occupancy being classified as a high hazard. Note c also recognizes the reduced hazard of the materials based on their water miscibility and limited

container size. A similar exception is indicated in Table 5003.1.1(2), and in IBC Tables 307.1(1) and 307.1(2).

Notes d and e of the table are significant in that, for certain materials, the MAQ may be increased due to the use of approved special hazardous material storage methods as listed in the note, an approved automatic sprinkler system, or both. The notes are intended to be cumulative in that up to four times the base MAQ may be allowed per control area, if the building is sprinklered and approved special storage methods are used, without classifying the building as Group H. While the use of approved special storage methods is not always a feasible or practical method of storage, they do provide sufficient additional protection to warrant an increase if utilized to contain the entire MAQ (not just the increase amount). For example, the tabular MAQ for the storage of Class IA flammable liquid is 30 gallons (114 L) and both Notes d and e apply. Applying the notes accumulatively, the increased MAQ becomes  $30 \times 2 = 60 \times 2 = 120$  gallons (454 L). Note e also requires that a safety can, when used for increasing the MAQ of flammable and combustible liquids stored or used indoors, be a listed metal safety can meeting the requirements of UL 30, as required by Section 5003.9.10 (also see the commentary to that section).

The code recognizes the relative lower hazard of Class IIIB liquids as compared to that of other flammable and combustible liquids by classifying them as Group H-3 and by establishing a base MAQ of 13,200 gallons (49 962 L). As indicated in Note f, the quantity of Class I oxidizers and Class IIIB liquids, without classifying the occupancy as Group H-3, would not be limited, provided the building is fully sprinklered in accordance with NFPA 13. The hazard presented by Class I oxidizers is that they slightly increase the burning rate of combustible materials that they may come into contact with during a fire. Class IIIB combustible liquids have flash points at or above 200°F (93°C). Motor oil is a typical example of a Class IIIB combustible liquid.

Note g recognizes that the hazard presented by certain materials is such that they may be stored or used only inside buildings that are fully sprinklered.

Note h clarifies for the user that while there is a combination MAQ for flammable liquids, no individual class of liquid (Class IA, IB or IC) may exceed its own individual MAQ.

Note i allows for a special quantity of inside combustible liquid storage in tanks that are connected to a fuel-oil piping system in accordance with Section 603.3.2. This would apply to most oil-fired stationary equipment, whether in industrial, commercial or residential occupancies. Oil-fired heating equipment and diesel engine-driven generator sets and their fuel supplies are indicative of the types of fuel-oil piping systems to which this note would apply.

Note k permits a larger amount of Class III oxidizers in a building when used for maintenance and

health purposes. The quantities proposed are reasonable for occupancies such as the health care industry where Class III oxidizers are used for maintenance purposes, sterilization and sanitation of equipment and operation sanitation. The method used to store the oxidizers is subject to the evaluation and approval of the fire code official.

Note l clarifies that the 125 pounds (57 kg) of storage permitted for consumer fireworks represents the net weight of the pyrotechnic composition of the fireworks in a nonsprinklered building. This amount represents approximately 12½ shipping cases (less than one and one-half pallet loads) of fireworks in a nonsprinklered storage condition. In cases where the net weight of the pyrotechnic composition of the fireworks is unknown, 25 percent of the gross weight of the fireworks is to be used. The gross weight is to include the weight of the packaging.

Note n provides an exception when the amount of hazardous material in storage and display in Group M and S occupancies meets the requirements of Section 5003.11.

While cotton is included in the definition of combustible fibers, Note o recognizes the lesser hazard of cotton when it is stored in densely packed bales. See the commentary to the Section 202 definitions of “Baled cotton, densely packed” and “Combustible fibers” for further information.

Note p clarifies that vehicles and appliances with closed fuel systems should be treated no differently than machinery or equipment when applying the provisions of the table. The fuel contained within the fuel tanks of vehicles or motorized equipment is not to be considered when calculating the aggregate quantity of hazardous materials within a control area of a building. For example, when evaluating a parking garage with several hundred cars parked inside, the capacity of their fuel tanks is not counted. Also, when motorized equipment, such as a floor buffer or forklift, is stored or used, those fuels are not included as long as the other code requirements are followed. This note also allows a reasonable amount of alcohol-based hand rub for infection control and patient safety located in Group I-2 occupancies in appropriately sized dispensers to be located in control areas and permits the amounts not to be included in determining the MAQ. Section 5705.5 addresses the specifics regarding these amounts and locations.

Note q draws attention to the particularly challenging hazards of combustible dusts. This note specifies that where combustible dusts are manufactured, generated or used, and the concentration of dust or operating conditions creates a fire or explosion hazard, the building or space must be classified as a Group H-2 occupancy. To avoid this occupancy classification, the analysis needs to demonstrate why such a classification is not warranted. It should include an analysis of the material’s characteristics, and the type of engineering and administrative controls that will be employed in the process to quantitatively mitigate the

risk of a dust deflagration. The basis for this determination must be documented in a technical report and opinion in accordance with Section 104.7.2 (or IBC Section 414.1.3). See also the commentary to the definition of “Combustible dust” in Chapter 2 and the commentary to Chapter 22.

**TABLE 5003.1.1(2).** See page 50-20.

❖ Table 5003.1.1(2), similar to Table 5003.1.1(1), specifies the MAQs of hazardous materials, liquids or chemicals allowed per control area before having to classify a part of the building (or the entire building) as a Group H occupancy and is subdivided based on whether the material is in storage or in use in a closed or open system. Definitions of both “Closed system” and “Open system” are found in Section 202. Within these subdivisions, the appropriate MAQ is listed in accordance with the physical state (solid, liquid or gas) of the material. A column for gas in open systems is not indicated because hazardous gaseous materials should not be allowed in a system that is continuously open to the atmosphere. This table contains health-hazard materials classified as Group H-4, in accordance with IBC Section 307.6.

While the materials listed in this table are considered health hazards, some of the materials may also possess physical hazard characteristics more indicative of materials classified as Group H-1, H-2 or H-3 (see IBC Section 5001.1). The MAQs listed in the table are indicative of industry practice and assume the materials are properly stored and handled, in accordance with the code. Group H-4 materials, while indeed hazardous, are primarily considered a handling problem and do not possess the same fire, explosion or reactivity potential associated with other hazardous materials.

Note that the MAQ values for gases are indicated (at the head of each gas column) as being “at NTP,” i.e., at a “normal” temperature of 70°F (21°C) and pressure of one atmosphere, or 14.7 psia (101 kPa). In other words, the MAQs for gases are based on a certain volume of free gas, not gas under pressure in its cylinder.

The MAQ of 810 cubic feet (23 m<sup>3</sup>) for corrosive and toxic gases established in the table was based on a single cylinder of chlorine. Historically, Note g to the table that existed in previous editions of the code (but which was deleted in 2009) recognized that a single cylinder of ammonia should be allowed; however, the use of 810 cubic feet (23 m<sup>3</sup>) did not allow for this given the fact that, by comparison, a 150-pound (68 kg) cylinder of ammonia contains over 3,300 cubic feet (93 m<sup>3</sup>) of gas. The preferred solution in lieu of trying to justify or create a series of footnotes to address individual gases was to use an index system that created a standardized approach to establish the unit of measure by using a widely distributed gas, such as chlorine, as an index. However, the unit of measure in terms of weight was not carried into the table when it was formulated, thereby creat-

ing the need for the use of footnotes to address ammonia. Compressed gases may be in liquid form or they may be gaseous. Maintaining the use of chlorine as the index to the table for toxic and corrosive properties and listing the threshold for liquefied gases (as well as those that are nonliquefied) eliminates the need for elaborate conversions in units of measure using data that in many cases is not readily available. The index used to establish the weight threshold is based on the use of arsine, a highly toxic gas with a specific volume of 5.0 cubic feet per pound.

It may be argued that recognizing the common forms of gases, e.g., liquefied and nonliquefied, allows a de facto increase in the threshold levels applied. It is possible that one could have a toxic gas that is liquefied and also one that is nonliquefied in the same area, therefore doubling the aggregate quantity of gas if all was considered. While this is theoretically possible, it is not considered to be the norm. In addition, there is precedent in using the approach as established in Table 5003.1.1(1) for flammable and oxidizing gases. Also see the commentary to Table 5003.1.1(1) for further discussion of liquefied gas MAQ units of measure.

Note b clearly indicates that the aggregate quantity of hazardous materials in use and storage, within a given control area, cannot exceed the quantity listed in the table for storage.

Without Note c, many common household products containing a negligible amount of a hazardous material could result in a Group M occupancy being classified as a high hazard. Note c recognizes the reduced hazard of the materials based on their water miscibility and limited container size. A similar exception is indicated in Table 5003.1.1(1), and IBC Tables 307.1(1) and 307.1(2).

Where applicable, Notes d and e provide an increase in the base maximum allowable amount similar to that in Table 5003.1.1(1) [see commentary, Table 5003.1.1(1)].

Note f provides an exception when the amount of hazardous material in storage and display in Group M and S occupancies meets the requirements of Section 5003.11.

Note g of the table is significant in that, for certain materials, their hazard is so great that their MAQ may be stored in the building only when approved exhausted enclosures or gas cabinets complying with Sections 5003.8.5 and 5003.8.6, respectively, are utilized.

**TABLE 5003.1.1(3).** See page 50-21.

❖ Table 5003.1.1(3) specifies the MAQs of hazardous materials, liquids or chemicals allowed per outdoor control area before being subject to additional regulations contained in Chapters 51 and 53 through 67, and is subdivided based on whether the material is in storage or in use in a closed or open system. Definitions of both “Closed system” and “Open system” are found in Section 202. Within these subdivisions, the

appropriate MAQ is listed in accordance with the physical state (solid, liquid or gas) of the material. A column for gas in open systems is not indicated because hazardous gaseous materials should not be allowed in a system that is continuously open to the atmosphere. This table contains physical-hazard materials, as defined in Section 202. While the materials listed in this table are considered physical hazards, some of the materials may also possess health-hazard characteristics, as defined in Section 202. The MAQs per outdoor control area listed in the table are indicative of industry practice and assume the materials are properly stored and handled in accordance with the code. The base MAQ per outdoor control area of 810 cubic feet (23 m<sup>3</sup>) for gases that are either corrosive or toxic is based on a standard-size chlorine cylinder. Note that the MAQ values for gases are indicated (at the head of each gas column) as being “at NTP,” i.e., at a “normal” temperature of 70°F (21°C) and pressure of one atmosphere, or 14.7 psia (101 kPa). In other words, the MAQs for gases are based on a certain volume of free gas, not gas under pressure in its cylinder.

Historically, the concept of “outdoor control areas” was introduced into the code as a means to establish a threshold where the general provisions of Chapter 50 would apply. When this table was created, the logic for assignment of threshold values was primarily based on the use of multipliers representing a multiple increase of the basic tabular values shown in Table 5003.1.1(1). In the first draft of the code, this table limited the MAQ of gaseous and liquefied flammable gases to 1,500 cubic feet (42 m<sup>3</sup>) and 15 gallons (57 L), respectively. The result was that the threshold level for liquefied flammable gases in interior areas was greater than that allowed for the same commodity when stored in outdoor areas. Assuming that the threshold level of 30 gallons (114 L) for indoor areas was correct, the value of 15 gallons (57 L) shown for outdoor areas is believed to have been in error. Code change F1324-98 increased the threshold quantities for flammable and oxidizing gases, as well as a number of other commodities, in storage in outdoor areas by a factor of 2 resulting in the increase for liquefied flammable gases from 15 to 30 gallons (57 to 114 L), furthering the inconsistency.

The table corrects the MAQ inconsistency for liquefied flammable gases and, as in Table 5003.1.1(1), changes the MAQ unit of measure to units of weight rather than those of volume. This eliminates confusing and elaborate calculations, thereby bringing the code closer into harmony with the commercial environment. The index system used to obtain a unit of measure for weight is based on multiples for a single 150-pound (68 kg) cylinder of butane for flammable gases and a single 150-pound (68 kg) cylinder for chlorine. The row for oxidizing gases provides consistency and correlates in concept with conversion to a weight basis [also see commentary, Table 5003.1.1(1)].

While hazardous materials within a closed or open system are considered to be “in use,” Note b clearly indicates that the aggregate quantity of hazardous materials in use and storage within a given outdoor control area cannot exceed the quantity listed in the table for storage.

Note c provides an exception when the amount of hazardous materials in outdoor storage in conjunction with a retail or wholesale Group M occupancy meets the requirements of Section 5003.11. The outside storage area must be under the same ownership as the Group M occupancy.

**TABLE 5003.1.1(4).** See page 50-22.

❖ Table 5003.1.1(4), similar to Table 5003.1.1(3), specifies the MAQs of hazardous materials, liquids or chemicals allowed per outdoor control area before being subject to additional regulations contained in Chapters 51 and 53 through 67. It is also subdivided based on whether the material is in storage or in use in a closed or open system. Definitions of both “Closed system” and “Open system” are found in Section 202. Within these subdivisions, the appropriate MAQ is listed in accordance with the physical state (solid, liquid or gas) of the material. A column for gas in open systems is not indicated because hazardous gaseous materials should not be allowed in a system that is continuously open to the atmosphere. This table contains health-hazard materials, as defined in Section 202.

While the materials listed in this table are considered health hazards, some of the materials may also possess physical-hazard characteristics, as defined in Section 202. The MAQs per outdoor control area listed in the table are indicative of industry practice and assume the materials are properly stored and handled in accordance with the code. These materials, while indeed hazardous, are primarily considered a handling problem and do not possess the same fire, explosion or reactivity hazard associated with other hazardous materials.

As in Tables 5003.1.1(1) through 5003.1.1(3), a weight unit of measure has been established for liquefied gas MAQs and the table has been revised to recognize that these materials may exist in liquid, as well as gaseous form. The index system used to establish the quantity for toxics and corrosives is based on multiples of a single 150-pound (68 kg) cylinder of chlorine. The index system used to establish the threshold quantity for highly toxic liquefied gases is based on arsine, a highly toxic gas with a specific volume of 5.0 cubic feet per pound [also see commentary, Table 5003.1.1(1)].

Note b clearly indicates that the aggregate quantity of hazardous materials in use and storage within a given outdoor control area cannot exceed the quantity listed in the table for storage.

Note c provides an exception when the amount of hazardous material in outdoor storage in conjunction with a retail or wholesale Group M occupancy meets the requirements of Section 5003.11. The outside

storage area must be under the same ownership as the Group M occupancy.

Note d of the table is significant in that, for certain materials, the hazard is so great that their MAQ may be stored only when approved exhausted enclosures or gas cabinets complying with Sections 5003.8.5 and 5003.8.6, respectively, or laboratory fume hoods are utilized.

Note e states that when toxic liquids with a vapor pressure in excess of 1 psia (7 kPa) at 77°F (25°C) are stored, the MAQ is limited to the amount listed for highly toxic materials.

**5003.1.2 Conversion.** Where quantities are indicated in pounds and where the weight per gallon of the liquid is not provided to the *fire code official*, a conversion factor of 10 pounds per gallon (1.2 kg/L) shall be used.

❖ If the weight of a liquid is not given either in the MSDS or in other documentation on the material, the fire code official is allowed to use a conversion rate of 10 pounds of liquid to 1 gallon of material (Note: 1 U.S. gallon = 0.1336805 cubic foot).

**5003.1.3 Quantities not exceeding the maximum allowable quantity per control area.** The storage, use and handling of hazardous materials in quantities not exceeding the *maximum allowable quantity per control area* indicated in Tables 5003.1.1(1) through 5003.1.1(4) shall be in accordance with Sections 5001 and 5003.

❖ See the commentary to Section 5003.1.1.

**5003.1.4 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of hazardous materials in quantities exceeding the *maximum allowable quantity per control area* indicated in Tables 5003.1.1(1) through 5003.1.1(4) shall be in accordance with this chapter.

❖ Once the amounts of chemicals exceed the maximum allowed in Tables 5003.1.1(1) through 5003.1.1(4) per control area, the area or building is considered a hazardous occupancy and must meet the general requirements and specific requirements in both the code and the IBC, based on the chemicals being used.

**5003.2 Systems, equipment and processes.** Systems, equipment and processes utilized for storage, dispensing, use or handling of hazardous materials shall be in accordance with Sections 5003.2.1 through 5003.2.8.

❖ Devices used in the process and storage or dispensing of hazardous materials are to meet the requirements of Sections 5003.1 through 5003.2.8.

**5003.2.1 Design and construction of containers, cylinders and tanks.** Containers, cylinders and tanks shall be designed and constructed in accordance with *approved* standards. Containers, cylinders, tanks and other means used for containment of hazardous materials shall be of an *approved* type. Pressure vessels not meeting DOTn requirements for transportation shall comply with the ASME *Boiler and Pressure Vessel Code*.

❖ This section sets forth requirements for the construction of containers, cylinders and tanks used for the storage of hazardous materials. It requires that pressure vessels be constructed in accordance with the ASME *Boiler and Pressure Vessel Code* (BPVC) where hazardous materials are stored, used or handled inside of vessels designed to be operated at pressures greater than 15 pounds per square inch gauge (psig) (103.4 kPa). This is consistent with the requirements for pressure vessels used for other than hazardous materials purposes, as set forth in Section 1003.1 of the IMC.

The reference to the BPVC is in response to an incident investigated by the United States Chemical Safety Board (USCSB) involving an improperly modified pressure vessel at the Marcus Oil Company in Houston, Texas. The 12-foot-diameter (305 mm), 50-foot-long (15 240 mm) pressure vessel, which had an empty weight of approximately 50,000 pounds (22 680 kg), lacked any evidence of being constructed in accordance with the BPVC. The pressure vessel was not equipped with a pressure relief device. The pressure vessel was modified by the company by using an oxygen-acetylene torch to add a steam line that was used to melt polyethylene wax. The cut section of the head was reinstalled and welded into place by welders who were not qualified to perform work on pressure vessels. After the vessel was modified, it was not subjected to a hydrostatic pressure test to determine if it would remain closed when subjected to its operating pressure.

The vessel was returned to service and was pressurized by a nitrogen/air mixture while heating the polyethylene wax at a temperature of 300°F (149°C). On the day of the incident, the vessel catastrophically failed and was propelled more than 150 feet (45 720 mm) into an adjacent business. A 900-pound (408 kg) section of the vessel was propelled 900 feet (274 m) away and a 2-pound (0.9 kg) steel plate was found in the front yard of a residence one-quarter mile from the explosion. Shattered glass and building structural damage occurred one-quarter mile away from the explosion.

TABLE 5003.1.1(1) MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD<sup>a, j, m, n, p</sup>

MATERIAL	CLASS	GROUP WHEN THE MAXIMUM ALLOWABLE QUANTITY IS EXCEEDED	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>					
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)			
Combustible dust	NA	H-2	See Note q	NA	NA	NA	See Note q	NA	NA	NA	See Note q	NA	NA	NA
Combustible fibers <sup>e</sup>	Loose Baled <sup>p</sup>	H-3	(100) (1,000)	NA	NA	NA	(100) (1,000)	NA	NA	NA	(20) (200)	NA	NA	NA
Combustible liquid <sup>c, i</sup>	II III A III B	H-2 or H-3 H-2 or H-3 NA	NA	120 <sup>d, e</sup> 330 <sup>d, e</sup> 13,200 <sup>o, f</sup>	NA	NA	NA	NA	120 <sup>d</sup> 330 <sup>d</sup> 13,200 <sup>f</sup>	NA	NA	NA	30 <sup>d</sup> 80 <sup>d</sup> 3,300 <sup>f</sup>	NA
Consumer fireworks	1.4G	H-3	125 <sup>e, 1</sup>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cryogenic Flammable	NA	H-2	NA	45 <sup>d</sup>	NA	NA	NA	NA	45 <sup>d</sup>	NA	NA	NA	10 <sup>d</sup>	NA
Cryogenic Inert	NA	NA	NA	NA	NL	NL	NA	NA	NA	NL	NA	NA	NA	NA
Cryogenic Oxidizing	NA	H-3	NA	45 <sup>d</sup>	NA	NA	NA	NA	45 <sup>d</sup>	NA	NA	NA	10 <sup>d</sup>	NA
Explosives	Division 1.1	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>	NA	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	(0.25) <sup>g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	(0.25) <sup>g</sup>	NA
	Division 1.2	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>	NA	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	(0.25) <sup>g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	(0.25) <sup>g</sup>	NA
	Division 1.3	H-1 or H-2	5 <sup>e, g</sup>	(5) <sup>e, g</sup>	NA	NA	1 <sup>g</sup>	(1) <sup>g</sup>	(1) <sup>g</sup>	NA	1 <sup>g</sup>	(1) <sup>g</sup>	(1) <sup>g</sup>	NA
	Division 1.4	H-3	50 <sup>e, g</sup>	(50) <sup>e, g</sup>	NA	NA	50 <sup>g</sup>	(50) <sup>g</sup>	(50) <sup>g</sup>	NA	50 <sup>g</sup>	(50) <sup>g</sup>	NA	NA
	Division 1.4G	H-3	125 <sup>d, e, 1</sup>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Division 1.5	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>	NA	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	(0.25) <sup>g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	(0.25) <sup>g</sup>	NA
Division 1.6	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Flammable gas	Gaseous Liquefied	H-2	NA	NA (150) <sup>d, e</sup>	1,000 <sup>d, e</sup> NA	1,000 <sup>d, e</sup> NA	NA	NA	NA (150) <sup>d, e</sup>	1,000 <sup>d, e</sup> NA	NA	NA	NA	NA
Flammable liquid <sup>c</sup>	IA	H-2 or H-3	NA	30 <sup>d, e</sup>	NA	NA	NA	NA	30 <sup>d</sup>	NA	NA	NA	10 <sup>d</sup>	NA
	IB and IC	H-3	NA	120 <sup>d, e</sup>	NA	NA	NA	NA	120 <sup>d</sup>	NA	NA	NA	30 <sup>d</sup>	NA
Flammable liquid, combination (IA, IB, IC)	NA	H-2 or H-3	NA	120 <sup>d, e, h</sup>	NA	NA	NA	NA	120 <sup>d, h</sup>	NA	NA	NA	30 <sup>d, h</sup>	NA
	NA	H-3	125 <sup>d, e</sup>	NA	NA	NA	125 <sup>d</sup>	NA	NA	NA	25 <sup>d</sup>	NA	NA	NA

(continued)



TABLE 5003.1.1(1)—continued  
 MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD<sup>a, i, m, n, p</sup>

MATERIAL	CLASS	GROUP WHEN ALLOWABLE QUANTITY IS EXCEEDED	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>			
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	
Inert Gas	Gaseous Liquefied	NA	NA	NL	NA	NA	NL	NA	NA	NL	NA	NA
		NA	NA	NL	NA	NA	NL	NA	NA	NL	NA	NA
Organic peroxide	UD	H-1	1 <sup>c, g</sup>	(1) <sup>c, g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>
	I	H-2	5 <sup>d, e</sup>	(5) <sup>d, e</sup>	NA	1 <sup>d</sup>	(1) <sup>d</sup>	1 <sup>d</sup>	(1) <sup>d</sup>	NA	1 <sup>d</sup>	(1) <sup>d</sup>
	II	H-3	50 <sup>d, e</sup>	(50) <sup>d, e</sup>	NA	50 <sup>d</sup>	(50) <sup>d</sup>	10 <sup>d</sup>	(10) <sup>d</sup>	NA	10 <sup>d</sup>	(10) <sup>d</sup>
	III	H-3	125 <sup>d, e</sup>	(125) <sup>d, e</sup>	NA	125 <sup>d</sup>	(125) <sup>d</sup>	25 <sup>d</sup>	(25) <sup>d</sup>	NA	25 <sup>d</sup>	(25) <sup>d</sup>
	IV	NA	NL	NL	NA	NL	NL	NL	NL	NA	NL	NL
V	NA	NL	NL	NA	NL	NL	NL	NL	NA	NL	NL	
Oxidizer	4	H-1	1 <sup>g</sup>	(1) <sup>c, g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>
	3 <sup>k</sup>	H-2 or H-3	10 <sup>d, e</sup>	(10) <sup>d, e</sup>	NA	2 <sup>d</sup>	(2) <sup>d</sup>	2 <sup>d</sup>	(2) <sup>d</sup>	NA	2 <sup>d</sup>	(2) <sup>d</sup>
	2	H-3	250 <sup>d, e</sup>	(250) <sup>d, e</sup>	NA	250 <sup>d</sup>	(250) <sup>d</sup>	50 <sup>d</sup>	(50) <sup>d</sup>	NA	50 <sup>d</sup>	(50) <sup>d</sup>
Oxidizing gas	Gaseous Liquefied	NA	4,000 <sup>e, f</sup>	(4,000) <sup>e, f</sup>	NA	4,000 <sup>f</sup>	(4,000) <sup>f</sup>	1,000 <sup>f</sup>	(1,000) <sup>f</sup>	NA	1,000 <sup>f</sup>	(1,000) <sup>f</sup>
		H-3	NA	NA	1,500 <sup>d, e</sup>	NA	1,500 <sup>d, e</sup>	NA	NA	1,500 <sup>d, e</sup>	NA	NA
Pyrophoric	NA	H-2	4 <sup>c, g</sup>	(4) <sup>c, g</sup>	50 <sup>c, g</sup>	1 <sup>g</sup>	(1) <sup>g</sup>	0	0	10 <sup>c, g</sup>	0	0
Unstable (reactive)	4	H-1	1 <sup>c, g</sup>	(1) <sup>c, g</sup>	10 <sup>c, g</sup>	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	2 <sup>c, g</sup>	0.25 <sup>g</sup>	(0.25) <sup>g</sup>
	3	H-1 or H-2	5 <sup>d, e</sup>	(5) <sup>d, e</sup>	50 <sup>d, e</sup>	1 <sup>d</sup>	(1) <sup>d</sup>	1 <sup>d</sup>	(1) <sup>d</sup>	10 <sup>d, e</sup>	1 <sup>d</sup>	(1) <sup>d</sup>
	2	H-3	50 <sup>d, e</sup>	(50) <sup>d, e</sup>	750 <sup>d, e</sup>	50 <sup>d</sup>	(50) <sup>d</sup>	10 <sup>d</sup>	(10) <sup>d</sup>	750 <sup>d, e</sup>	10 <sup>d</sup>	(10) <sup>d</sup>
	1	NA	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL
Water reactive	3	H-2	5 <sup>d, e</sup>	(5) <sup>d, e</sup>	NA	5 <sup>d</sup>	(5) <sup>d</sup>	1 <sup>d</sup>	(1) <sup>d</sup>	NA	1 <sup>d</sup>	(1) <sup>d</sup>
	2	H-3	50 <sup>d, e</sup>	(50) <sup>d, e</sup>	NA	50 <sup>d</sup>	(50) <sup>d</sup>	10 <sup>d</sup>	(10) <sup>d</sup>	NA	10 <sup>d</sup>	(10) <sup>d</sup>
	1	NA	NL	NL	NA	NL	NL	NL	NL	NA	NL	NL

For SI: 1 cubic foot = 0.02832 m<sup>3</sup>, 1 pound = 0.454 kg, 1 gallon = 3.785 L.

NA = Not Applicable, NL = Not Limited, UD = Unclassified Detonable.

a. For use of control areas, see Section 5003.8.3.

b. The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

c. The quantities of alcoholic beverages in retail and wholesale sales occupancies shall not be limited providing the liquids are packaged in individual containers not exceeding 1.3 gallons. In retail and wholesale sales occupancies, the quantities of medicines, foodstuff or consumer products and cosmetics containing not more than 50 percent by volume of water-miscible liquids with the remainder of the solutions not being flammable shall not be limited, provided that such materials are packaged in individual containers not exceeding 1.3 gallons.

d. Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both notes shall be applied accumulatively.

(continued)

**TABLE 5003.1.1(1)—continued**  
**MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD<sup>a, i, m, n, p</sup>**

- e. Maximum allowable quantities shall be increased 100 percent where stored in approved storage cabinets, day boxes, gas cabinets, gas rooms, exhausted enclosures or in listed safety cans in accordance with Section 5003.9.10. Where Note d also applies, the increase for both notes shall be applied accumulatively.
- f. Quantities shall not be limited in a building equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1.
- g. Allowed only in buildings equipped throughout with an approved automatic sprinkler system.
- h. Containing not more than the maximum allowable quantity per control area of Class IA, Class IB or Class IC flammable liquids.
- i. The maximum allowable quantity shall not apply to fuel oil storage complying with Section 603.3.2.
- j. Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.
- k. A maximum quantity of 200 pounds of solid or 20 gallons of liquid Class 3 oxidizers is allowed where such materials are necessary for maintenance purposes, operation or sanitation of equipment where the storage containers and the manner of storage are approved.
- l. Net weight of pyrotechnic composition of the fireworks. Where the net weight of the pyrotechnic composition of the fireworks is not known, 25 percent of the gross weight of the fireworks including packaging shall be used.
- m. For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 5003.1.2.
- n. For storage and display quantities in Group M and storage quantities in Group S occupancies complying with Section 5003.11, see Table 5003.11.1.
- o. Densely-packed baled cotton that complies with the packing requirements of ISO 8115 shall not be included in this material class.
- p. The following shall not be included in determining the maximum allowable quantities:
1. Liquid or gaseous fuel in fuel tanks on vehicles.
  2. Liquid or gaseous fuel in fuel tanks on motorized equipment operated in accordance with this code.
  3. Gaseous fuels in piping systems and fixed appliances regulated by the *International Fuel Gas Code*.
  4. Liquid fuels in piping systems and fixed appliances, regulated by the *International Mechanical Code*.
  5. Alcohol-based hand rubs classified as Class I or II liquids in dispensers that are installed in accordance with Sections 5705.5 and 5705.5.1. The location of the alcohol-based hand rub (ABHR) dispensers shall be provided in the construction documents.
- q. Where manufactured, generated or used in such a manner that the concentration and conditions create a fire or explosion hazard based on information prepared in accordance with Section 104.7.2.

TABLE 5003.1.1(2) MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIAL POSING A HEALTH HAZARD<sup>a, c, f, h, i</sup>

MATERIAL	STORAGE <sup>b</sup>		USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>		
	Solid pounds <sup>a, e</sup>	Liquid gallons (pounds) <sup>d, e</sup>	Gas cubic feet at NTP (pounds) <sup>d</sup>	Solid pounds <sup>d</sup>	Liquid gallons (pounds) <sup>d</sup>	Gas cubic feet at NTP (pounds) <sup>d</sup>	Solid pounds <sup>d</sup>	Liquid gallons (pounds) <sup>d</sup>
Corrosives	5,000	500	Gaseous 810 <sup>e</sup> Liquefied (150)	5,000	500	Gaseous 810 <sup>e</sup> Liquefied (150)	1,000	100
Highly Toxics	10	(10)	Gaseous 20 <sup>g</sup> Liquefied (4) <sup>g</sup>	10	(10)	Gaseous 20 <sup>g</sup> Liquefied (4) <sup>g</sup>	3	(3)
Toxics	500	(500)	Gaseous 810 <sup>e</sup> Liquefied (150) <sup>e</sup>	500	(500)	Gaseous 810 <sup>e</sup> Liquefied (150) <sup>e</sup>	125	(125)

For SI: 1 cubic foot = 0.02832 m<sup>3</sup>, 1 pound = 0.454 kg, 1 gallon = 3.785 L.

- a. For use of control areas, see Section 5003.8.3.
- b. The aggregate quantity in use and storage shall not exceed the quantity listed for storage.
- c. In retail and wholesale sales occupancies, the quantities of medicines, foodstuff or consumer products and cosmetics, containing not more than 50 percent by volume of water-miscible liquids and with the remainder of the solutions not being flammable, shall not be limited, provided that such materials are packaged in individual containers not exceeding 1.3 gallons.
- d. Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both notes shall be applied accumulatively.
- e. Maximum allowable quantities shall be increased 100 percent where stored in approved storage cabinets, gas cabinets or exhausted enclosures. Where Note d also applies, the increase for both notes shall be applied accumulatively.
- f. For storage and display quantities in Group M and storage quantities in Group S occupancies complying with Section 5003.11, see Table 5003.11.1.
- g. Allowed only where stored in approved exhausted gas cabinets or exhausted enclosures.
- h. Quantities in parentheses indicate quantity units in parentheses at the head of each column.
- i. For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 5003.1.2.

**TABLE 5003.1.1(3)  
MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD IN AN OUTDOOR CONTROL AREA<sup>a, b, c, d</sup>**

MATERIAL	CLASS	STORAGE <sup>b</sup>		USE-CLOSED SYSTEMS <sup>b</sup>		USE-OPEN SYSTEMS <sup>b</sup>			
		Solid pounds (cubic feet)	Liquid gallons (pounds) <sup>d</sup>	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds) <sup>d</sup>	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds) <sup>d</sup>
Flammable gas	Gaseous Liquefied	Not Applicable	Not Applicable (300)	3,000 Not Applicable	Not Applicable	Not Applicable	1,500 Not Applicable	Not Applicable	Not Applicable
Flammable solid	Not Applicable	500	Not Applicable	Not Applicable	250	Not Applicable	Not Applicable	50	Not Applicable
Inert Gas	Gaseous Liquefied	Not Applicable	Not Applicable	Not Limited	Not Applicable	Not Applicable	Not Limited	Not Applicable	Not Applicable
Cryogenic inert	Not Applicable	Not Applicable	Not Applicable	Not Limited	Not Applicable	Not Applicable	Not Limited	Not Applicable	Not Applicable
Organic peroxide	Unclassified Detonable	1	(1)	Not Applicable	0.25	(0.25)	Not Applicable	0.25	(0.25)
Organic peroxide	I	20	(20)	Not Applicable	10	(10)	Not Applicable	2	(2)
	II	200	(200)		100	(100)		20	(20)
	III	500	(500)		250	(250)		50	(50)
	IV	1,000	(1,000)		500	(500)		100	(100)
	V	Not Limited	Not Limited		Not Limited	Not Limited		Not Limited	Not Limited
Oxidizer	4	2	(2)	Not Applicable	1	(1)	Not Applicable	0.25	(0.25)
	3	40	(40)		20	(20)		4	(4)
	2	1,000	(1,000)		500	(500)		100	(100)
	1	Not Limited	Not Limited		Not Limited	Not Limited		Not Limited	Not Limited
Oxidizing gas	Gaseous Liquefied	Not Applicable	Not Applicable (600)	6,000 Not Applicable	Not Applicable	Not Applicable	1,500 Not Applicable	Not Applicable	Not Applicable
Pyrophoric materials	Not Applicable	8	(8)	100	4	(4)	10	0	0
Unstable (reactive)	4	2	(2)	Not Applicable	1	(1)	Not Applicable	0.25	(0.25)
	3	20	(20)		10	(10)		1	(1)
	2	200	(200)		100	(100)		10	(10)
Water reactive	1	Not Limited	Not Limited	1,500	Not Limited	Not Limited	Not Limited	Not Limited	Not Limited
	3	20	(20)	Not Applicable	10	(10)	Not Applicable	1	(1)
	2	200	(200)		100	(100)		10	(10)
1	Not Limited	Not Limited	Not Limited		Not Limited	Not Limited		Not Limited	

For SI: 1 pound = 0.454 kg, 1 gallon = 3.785 L, 1 cubic foot = 0.02832 m<sup>3</sup>.

a. For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 5003.1.2.

b. The aggregate quantities in storage and use shall not exceed the quantity listed for storage.

c. The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials allowed in outdoor storage per single property under the same ownership or control used for retail or wholesale sales is allowed to exceed the maximum allowable quantity per control area where such storage is in accordance with Section 5003.11.

d. Quantities in parentheses indicate quantity units in parentheses at the head of each column.

TABLE 5003.1.1(4) MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A HEALTH HAZARD IN AN OUTDOOR CONTROL AREA<sup>a, b, c, f</sup>

MATERIAL	STORAGE		USE-CLOSED SYSTEMS			USE-OPEN SYSTEMS		
	Solid pounds	Liquid gallons (pounds)	Gas cubic feet at NTP (pounds)	Solid pounds	Liquid gallons (pounds)	Gas cubic feet at NTP (pounds)	Solid pounds	Liquid gallons (pounds)
Corrosives	20,000	2,000	Gaseous 1,620 Liquefied (300)	10,000	1,000	Gaseous 810 Liquefied (150)	1,000	100
Highly toxics	20	(20)	Gaseous 40 <sup>d</sup> Liquefied (8) <sup>d</sup>	10	(10)	Gaseous 20 <sup>d</sup> Liquefied (4) <sup>d</sup>	3	(3)
Toxics	1,000	(1,000) <sup>e</sup>	Gaseous 1,620 Liquefied (300)	500	50 <sup>e</sup>	Gaseous 810 Liquefied (150)	125	(125) <sup>e</sup>

For SI: 1 cubic foot = 0.02832 m<sup>3</sup>, 1 pound = 0.454 kg, 1 gallon = 3.785 L, 1 pound per square inch absolute = 6.895 kPa, °C = [(°F)-32]/1.8].

- a. For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 5003.1.2.
- b. The aggregate quantities in storage and use shall not exceed the quantity listed for storage.
- c. The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials allowed in outdoor storage per single property under the same ownership or control used for retail or wholesale sales is allowed to exceed the maximum allowable quantity per control area where such storage is in accordance with Section 5003.1.1.
- d. Allowed only where used in approved exhausted gas cabinets, exhausted enclosures or under fume hoods.
- e. The maximum allowable quantity per control area for toxic liquids with vapor pressures in excess of 1 psia at 77°F shall be the maximum allowable quantity per control area listed for highly toxic liquids.
- f. Quantities in parentheses indicate quantity units in parentheses at the head of each column.

**5003.2.2 Piping, tubing, valves and fittings.** Piping, tubing, valves, and fittings conveying hazardous materials shall be designed and installed in accordance with ASME B31 or other approved standards, and shall be in accordance with Sections 5003.2.2.1 and 5003.2.2.2.

❖ The design and construction of piping, tubing, valves and fittings must meet the requirements listed in Chapters 50 through 67, and the referenced standard or other approved standards acceptable to the fire code official. ASME B31 is the primary code for pressure piping. It is divided into nine sections, each regulating a different type of piping, and it has detailed requirements for installation, inspection and testing. Including ASME B31 in this general section on hazardous material piping will assist designers in referencing the correct standard in project specifications.

**5003.2.2.1 Design and construction.** Piping, tubing, valves, fittings and related components used for hazardous materials shall be in accordance with the following:

1. Piping, tubing, valves, fittings and related components shall be designed and fabricated from materials that are compatible with the material to be contained and shall be of adequate strength and durability to withstand the pressure, structural and seismic stress and exposure to which they are subject.
2. Piping and tubing shall be identified in accordance with ASME A13.1 to indicate the material conveyed.
3. Readily accessible manual valves or automatic remotely activated fail-safe emergency shutoff valves shall be installed on supply piping and tubing at the following locations:
  - 3.1. The point of use.
  - 3.2. The tank, cylinder or bulk source.
4. Manual emergency shutoff valves and controls for remotely activated emergency shutoff valves shall be identified and the location shall be clearly visible, accessible and indicated by means of a sign.
5. Backflow prevention or check valves shall be provided where the backflow of hazardous materials could create a hazardous condition or cause the unauthorized discharge of hazardous materials.
6. Where gases or liquids having a hazard ranking of:
  - Health Class 3 or 4
  - Flammability Class 4
  - Instability Class 3 or 4

in accordance with NFPA 704 are carried in pressurized piping above 15 pounds per square inch gauge (psig) (103 kPa), an *approved* means of leak detection and emergency shutoff or excess flow control shall be provided. Where the piping originates from within a hazardous material storage room or area, the excess flow control shall be located within the storage room or area. Where the piping originates from a

bulk source, the excess flow control shall be located as close to the bulk source as practical.

**Exceptions:**

1. Piping for inlet connections designed to prevent backflow.
  2. Piping for pressure relief devices.
- ❖ This section specifies minimum design requirements for any piping system handling hazardous materials. All associated piping, valves and fittings should also be compatible with the material to be used. As may be required by industry standards and OSHA regulations, piping and tubing conveying hazardous materials must be properly identified. Identification could include color-coded piping and permanent labeling on the piping and tubing. The method of operation of accessible manual shutoff valves must be identified as to what they control, as well. Backflow protection must be provided as necessary to protect potable water supplies and the environment, as required by local health departments, environmental agencies and fire code officials. This section mandates that a means of leak detection and either an emergency shutoff valve or excess flow control are to be provided.

**5003.2.2.2 Additional regulations for supply piping for health-hazard materials.** Supply piping and tubing for gases and liquids having a health-hazard ranking of 3 or 4 in accordance with NFPA 704 shall be in accordance with ASME B31.3 and the following:

1. Piping and tubing utilized for the transmission of highly toxic, toxic or highly volatile *corrosive* liquids and gases shall have welded, threaded or flanged connections throughout except for connections located within a ventilated enclosure if the material is a gas, or an *approved* method of drainage or containment is provided for connections if the material is a liquid.
2. Piping and tubing shall not be located within *corridors*, within any portion of a *means of egress* required to be enclosed in fire-resistance-rated construction or in concealed spaces in areas not classified as Group H occupancies.

**Exception:** Piping and tubing within the space defined by the walls of *corridors* and the floor or roof above or in concealed spaces above other occupancies where installed in accordance with Section 415.11.6.4 of the *International Building Code* for Group H-5 occupancies.

❖ Requirements of this section are dependent on whether the hazardous material involved has a health-hazard ranking of 3 or 4 based on the hazard classification system in NFPA 704. This section is not applicable to materials with a flammability or reactivity rating of 3 or 4; rather, it addresses piping systems handling highly toxic or toxic liquids and gases.

Leaks or piping failures are most common around threaded connections in the piping or tubing. Therefore, a means of containment is required around connections unless metallic piping or tubing with welded connections is used.

Hazardous material piping may not be located in an exit access corridor, exit or areas not classified as high hazard so that the required means of egress are available. The exception in this section recognizes specific design provisions for existing hazardous production materials facilities, which commonly transport hazardous materials through service passages or corridors. Also required are excess-flow control valves (to regulate the rate of flow of hazardous materials within the piping system) and emergency shutoff valves (to stop the flow of hazardous materials from possibly deteriorating further in an emergency scenario).

**5003.2.3 Equipment, machinery and alarms.** Equipment, machinery and required detection and alarm systems associated with the use, storage or handling of hazardous materials shall be listed or *approved*.

❖ Equipment associated with the use or storage of hazardous materials must be listed or approved by a third-party testing agency.

**5003.2.4 Installation of tanks.** Installation of tanks shall be in accordance with Sections 5003.2.4.1 through 5003.2.4.2.1.

❖ The installation of tanks shall be in accordance with Chapter 57, the referenced standards in Chapter 80 and Sections 5003.2.4.1 through 5003.2.4.2.1.

**5003.2.4.1 Underground tanks.** Underground tanks used for the storage of liquid hazardous materials shall be provided with secondary containment. In lieu of providing secondary containment for an underground tank, an above-ground tank in an underground vault complying with Section 5704.2.8 shall be permitted.

❖ This section requires that all new underground tanks for the storage of hazardous materials comply with applicable code requirements regarding the hazardous material in the tank. Secondary containment provides an additional measure of confining hazardous materials at their point of generation in case of a tank failure. As an alternative to providing secondary containment, an above-ground tank installed in an underground vault for flammable or combustible liquids in accordance with Section 5704.2.8 is allowed as being equivalent. Note that the requirement for secondary containment is a general requirement subject to the limitations and exclusions of Section 5001.1.

**5003.2.4.2 Above-ground tanks.** Above-ground stationary tanks used for the storage of hazardous materials shall be located and protected in accordance with the requirements for outdoor storage of the particular material involved.

**Exception:** Above-ground tanks that are installed in vaults complying with Section 5303.16 or 5704.2.8 shall not be

required to comply with location and protection requirements for outdoor storage.

❖ Requirements for above-ground tanks depend on the hazards associated with the material being stored. Tank requirements can be found in Sections 2306, 5404 and 5704.2. The exception allows the use of an above-ground tank in a below-grade tank vault in lieu of an underground tank. Installation of a tank in a vault is regarded as equivalent in safety to an underground tank by Chapter 57, and it is a superior method with regard to environmental safety. When such an installation is provided, requirements for location on site and similar provisions should be regarded as an underground installation.

**5003.2.4.2.1 Marking.** Above-ground stationary tanks shall be marked as required by Section 5003.5.

❖ This section requires that NFPA 704 hazard identification signs in accordance with Section 5003.5 be provided for above-ground tanks to assist emergency responders in identifying the hazards of the tanks' contents in case of a spill or fire incident.

**5003.2.5 Empty containers and tanks.** Empty containers and tanks previously used for the storage of hazardous materials shall be free from residual material and vapor as defined by DOTn, the Resource Conservation and Recovery Act (RCRA) or other regulating authority or maintained as specified for the storage of hazardous material.

❖ Tanks must be purged and cleaned of all residual hazardous chemicals before reuse for storage. Containers and tanks that have not been cleaned must be stored in areas meeting the requirements for a hazardous use area. Under the Resource Conservation and Recovery Act (RCRA), the EPA issues "cradle-to-grave" regulations for storing, using and disposing of hazardous waste. The act, enacted by Congress in 1976, established a uniform national policy for hazardous and solid waste disposal. This section requires that containers, cylinders and tanks, if still in use, either be properly maintained as required or comply with the EPA or other state and local environmental regulations.

**5003.2.6 Maintenance.** In addition to the requirements of Section 5003.2.3, equipment, machinery and required detection and alarm systems associated with hazardous materials shall be maintained in an operable condition. Defective containers, cylinders and tanks shall be removed from service, repaired or disposed of in an *approved* manner. Defective equipment or machinery shall be removed from service and repaired or replaced. Required detection and alarm systems shall be replaced or repaired where defective.

❖ Equipment, machinery and required detection and alarm equipment must be maintained in an operable condition at all times.

**5003.2.6.1 Tanks out of service for 90 days.** Stationary tanks not used for a period of 90 days shall be properly safe-

guarded or removed in an *approved* manner. Such tanks shall have the fill line, gauge opening and pump connection secured against tampering. Vent lines shall be properly maintained.

❖ This section places a time limitation on out-of-service storage tanks of hazardous materials. Within 90 days, proper steps should be taken to address any potential hazard with the storage tank. Without a time limitation for safeguarding the out-of-service storage tank, it is likely that the tank will not be properly monitored or inspected as necessary and, consequently, the risk of the tank becoming defective increases. Care shall be taken to prevent tampering with all associated equipment. Vent lines must be kept clear and be properly maintained during this time.

**5003.2.6.1.1 Return to service.** Tanks that are to be placed back in service shall be tested in an *approved* manner.

❖ Tanks must be tested as a new installation before being placed back in service.

**5003.2.6.2 Defective containers and tanks.** Defective containers and tanks shall be removed from service, repaired in accordance with approved standards or disposed of in an *approved* manner.

❖ Damaged containers, cylinders and tanks pose the potential hazard of content release. Care must be taken to determine that disposal does not present a greater hazard than the damaged container, cylinder or tank.

Small containers usually cannot be repaired easily. Large containers and fixed tank installations often cannot be easily replaced and must be repaired. Temporary storage of hazardous materials during container repair must comply with code requirements.

**5003.2.7 Liquid-level limit control.** Atmospheric tanks having a capacity greater than 500 gallons (1893 L) and that contain hazardous material liquids shall be equipped with a liquid-level limit control or other *approved* means to prevent overfilling of the tank.

❖ Overfilling of tanks has been a problem over the years. This section requires atmospheric tanks with a capacity greater than 500 gallons (1893 L) containing hazardous materials to be equipped with an approved method of fill control.

**5003.2.8 Seismic protection.** Machinery and equipment utilizing hazardous materials shall be braced and anchored in accordance with the seismic design requirements of the *International Building Code* for the seismic design category in which the machinery or equipment is classified.

❖ In areas listed in IBC Chapter 16 as requiring seismic protection, machinery and equipment containing hazardous materials must be protected against seismic activity. The IBC assigns importance factors in classifying buildings. Buildings containing sufficient quantities of toxic or explosive substances that are considered to be dangerous to the public if release occurs carry an importance factor of 1.25 and struc-

tures containing highly toxic materials where the storage or use exceeds the MAQ have an importance factor of 1.50.

**5003.2.9 Testing.** The equipment, devices and systems listed in Section 5003.2.9.1 shall be tested at the time of installation and at one of the intervals listed in Section 5003.2.9.2. Records of the tests conducted or maintenance performed shall be maintained in accordance with the provisions of Section 107.2.1.

**Exceptions:**

1. Periodic testing shall not be required where *approved* written documentation is provided stating that testing will damage the equipment, device or system and the equipment, device or system is maintained as specified by the manufacturer.
2. Periodic testing shall not be required for equipment, devices and systems that fail in a fail-safe manner.
3. Periodic testing shall not be required for equipment, devices and systems that self-diagnose and report trouble. Records of the self-diagnosis and trouble reporting shall be made available to the *fire code official*.
4. Periodic testing shall not be required if system activation occurs during the required test cycle for the components activated during the test cycle.
5. *Approved* maintenance in accordance with Section 5003.2.6 that is performed not less than annually or in accordance with an *approved* schedule shall be allowed to meet the testing requirements set forth in Sections 5003.2.9.1 and 5003.2.9.2.

❖ This section establishes that the critical life safety and property protection systems and equipment listed in Section 5003.2.9.1 associated with the storage, handling and use of hazardous materials must undergo regular, documented maintenance to verify that they will perform as designed when needed. The section also requires that, as with any other safeguard required by the code, maintenance records must be maintained and be available to the fire code official (see commentary, Section 107.2).

Exception 1 recognizes that certain equipment, devices or systems are designed to function when needed but could be damaged by periodic testing. This fact must be documented in writing by an authority on the equipment, device or system that is acceptable to the fire code official. This would most likely be the equipment, device or system manufacturer since it is most familiar with its product. In addition to the written documentation, the manufacturer's maintenance specifications must be followed in order to take this exception.

Exception 2 recognizes that some equipment, devices or systems are designed with a feature for automatically counteracting the effect of an anticipated failure and eliminating or mitigating a hazardous condition caused by that failure by compensating for it. The term "fail-safe" is defined in Chapter 2.

Exception 3 recognizes the reliability of technology that allows equipment, devices or systems to self-monitor, diagnose and report any problems that could lead to a failure. Many fire alarm systems have this capability. In order to take the exception, records of the self-diagnosis and reporting must be kept and be available to the fire code official in accordance with Section 107.2.1.

Exception 4 states that, in the unlikely (but possible) event that an actual activation of the equipment, device or system occurs during a scheduled test of the equipment, device or system, the actual activation can be accepted in lieu of the scheduled test of the affected components.

Exception 5 states that the maintenance required by Section 5003.2.6 of equipment, devices or systems can be conducted in accordance with Section 5003.2.9.2, Item 1 or 4.

**5003.2.9.1 Equipment, devices and systems requiring testing.** The following equipment, systems and devices shall be tested in accordance with Sections 5003.2.9 and 5003.2.9.2.

1. Gas detection systems, alarms and automatic emergency shutoff valves required by Section 6004.2.2.10 for highly toxic and toxic gases.
  2. Limit control systems for liquid level, temperature and pressure required by Sections 5003.2.7, 5004.8 and 5005.1.4.
  3. Emergency alarm systems and supervision required by Sections 5004.9 and 5005.4.4.
  4. Monitoring and supervisory systems required by Sections 5004.10 and 5005.1.6.
  5. Manually activated shutdown controls required by Section 6403.1.1.1 for *compressed gas* systems conveying pyrophoric gases.
- ❖ This section lists the equipment, devices and systems that are subject to the provisions of Sections 5003.2.9 and 5003.2.9.2.

**5003.2.9.2 Testing frequency.** The equipment, systems and devices listed in Section 5003.2.9.1 shall be tested at one of the frequencies listed below:

1. Not less than annually.
  2. In accordance with the *approved* manufacturer's requirements.
  3. In accordance with *approved* recognized industry standards.
  4. In accordance with an *approved* schedule.
- ❖ This section provides a list of suggested testing frequencies for equipment, devices and systems required by Section 5003.2.9.1 to be tested. The party responsible for compliance with the testing requirements can choose one of the four testing frequencies that meets its needs. Note that Section 5003.2.3 requires that equipment, devices or systems associated with the storage, handling and use of hazardous materials be listed or approved. When the fire

code official determines that listing is required, the choice of testing frequency must be correlated with the manufacturer's testing requirements, which are often included as an integral part of the listing of the product.

**5003.3 Release of hazardous materials.** Hazardous materials in any quantity shall not be released into a sewer, storm drain, ditch, drainage canal, creek, stream, river, lake or tidal waterway or on the ground, sidewalk, street, highway or into the atmosphere.

**Exceptions:**

1. The release or emission of hazardous materials is allowed where in compliance with federal, state or local governmental agencies, regulations or permits.
2. The release of pesticides is allowed where used in accordance with registered label directions.
3. The release of fertilizer and soil amendments is allowed where used in accordance with manufacturer's specifications.

❖ Because of the toxic and hazardous nature of chemicals governed by this section, no amount of release is allowed, unless it is in compliance with federal, state or local regulations. The release of pesticides is allowed when they are used in compliance with the manufacturer's instructions. Fertilizer and soil amendments are also allowed when they are used as the manufacturer specifies.

**5003.3.1 Unauthorized discharges.** Where hazardous materials are released in quantities reportable under state, federal or local regulations, the *fire code official* shall be notified and the following procedures required in accordance with Sections 5003.3.1.1 through 5003.3.1.4.

❖ As stated above, release of hazardous chemicals is prohibited; however, when a release does occur in quantities that exceed the requirements of federal, state and local regulations, the fire code official must be notified.

**5003.3.1.1 Records.** Records of the unauthorized discharge of hazardous materials by the permittee shall be maintained.

❖ The amounts released, the cause of the release, containment efforts, cleanup efforts and environmental impact are items that should be included in the records submitted and kept on the incident.

**5003.3.1.2 Preparation.** Provisions shall be made for controlling and mitigating unauthorized discharges.

❖ A facility preplan for controlling and mitigating a release is recommended. After a release, this plan should be immediately implemented.

**5003.3.1.3 Control.** Where an unauthorized discharge caused by primary container failure is discovered, the involved primary container shall be repaired or removed from service.

❖ Once the cause of the release has been determined, repair of defective equipment or changes in operating procedures must begin immediately.

**5003.3.1.4 Responsibility for cleanup.** The person, firm or corporation responsible for an unauthorized discharge shall institute and complete all actions necessary to remedy the effects of such unauthorized discharge, whether sudden or gradual, without cost to the jurisdiction. Where deemed necessary by the *fire code official*, cleanup can be initiated by the fire department or by an authorized individual or firm. Costs associated with such cleanup shall be borne by the *owner*, operator or other person responsible for the unauthorized discharge.

❖ Cleanup is the responsibility of the person, firm or corporation responsible for an unauthorized release. Cleanup must begin immediately once the incident is stable.

**5003.4 Material Safety Data Sheets.** Material Safety Data Sheets (MSDS) shall be readily available on the premises for hazardous materials regulated by this chapter. Where a hazardous substance is developed in a laboratory, available information shall be documented.

**Exception:** Designated hazardous waste.

❖ Both the number and the diversity of industrial chemicals are constantly increasing. The inventory of chemicals at modern industrial operations is sometimes quite variable. These factors make accurate and timely information more important to emergency responders. This section specifies requirements for submitting MSDS and other emergency response information. Regardless of quantity, MSDS are required for all hazardous materials regulated by the code, even if the intended quantities do not require a permit or exceed the maximum quantities allowed per control area relative to a high-hazard occupancy classification. Preincident planning is essential for buildings containing hazardous materials, regardless of quantity. See the commentary to the definition of “Material safety data sheet” in Section 202.

The exception recognizes that the information contained in the Uniform Hazardous Waste Manifest (EPA Form 870022A) required by DOTn 49 CFR regulations contains sufficient information on the hazards of the waste material. Because EPA shipping rules for hazardous waste require that the manifest be with the waste material at all times, the manifest serves the same purpose as an MSDS.

The following is the minimum information needed from the MSDS to assist in determining the hazardous occupancy. The special consideration area will tell when items such as emergency showers, eye wash centers, acid piping and special ventilation are required. The MSDS will have the following information:

- The chemical name.
- The boiling point.
- The flash point.
- The UFL.
- The LFL.

- The solubility of the chemical.
- The IDLH.
- The LD50.
- The NFPA 704 classification.
- Any special consideration with the chemical.

Note that as part of OSHA’s planned conversion to the Globally Harmonized System of Classification and Labeling of Chemicals (GHS/HC) by 2016, the MSDS will be reformatted to 16 sections and renamed as “Safety Data Sheets” (SDS). The format of the new SDS is expected to include the following information:

- Section 1. Identification
- Section 2. Hazard(s) identification
- Section 3. Composition/information on ingredients
- Section 4. First-aid measures
- Section 5. Fire-fighting measures
- Section 6. Accidental release measures
- Section 7. Handling and storage
- Section 8. Exposure controls/personal protection
- Section 9. Physical and chemical properties
- Section 10. Stability and reactivity
- Section 11. Toxicological information
- Section 12. Ecological information
- Section 13. Disposal considerations
- Section 14. Transport information
- Section 15. Regulatory information
- Section 16. Other information, including date of preparation or last revision

The purpose of the GHS/HC system is rooted in the agencies that will administer the regulations, i.e., OSHA and the United Nations. Neither agency is exclusively focused on emergency responder notifications but, rather, they focus on worker/workplace regulations and global transportation and shipping of hazardous materials.

**5003.5 Hazard identification signs.** Unless otherwise exempted by the *fire code official*, visible hazard identification signs as specified in NFPA 704 for the specific material contained shall be placed on stationary containers and above-ground tanks and at entrances to locations where hazardous materials are stored, dispensed, used or handled in quantities requiring a permit and at specific entrances and locations designated by the *fire code official*.

❖ This section contains requirements for identification signage and labeling of containers with hazardous materials. Signs are required to alert occupants who may unknowingly enter an area containing hazardous materials.

The hazard identification symbol (see Commentary Figure 5003.5) is a color-coded array of four numbers or letters arranged in a diamond shape. This symbol appears on the label of many chemicals acquired from commercial vendors.

The **blue diamond**, appearing on the left side of

the label, conveys **health hazard** information. A number from 0 to 4 appears in the blue diamond indicating the degree of the hazard. The higher the number, the higher the hazard, as follows:

- 0—No hazard.
- 1—Can cause irritation if not treated.
- 2—Can cause injury. Requires prompt treatment.
- 3—Can cause serious injury despite medical treatment.
- 4—Can cause death or major injury despite medical treatment.

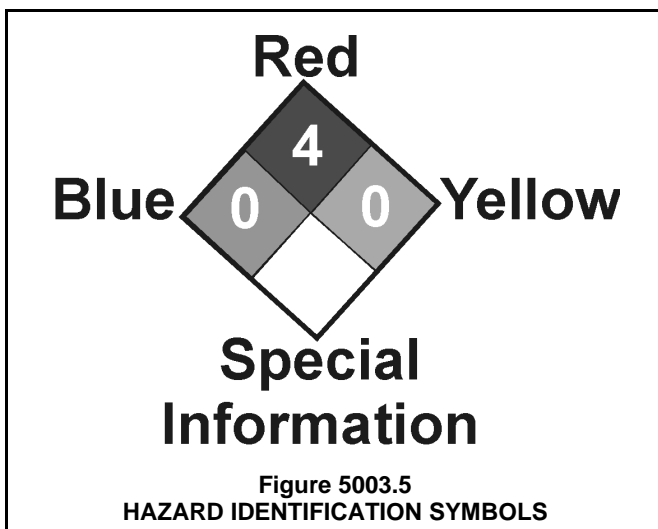
The **red diamond**, appearing at the top of the label, conveys **flammability hazard** information. Again, the numbers 0 to 4 are used to rate the flammability hazard as follows:

- 0—No hazard.
- 1—Ignites after considerable heating.
- 2—Ignites if moderately heated.
- 3—Can be ignited at all normal temperatures.
- 4—Very flammable gases or very volatile flammable liquid.

The **yellow diamond**, appearing on the right side of the label, conveys **reactivity hazard** information. The numbers 0 to 4 are used to rank reactivity hazards as follows:

- 0—Normally stable. Not reactive with water.
- 1—Normally stable. Unstable at high temperatures and pressure. Reacts with water.
- 2—Normally unstable but will not detonate.
- 3—Can detonate or explode but requires strong initiating force or heating under confinement.
- 4—Readily detonates or explodes.

The **white diamond**, appearing at the bottom of the label, conveys **special hazard** information. This information is conveyed by the use of symbols that



represent the special hazard. Two of the common symbols are:

W—The material is water reactive.

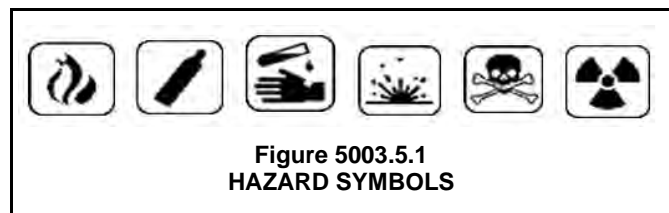
OX—An oxidizing agent.

Some labels use the white diamond to convey personal protective equipment or engineering controls required to work with the material safely. You may see a picture of gloves, safety glasses or a fume hood in the white diamond.

NFPA hazard ratings can be found on the MSDS for a given chemical. Also, this symbol, or a form of this symbol, often appears on the label of commercial chemical products.

**5003.5.1 Markings.** Individual containers, cartons or packages shall be conspicuously marked or labeled in an approved manner. Rooms or cabinets containing *compressed gases* shall be conspicuously labeled: COMPRESSED GAS.

❖ DOTn 49 CFR requires labels on all containers, cartons and packages of hazardous materials during transportation. Many manufacturers also post comprehensive labels on all containers and packages. These labels often include hazard information beyond that required by DOTn 49 CFR. The international pictorial symbols likely to be found on these labels are shown in Commentary Figure 5003.5.1.



**5003.6 Signs.** Signs and markings required by Sections 5003.5 and 5003.5.1 shall not be obscured or removed, shall be in English as a primary language or in symbols allowed by this code, shall be durable, and the size, color and lettering shall be *approved*.

❖ Signs must be in English as the primary language, or in symbols allowed by the code, and be made of a durable material with the size, color and lettering approved by the fire code official or other sections of the I-Codes.

**5003.7 Sources of ignition.** Sources of ignition shall comply with Sections 5003.7.1 through 5003.7.3.

❖ This section introduces the provisions for ignition control. A form of heat is required to ignite the vapors of flammable and combustible liquids. By limiting the sources of ignition in the storage or use area, one can reduce the possibility of a fire.

**5003.7.1 Smoking.** Smoking shall be prohibited and “No Smoking” signs provided as follows:

1. In rooms or areas where hazardous materials are stored or dispensed or used in *open systems* in amounts requiring a permit in accordance with Section 5001.5.

2. Within 25 feet (7620 mm) of outdoor storage, dispensing or open use areas.
3. Facilities or areas within facilities that have been designated as totally “no smoking” shall have “No Smoking” signs placed at all entrances to the facility or area. Designated areas within such facilities where smoking is permitted either permanently or temporarily, shall be identified with signs designating that smoking is permitted in these areas only.
4. In rooms or areas where flammable or combustible hazardous materials are stored, dispensed or used.

Signs required by this section shall be in English as a primary language or in symbols allowed by this code and shall comply with Section 310.

- ❖ The four areas listed in this section, because of their hazard characteristics, have been designated to receive “No Smoking” signs, in accordance with Section 310.

**5003.7.2 Open flames.** Open flames and high-temperature devices shall not be used in a manner that creates a hazardous condition and shall be *listed* for use with the hazardous materials stored or used.

- ❖ Processes that use open flames must be installed and safeguarded in accordance with the manufacturer’s specifications. It should be noted that a chemical that is preheated can change from a nonhazardous classification to a hazardous classification or move from a lower hazard to a higher hazard. Safety is further enhanced by the requirement for devices to be listed for use in proximity to hazardous materials.

**5003.7.3 Industrial trucks.** Powered industrial trucks used in areas designated as hazardous (classified) locations in accordance with NFPA 70 shall be *listed* and *labeled* for use in the environment intended in accordance with NFPA 505.

- ❖ Powered industrial trucks used in hazardous locations defined in accordance with NFPA 70 must meet the requirements of NFPA 505 (see also Section 309).

**5003.8 Construction requirements.** Buildings, *control areas*, enclosures and cabinets for hazardous materials shall be in accordance with Sections 5003.8.1 through 5003.8.6.3.

- ❖ Both the code and the IBC have requirements for construction of hazardous use areas. Each of these codes must be consulted for the specific and general requirements based on the chemicals being protected.

**5003.8.1 Buildings.** Buildings, or portions thereof, in which hazardous materials are stored, handled or used shall be constructed in accordance with the *International Building Code*.

- ❖ Buildings must meet the construction requirements of the IBC. Note that IBC Section 414 is a good starting point for this review.

**5003.8.2 Required detached buildings.** Group H occupancies containing quantities of hazardous materials in excess of

those set forth in Table 5003.8.2 shall be in detached buildings.

- ❖ The definition of a “Detached building” is found in Section 202. As defined, a detached storage building is a separate single-story building, without a basement or crawl space, that is used for the storage of hazardous materials and located an approved distance from all other structures.

The manufacture and storage of hazardous materials are frequently integrated into a single building. Additionally, it is not unusual for certain manufacturing buildings to contain multiple Group H uses where the threshold quantities are exceeded. Limiting the uses of identified hazardous materials to separate buildings containing only Group H uses maintains the intent of the code, which is to isolate large quantities of certain physical hazardous materials from uses other than those in Group H.

**TABLE 5003.8.2.** See page 50-30.

- ❖ Table 5003.8.2 gives the MAQs of materials that can be stored in Group H occupancies without detached storage.

**5003.8.3 Control areas.** *Control areas* shall comply with Sections 5003.8.3.1 through 5003.8.3.5.

- ❖ As defined in Section 202, a “Control area” is a space within a building where quantities of hazardous materials not exceeding the MAQs per control area are stored, dispensed, used or handled.

This section, in conjunction with the MAQ tables in Section 5003.1, utilizes a density concept for hazardous materials through the use of control areas. The intent of the control area concept is to provide an alternative method for the handling of hazardous materials without classifying the occupancy as Group H. In order to not be considered Group H, the amount of hazardous materials within any single control area bounded by fire barriers, horizontal assemblies, fire walls or exterior walls cannot exceed the MAQ for a specific material listed in Table 5003.1.1(1) or 5003.1.1(2) [see Commentary Figure 5003.8.3(1)]. A control area may be an entire building or a portion thereof. Where a building is not compartmented as required by the code for control areas, the entire building would be considered a single control area, in which case the entire MAQ of material from Table 5003.1.1(1) or 5003.1.1(2) located on any story would be subject to the limitations of Table 5003.8.3.2 based on IFC Committee Interpretations 51-07 and 52-07 of the table. Note that MAQs are based on the physical state, situation and hazard classification of materials and that up to the MAQ of each state of each class of material is permitted in each control area, subject to material incompatibility issues (see Section 5003.9.8).

As noted above, application of the control area provisions is intended only as a means for a building to avoid classification as Group H. It is not intended in

all cases to result in adequate separation of certain hazardous materials storage. For example, a control area for the storage of flammable liquids not exceeding the MAQ indicated in Table 5003.1.1(1) and constructed in accordance with these sections may require a fire-resistance rating of 1 hour for a building to avoid classification in Group H. However, the provisions of Chapter 57 or the referenced standard on flammable liquids, NFPA 30, may require a higher fire-resistance rating to provide proper separation based on the hazards of the flammable liquid being stored. In such a case, the provisions requiring the higher rating would apply.

**5003.8.3.1 Construction requirements.** *Control areas* shall be separated from each other by *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.

❖ This section requires that control areas be separated both vertically and horizontally, from one another as well as the rest of the building in which they are located, by the same type of construction as is used for occupancy separations. The fire barriers and horizontal assemblies thus required must be constructed in accordance with IBC Sections 707 and 711, respectively. Requiring fire-resistance-rated compartmentation of control areas minimizes the possibility of simultaneous involvement of multiple control areas in

a single fire incident. A fire in a single control area would involve only the amount of hazardous materials in that control area, which would not exceed the MAQ.

**5003.8.3.2 Percentage of maximum allowable quantities.**

The percentage of maximum allowable quantities of hazardous materials per *control area* allowed at each floor level within a building shall be in accordance with Table 5003.8.3.2.

❖ See the commentary to Table 5003.8.3.2.

**TABLE 5003.8.3.2.** See page 50-31.

❖ Table 5003.8.3.2 establishes the maximum quantity of hazardous materials permitted in a building and the required fire-resistance-rated separation for control areas. The overall maximum quantity of hazardous materials that can be present in the entire building is established based on the number of permitted control areas in Table 5003.8.3.2 and the maximum quantity of materials allowed in each control area per floor.

Based on the table, the first floor level could contain four control areas with up to 100 percent of the MAQ of each hazardous material per control area. For example, a single control area in a one-story, nonsprinklered building could contain up to 30 gallons (114 L) of Class 1A flammable liquids [see Table 5003.1.1(1)], 125 pounds (57 kg) of Class III organic peroxides [see Table 5003.1.1(1)], 250 pounds (114

**TABLE 5003.8.2  
DETACHED BUILDING REQUIRED**

A DETACHED BUILDING IS REQUIRED WHERE THE QUANTITY OF MATERIAL EXCEEDS THAT LISTED HEREIN			
Material	Class	Solids and liquids (tons) <sup>a, b</sup>	Gases (cubic feet) <sup>a, b</sup>
Explosives	Division 1.1	Maximum Allowable Quantity	Not Applicable
	Division 1.2	Maximum Allowable Quantity	
	Division 1.3	Maximum Allowable Quantity	
	Division 1.4	Maximum Allowable Quantity	
	Division 1.4 <sup>c</sup>	1	
	Division 1.5	Maximum Allowable Quantity	
	Division 1.6	Maximum Allowable Quantity	
Oxidizers	Class 4	Maximum Allowable Quantity	Maximum Allowable Quantity
Unstable (reactives) detonable	Class 3 or 4	Maximum Allowable Quantity	Maximum Allowable Quantity
Oxidizer, liquids and solids	Class 3	1,200	Not Applicable
	Class 2	2,000	
Organic peroxides	Detonable	Maximum Allowable Quantity	Not Applicable
	Class I	Maximum Allowable Quantity	
	Class II	25	
	Class III	50	
Unstable (reactives) nondetonable	Class 3	1	2,000
	Class 2	25	10,000
Water reactives	Class 3	1	Not Applicable
	Class 2	25	
Pyrophoric gases	Not Applicable	Not Applicable	2,000

For SI: 1 pound = 0.454 kg, 1 cubic foot = 0.02832 m<sup>3</sup>, 1 ton = 2000 lbs. = 907.2 kg.

- a. For materials that are detonable, the distance to other buildings or lot lines shall be as specified in the *International Building Code*. For materials classified as explosives, the required separation distances shall be as specified in Chapter 56.
- b. “Maximum Allowable Quantity” means the maximum allowable quantity per control area set forth in Table 5003.1.1(1).
- c. Limited to Division 1.4 materials and articles, including articles packaged for shipment, that are not regulated as an explosive under Bureau of Alcohol, Tobacco, Firearms and Explosives regulations, or unpackaged articles used in process operations that do not propagate a detonation or deflagration between articles, providing the net explosive weight of individual articles does not exceed 1 pound.

kg) of Class 2 oxidizers [see Table 5003.1.1(1)] and 500 gallons (1892 L) of corrosive liquids [see Table 5003.1.1(2)]. These quantities could be contained in four different control areas if they are separated from one another by a minimum 1-hour fire-resistance-rated fire barrier.

The amount of hazardous materials per control area and the number of control areas per floor are reduced if hazardous materials are stored or used above the first floor. Difficulty in gaining access for fire fighting or other emergency response purposes and potential hazard to building occupants who must egress that area are increased above the first floor. The use of control areas on upper floors can be advantageous for multistory research and laboratory-type facilities that often have a functional need to use limited amounts of hazardous materials throughout

various portions of the building. Without control areas, the MAQ for a hazardous material would be limited to an entire building area regardless of the overall size or height of the building. For example, if control areas are not used, a 50,000-square-foot (4645 m<sup>2</sup>) multistory building would be limited to the same MAQ of hazardous materials as a single-story building of 5,000 square feet (465 m<sup>2</sup>), subject to the per-floor limitations of the table based on IFC Committee Interpretations of Chapter 50.

Note a clarifies that the MAQ is based on Table 5003.1.1(1) or 5003.1.1(2) including the increases allowed by an automatic sprinkler system in accordance with NFPA 13, approved hazardous material storage cabinets or both where applicable.

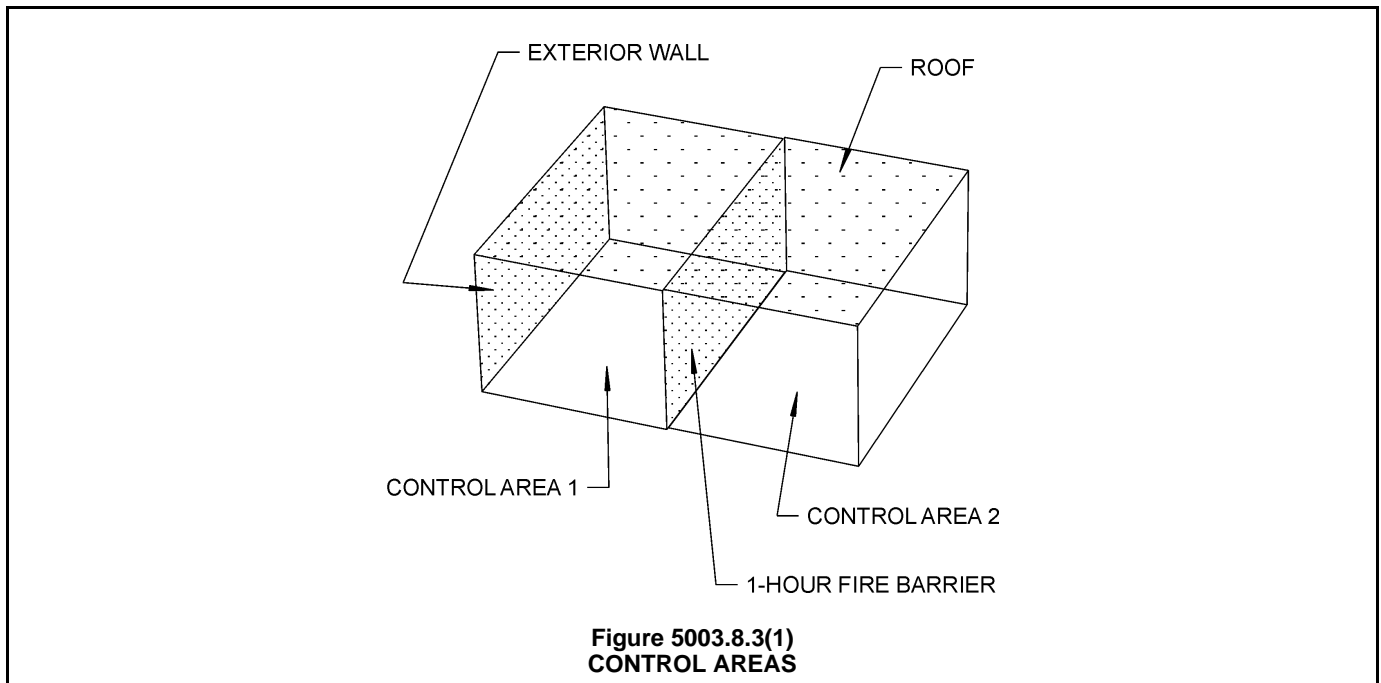
Note b clarifies the fire barrier separation needed to establish the boundaries of the control area that

**TABLE 5003.8.3.2  
DESIGN AND NUMBER OF CONTROL AREAS**

FLOOR LEVEL		PERCENTAGE OF THE MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA <sup>a</sup>	NUMBER OF CONTROL AREAS PER FLOOR	FIRE-RESISTANCE RATING FOR FIRE BARRIERS IN HOURS <sup>b</sup>
Above grade plane	Higher than 9	5	1	2
	7-9	5	2	2
	6	12.5	2	2
	5	12.5	2	2
	4	12.5	2	2
	3	50	2	1
	2	75	3	1
	1	100	4	1
Below grade plane	1	75	3	1
	2	50	2	1
	Lower than 2	Not Allowed	Not Allowed	Not Allowed

a. Percentages shall be of the maximum allowable quantity per control area shown in Tables 5003.1.1(1) and 5003.1.1(2), with all increases allowed in the footnotes to those tables.

b. Separation shall include fire barriers and horizontal assemblies as necessary to provide separation from other portions of the building.



include not only the vertical wall assemblies but also the floor/ceiling assemblies in order to be adequately separated from all adjacent interior spaces.

Example: Determine the maximum amount of Class IB flammable liquids that can be stored within a single-story, 10,000-square-foot (929 m<sup>2</sup>) nonsprinklered Group F-1 occupancy [see Commentary Figure 5003.8.3(2)] of Type IIB construction without classifying the storage area Group H-2.

Based on a MAQ of 120 gallons (454 L) for Class IB flammable liquids from Table 5003.1.1(1), a maximum of 120 gallons (454 L) can be stored in each of the four control areas; therefore, while the building may actually contain a total of 480 gallons (1817 L), a maximum of 120 gallons (454 L) is permitted in each control area that is separated from all adjacent control areas by minimum 1-hour fire barriers constructed in accordance with IBC Section 707.

The building, in this case, could still be classified as Group F-1. An automatic fire suppression system would not be required, since the 12,000-square-foot (1115 m<sup>2</sup>) threshold for suppression of Group F-1 fire areas is not exceeded (see Section 903.2.3) and there are no control areas containing hazardous materials that exceed the MAQ. Notes d and e of Table 5003.1.1(1) would allow the base quantity of Class IB flammable liquids to be increased 100 percent in buildings protected with an automatic sprinkler system or when the material is stored in approved hazardous material storage cabinets. In this example, this would result in increasing the MAQ of Class IB flammable liquids by a factor of two; therefore, the building could now contain a total of 960 gallons (3634 L) with a maximum of 240 gallons (908 L) in

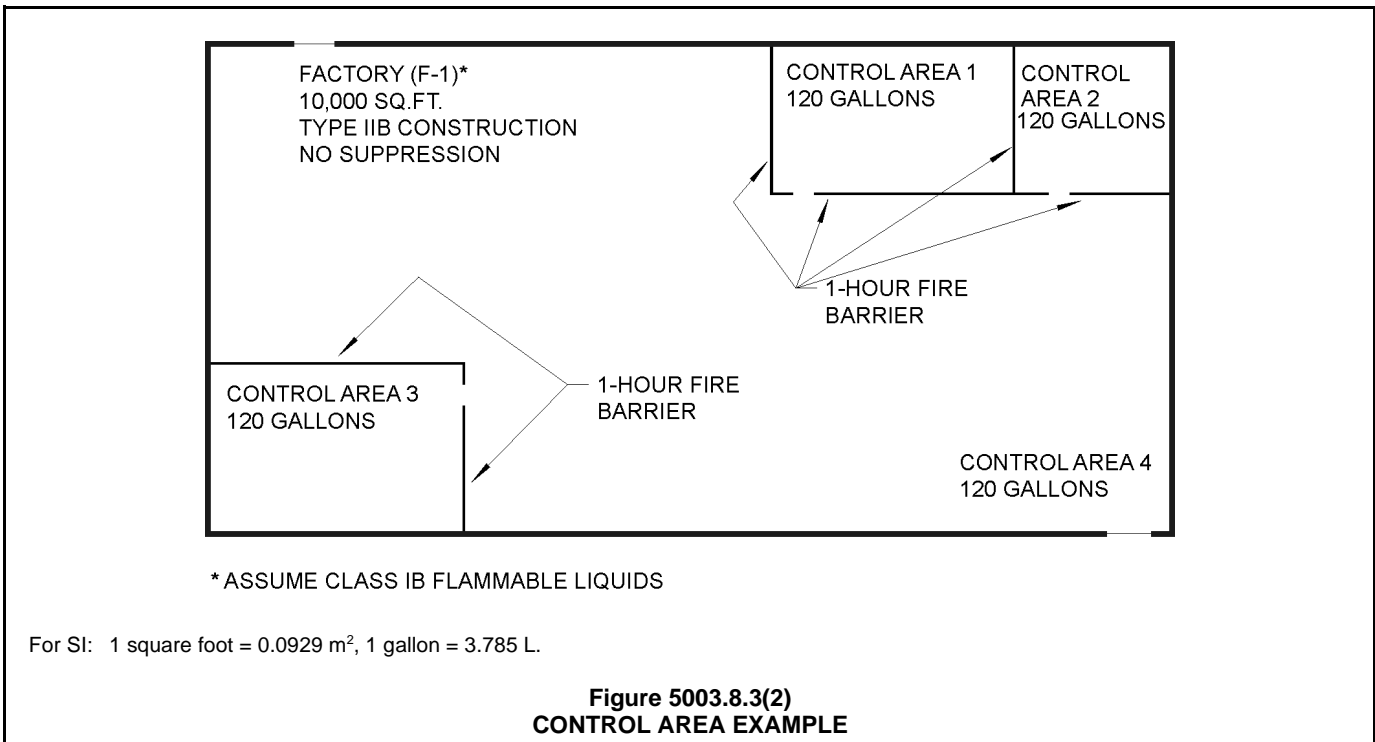
each of the four control areas, separated as required by the code, and still maintain a Group F-1 classification.

If both an automatic sprinkler system and hazardous material storage cabinets are used to protect the Class IB flammable liquids, then the base quantity of Table 5003.1.1(1) could be increased by a factor of four. The building in this example, therefore, with both sprinkler protection and approved cabinets, could contain a total of 1,920 gallons (7267 L) with a maximum of 480 gallons (1817 L) in each of the four control areas, separated as required by the code, and still maintain a Group F-1 classification.

The allowable increase in the MAQ is offset by the additional level or levels of protection. The use of control areas provides a tradeoff based on building compartmentation. Fire protection (automatic sprinkler systems) and controlled storage through the use of approved hazardous material storage cabinets also adds a degree of protection, justifying the increased allowable quantities. See IFC Committee Interpretations 51-07 and 52-07 in Commentary Figure 5003.8.3.2.

**5003.8.3.3 Number.** The maximum number of *control areas* per floor within a building shall be in accordance with Table 5003.8.3.2.

❖ It is not the code's intent to require multiple control areas. As previously indicated, in a building that is entirely one control area, if the total quantity of hazardous materials does not exceed the MAQ, the building would not be classified as Group H. Similarly, if the owner is satisfied with an occupancy classification of Group H, multiple control areas would not be required. Therefore, control areas are characterized



**COMMITTEE INTERPRETATION NO. 51-07**

Section 5003.8.3.2

Issued on 2006 edition – Issued 04-29-08

Q: Given a nonsprinklered, multistory building of Type IIB construction. The building is used for the storage of hazardous materials that do not exceed the maximum allowable quantity per control area in accordance with Tables 5003.1.1(1) and 5003.1.1(2) of the *International Fire Code*. The building contains no fire walls, interior fire barriers or fire-resistance-rated horizontal assemblies. The entire building is defined as a single control area.

Are the provisions of Section 5003.8.3.2 of the *International Fire Code*, which limit the percentage of the maximum allowable quantity of hazardous materials for any floor, applicable to a multistory building consisting of a single control area?

A: Yes. When the quantity of hazardous material stored in the building is equal to or less than the maximum allowable quantity per control area in Tables 5003.1.1(1) and 5003.1.1(2), the entire building would be considered the control area. When the entire building is the control area, the maximum allowable quantity of material may be located anywhere in the building subject to the per-floor limitations of Table 5003.8.3.2.

**COMMITTEE INTERPRETATION NO. 52-07**

Section 5003.8.3.2

Issued on 2006 edition – Issued 04-29-08

Q: Given a nonsprinklered multistory building of Type IIB construction. The building is used for the storage of hazardous materials that exceeds the maximum allowable quantity permitted for a single control area in accordance with Tables 5003.1.1(1) and 5003.1.1(2) of the *International Fire Code*. An interior fire barrier is constructed that spans from the foundation to the roof for the entire height of the building. There are no fire-resistance-rated horizontal assemblies provided between floors. Therefore, the entire building is defined as having two independent multistory control areas.

Are the provisions of Section 5003.8.3.2 of the *International Fire Code*, which limit the percentage of the maximum allowable quantity of hazardous materials for any floor, applicable to a multistory building consisting of multiple control areas?

A: Yes. When the quantity of hazardous material being stored in each control area is equal to or less than the maximum allowable quantity per control area in Tables 5003.1.1(1) and 5003.1.1(2), the maximum allowable quantity of material per control area may be located anywhere within a multistory control area, subject to the per-floor limitations of Table 5003.8.3.2.

**Figure 5003.8.3.2**  
**COMMITTEE INTERPRETATIONS**

as an alternative means by which a building can be classified as other than Group H. Again, the provisions are applicable only when control areas are chosen as a design alternative to classification of the occupancy as Group H (see commentary, Table 5003.8.3.2).

**5003.8.3.4 Fire-resistance-rating requirements.** The required *fire-resistance rating* for *fire barriers* shall be in accordance with Table 5003.8.3.2. The floor assembly of the *control area* and the construction supporting the floor of the

*control area* shall have a *fire-resistance rating* of not less than 2 hours.

**Exception:** The floor assembly of the *control area* and the construction supporting the floor of the *control area* is allowed to be 1-hour *fire-resistance* rated in buildings of Type IIA, IIIA and VA construction, provided that both of the following conditions exist:

1. The building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

2. The building is three stories or less above grade plane.

- ❖ The fire separation requirements for control areas, both horizontal and vertical, are dependent on their location in a building in accordance with Table 5003.8.3.2. The amount of hazardous materials per control area, as well as the number of control areas per floor, are reduced if stored or used above the first floor.

Where the control area is located above the first floor, the floor assembly and all supporting construction for the control area would require a minimum 2-hour fire-resistance rating. The required 2-hour fire-resistance rating of the floor construction only refers to the floor of the control area. The increased fire-resistance rating and reduced quantities are intended to aid the fire department and other emergency response personnel in overcoming the difficulties associated with dealing with hazardous materials incidents above the level of fire department access (see commentary, Table 5003.8.3.2). The use of control areas on upper floors provides an alternative method for multistory research and laboratory-type facilities that may need to use a limited amount of hazardous materials throughout various portions of the building. Without control areas, the MAQ for a hazardous material would be limited to a single building area regardless of the overall size or height of the building. For example, if control areas are not utilized, a 50,000-square-foot (4645 m<sup>2</sup>) single-story building would be limited to the same quantity of hazardous materials as a two-story building with 5,000 square feet (464 m<sup>2</sup>) per floor.

Buildings of Type IIA, IIIA and VA construction are required to have floor construction with a minimum fire-resistance rating of 1 hour as indicated in IBC Table 601. The exception recognizes the combination of a 1-hour horizontal assembly in conjunction with sprinkler protection as a reasonable alternative for the noted construction types. The three-story limitation is consistent with the fire-resistant-rating requirements for fire barriers in Table 5003.8.3.2.

**5003.8.3.5 Hazardous material in Group M display and storage areas and in Group S storage areas.** The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials allowed within a single control area of a Group M display and storage area or a Group S storage area is allowed to exceed the *maximum allowable quantities per control area* specified in Tables 5003.1.1(1) and 5003.1.1(2) without classifying the building or use as a Group H occupancy, provided that the materials are displayed and stored in accordance with Section 5003.11.

- ❖ This section addresses an option for control areas containing certain nonflammable or noncombustible hazardous materials that are stored in mercantile and storage occupancies, including outdoor control areas. This option would allow Group H-4 materials, which present a health hazard rather than a physical hazard, as well as limited Group H-2 and H-3 materials

such as oxidizers, to be stored in both retail display and stock areas of regulated mercantile occupancies and in storage-related occupancies in excess of the MAQs of Tables 5003.1.1(1) and 5003.1.1(2) without classifying the building as Group H. Without this option, many mercantile and storage occupancies could be classified technically as Group H. The increased quantities of certain hazardous materials are based on the recognition that while there is limited risk in these occupancies, the packaging and storage arrangements can be controlled. For further information on the storage limitations required for these types of materials, see Section 5003.11.3.

This section, in conjunction with Table 5003.11.1, establishes the maximum quantity of the indicated hazardous materials permitted within a single control area of a mercantile occupancy. As indicated in Table 5003.11.1, this section only applies to certain nonflammable solids and nonflammable or noncombustible liquids. Note that this option is not applicable to mercantile and storage occupancies containing hazardous materials other than those indicated in Table 5003.11.1.

**5003.8.4 Gas rooms.** Where a gas room is used to increase the *maximum allowable quantity per control area* or provided to comply with the provisions of Chapter 60, the gas room shall be in accordance with Sections 5003.8.4.1 and 5003.8.4.2.

- ❖ Where gas rooms are provided as required by Chapter 60 or where they are used in accordance with Table 5003.1.1(1), Note e to increase the maximum allowable quantity per control area (MAQ) of hazardous materials, they must meet the requirements stated in the subsections that follow. Gas rooms are required to be protected by automatic sprinklers, separated based on the occupancy, and have ventilation designed to operate at a negative pressure. These requirements are similar to those that apply to exhausted enclosures that allow the quantity increase. This section will bring consistency between the requirements for gas cabinets, exhausted enclosures and gas rooms with respect to application and MAQ.

**5003.8.4.1 Construction.** Gas rooms shall be protected with an *automatic sprinkler system*. Gas rooms shall be separated from the remainder of the building in accordance with the requirements of the *International Building Code* based on the occupancy group into which it has been classified.

- ❖ Construction shall be based on the occupancy separation requirements of IBC Table 302.3.3. A gas room would typically be a Group H-4 occupancy; therefore, the separation requirements would be from a Group H-4 occupancy to the other occupancy (i.e., business, institutional, storage, etc.).

**5003.8.4.2 Ventilation system.** The ventilation system for gas rooms shall be designed to operate at a negative pressure in relation to the surrounding area. Highly toxic and toxic gases shall also comply with Section 6004.2.2.6. The ventila-

tion system shall be installed in accordance with the *International Mechanical Code*.

- ❖ The gas room exhaust ventilation system must be designed to operate at a negative pressure to the area in which it is located in order to maintain a safe atmosphere outside the gas room in the event of a leak. Section 6004.2.2.6 also has specific ventilation requirements for highly toxic and toxic gases. Ventilation systems must comply with the IMC.

**5003.8.5 Exhausted enclosures.** Where an exhausted enclosure is used to increase *maximum allowable quantity per control area* or where the location of hazardous materials in exhausted enclosures is provided to comply with the provisions of Chapter 60, the exhausted enclosure shall be in accordance with Sections 5003.8.5.1 through 5003.8.5.3.

- ❖ When exhausted enclosures are provided as required by Chapter 60, they must meet the requirements of the following subsections.

**5003.8.5.1 Construction.** Exhausted enclosures shall be of noncombustible construction.

- ❖ See IBC Section 202 for the definition of “Noncombustible construction.”

**5003.8.5.2 Ventilation.** Exhausted enclosures shall be provided with an exhaust ventilation system. The ventilation system for exhausted enclosures shall be designed to operate at a negative pressure in relation to the surrounding area. Ventilation systems used for highly toxic and toxic gases shall also comply with Items 1, 2 and 3 of Section 6004.1.2. The ventilation system shall be installed in accordance with the *International Mechanical Code*.

- ❖ The exhausted enclosure exhaust ventilation system must be designed to operate at a negative pressure to the area in which it is located in order to maintain a safe atmosphere in the area in the event of a leak. Section 6004.2.2.6 also has specific ventilation requirements for highly toxic and toxic gases. Ventilation systems must comply with the IMC.

**5003.8.5.3 Fire-extinguishing system.** Exhausted enclosures where flammable materials are used shall be protected by an approved automatic fire-extinguishing system in accordance with Chapter 9.

- ❖ Special care is required in selecting the correct type of automatic fire suppression system. The MSDS should be consulted for compatibility of the suppression system and the chemicals being used.

**5003.8.6 Gas cabinets.** Where a gas cabinet is used to increase the *maximum allowable quantity per control area* or where the location of *compressed gases* in gas cabinets is provided to comply with the provisions of Chapter 60, the gas cabinet shall be in accordance with Sections 5003.8.6.1 through 5003.8.6.3.

- ❖ When gas cabinets are provided as required by Chapter 60, they must meet the requirements of the following subsections.

**5003.8.6.1 Construction.** Gas cabinets shall be constructed in accordance with the following:

1. Constructed of not less than 0.097-inch (2.5 mm) (No. 12 gage) steel.
2. Be provided with self-closing limited access ports or noncombustible windows to give access to equipment controls.
3. Be provided with self-closing doors.
4. Gas cabinet interiors shall be treated, coated or constructed of materials that are compatible with the hazardous materials stored. Such treatment, coating or construction shall include the entire interior of the cabinet.

- ❖ This section itemizes four requirements for the construction of gas cabinets. Listed and labeled gas cabinets can be assumed to meet these minimum requirements when they have been tested by an approved third-party testing agency.

**5003.8.6.2 Ventilation.** Gas cabinets shall be provided with an exhaust ventilation system. The ventilation system for gas cabinets shall be designed to operate at a negative pressure in relation to the surrounding area. Ventilation systems used for highly toxic and toxic gases shall also comply with Items 1, 2 and 3 of Section 6004.1.2. The ventilation system shall be installed in accordance with the *International Mechanical Code*.

- ❖ The gas cabinet exhaust ventilation system must be designed to operate at a negative pressure to the area in which it is located in order to maintain a safe atmosphere in the area in the event of a leak. Section 6004.2.2.6 also has specific ventilation requirements for highly toxic and toxic gases. Ventilation systems must comply with the IMC.

**5003.8.6.3 Maximum number of cylinders per gas cabinet.** The number of cylinders contained in a single gas cabinet shall not exceed three.

- ❖ This section limits the number of cylinders of compressed gases within a gas cabinet for quantity control purposes in an effort to reduce the potential involvement of other gas cylinders in a fire.

**5003.8.7 Hazardous materials storage cabinets.** Where storage cabinets are used to increase *maximum allowable quantity per control area* or to comply with this chapter, such cabinets shall be in accordance with Sections 5003.8.7.1 and 5003.8.7.2.

- ❖ This section recognizes that the use of approved storage cabinets is an acceptable alternative to increase the MAQ of certain hazardous materials. For example, the base MAQ in each control area for storage of Class IB flammable liquids is 120 gallons (454 L) as indicated in Table 5003.1.1(1). However, if Class IB flammable liquids are stored in an approved storage cabinet, the base MAQ could be increased to 240 gallons (908 L). Therefore, a building could contain 240 gallons (908 L) of Class IB liquids in each control

area without classifying the building as a high-hazard occupancy if all flammable liquids are stored in an approved storage cabinet. These types of storage cabinets are sometimes known as flammable liquid cabinets or acid storage cabinets.

**5003.8.7.1 Construction.** The interior of cabinets shall be treated, coated or constructed of materials that are nonreactive with the hazardous material stored. Such treatment, coating or construction shall include the entire interior of the cabinet. Cabinets shall either be *listed* in accordance with UL 1275 as suitable for the intended storage or constructed in accordance with the following:

1. Cabinets shall be of steel having a thickness of not less than 0.0478 inch (1.2 mm) (No. 18 gage). The cabinet, including the door, shall be double walled with a 1½-inch (38 mm) airspace between the walls. Joints shall be riveted or welded and shall be tight fitting. Doors shall be well fitted, self-closing and equipped with a self-latching device.
2. The bottoms of cabinets utilized for the storage of liquids shall be liquid tight to a minimum height of 2 inches (51 mm).

Electrical equipment and devices within cabinets used for the storage of hazardous gases or liquids shall be in accordance with NFPA 70.

❖ This section gives two methods of acceptance. Either the cabinet is listed in accordance with UL 1275 or construction meets the requirements of this section.

This section specifies minimum construction requirements for hazardous material storage cabinets similar to those cabinets required for flammable and combustible liquids in NFPA 30. While both this section and NFPA 30 require the door of the cabinet to be equipped with a latching device, this section does not specifically require a three-point latch arrangement on all cabinet doors. The three-point latch arrangement is recommended to enhance the integrity of the cabinet in a fire. The door sill of hazardous material storage cabinets used for storing liquids must be raised 2 inches (51 mm) above the bottom of the cabinet. The 2-inch (51 mm) raised sill is intended to retain any spilled liquid within the cabinet. The surface of the cabinets must be compatible with the material stored in the cabinets. Any electrical equipment must comply with NFPA 70.

**5003.8.7.2 Warning markings.** Cabinets shall be clearly identified in an approved manner with red letters on a contrasting background to read:

HAZARDOUS—KEEP FIRE AWAY.

❖ To warn the general public and employees of potential exposure to hazardous materials within storage cabinets, appropriate warning labels are required. Cabinets shall be clearly identified with the wording given in this section.

**5003.9 General safety precautions.** General precautions for the safe storage, handling or care of hazardous materials shall be in accordance with Sections 5003.9.1 through 5003.9.10.

❖ The following subsections deal with the safe handling and storage of hazardous materials.

**5003.9.1 Personnel training and written procedures.** Persons responsible for the operation of areas in which hazardous materials are stored, dispensed, handled or used shall be familiar with the chemical nature of the materials and the appropriate mitigating actions necessary in the event of fire, leak or spill.

❖ Each tenant or owner should develop a mitigation plan. This plan should be posted and be familiar to all workers. In the event of a release, this plan should be immediately placed into effect.

**5003.9.1.1 Fire department liaison.** Responsible persons shall be designated and trained to be liaison personnel to the fire department. These persons shall aid the fire department in preplanning emergency responses and identifying the locations where hazardous materials are located, and shall have access to Material Safety Data Sheets and be knowledgeable in the site's emergency response procedures.

❖ It goes without saying that an emergency is not the time to wonder who, what, when or where. The code section recommends that a working relationship be established with the emergency services prior to the emergency. A plant engineer or chemist who knows the type of materials, methods of storage, location of storage in the structure and chemical makeup would typically be the best person for this liaison work.

**5003.9.2 Security.** Storage, dispensing, use and handling areas shall be secured against unauthorized entry and safeguarded in a manner *approved* by the *fire code official*.

❖ Safeguards must be in place to assist in the prevention of unauthorized entry into the building or the removal of hazardous chemicals.

**5003.9.3 Protection from vehicles.** Guard posts or other *approved* means shall be provided to protect storage tanks and connected piping, valves and fittings; dispensing areas; and use areas subject to vehicular damage in accordance with Section 312.

❖ Storage, piping or other process equipment that could be damaged by vehicular traffic must be protected with barriers designed to meet the requirements of Section 312.

**5003.9.4 Electrical wiring and equipment.** Electrical wiring and equipment shall be installed and maintained in accordance with NFPA 70.

❖ Article 500 of NFPA 70 is the applicable article for classified locations.

**5003.9.5 Static accumulation.** Where processes or conditions exist where a flammable mixture could be ignited by

static electricity, means shall be provided to prevent the accumulation of a static charge.

- ❖ NFPA 77 gives some guidance into the methods of protection against static electricity. NFPA 70 also provides guidance on the requirements.

**5003.9.6 Protection from light.** Materials that are sensitive to light shall be stored in containers designed to protect them from such exposure.

- ❖ Light-sensitive chemicals must be protected from UV lights or other spectrum patterns that may be damaging. See the MSDS for additional information and requirements for chemicals.

**5003.9.7 Shock padding.** Materials that are shock sensitive shall be padded, suspended or otherwise protected against accidental dislodgement and dislodgement during seismic activity.

- ❖ Several explosive chemicals are shock sensitive and must be protected against accidents that could knock them from their shelves. If the building in which they are stored or used is in a seismic zone, they must also be protected.

**5003.9.8 Separation of incompatible materials.** *Incompatible materials* in storage and storage of materials that are incompatible with materials in use shall be separated where the stored materials are in containers having a capacity of more than 5 pounds (2 kg) or 0.5 gallon (2 L). Separation shall be accomplished by:

1. Segregating *incompatible materials* in storage by a distance of not less than 20 feet (6096 mm).
2. Isolating *incompatible materials* in storage by a non-combustible partition extending not less than 18 inches (457 mm) above and to the sides of the stored material.
3. Storing liquid and solid materials in hazardous material storage cabinets.
4. Storing *compressed gases* in gas cabinets or exhausted enclosures in accordance with Sections 5003.8.5 and 5003.8.6. Materials that are incompatible shall not be stored within the same cabinet or exhausted enclosure.

- ❖ Materials that are incompatible with each other must be separated. This section gives four methods of separation. If cabinets or exhausted enclosures are used, only compatible chemicals can be stored in any one cabinet or enclosure.

**5003.9.9 Shelf storage.** Shelving shall be of substantial construction, and shall be braced and anchored in accordance with the seismic design requirements of the *International Building Code* for the seismic zone in which the material is located. Shelving shall be treated, coated or constructed of materials that are compatible with the hazardous materials

stored. Shelves shall be provided with a lip or guard where used for the storage of individual containers.

**Exceptions:**

1. Storage in hazardous material storage cabinets or laboratory furniture specifically designed for such use.
2. Storage of hazardous materials in amounts not requiring a permit in accordance with Section 5001.5.

Shelf storage of hazardous materials shall be maintained in an orderly manner.

- ❖ Where hazardous chemicals are stored on shelves, the shelves must have a lip or guard at the edges. The shelving must be treated or otherwise protected to be compatible with the chemicals stored.

**5003.9.10 Safety cans.** Safety cans shall be *listed* in accordance with UL 30 where used to increase the *maximum allowable quantities per control area* of flammable or *combustible liquids* in accordance with Table 5003.1.1(1). Safety cans *listed* in accordance with UL 1313 are allowed for flammable and *combustible liquids* where not used to increase the *maximum allowable quantities per control area* and for other hazardous material liquids in accordance with the listing.

- ❖ This section specifically prescribes the use of metallic safety cans listed in accordance with UL 30 when increasing the MAQ of flammable and combustible liquids in Table 5003.1.1(1). For all other physical hazard classes of hazardous material, a listed safety can constructed of either metal or nonmetallic material can be used to increase the MAQ provided that the safety can is suitable and listed for the particular hazardous material.

It should be noted that metal safety cans listed under UL 30 are "...primarily intended to store and handle flammable and combustible liquids, such as gasoline, naphtha, kerosene, acetone, MEK and similar liquids..." according to the scope statement of that standard. As such, a listed safety can constructed of metal may not always be the appropriate container for hazardous materials presenting multiple hazards. Consider acetic acid, which is not only a Class II combustible liquid, but also a corrosive liquid. Galvanized steel is an inappropriate construction material because the acid will corrode the steel. However, a material like polyethylene, which is used in the manufacturing of nonmetallic safety cans, is chemically compatible with acetic acid. Once again, however, the caution is raised that the scope statement of UL 1313 states that nonmetallic safety cans "...are primarily intended to store and handle fuel oil, gasoline, kerosene. Nonmetallic safety cans that are intended to store and handle liquid fuels other than those specified...may be subjected to additional

requirements not covered in the Standard.” Also see the commentary to Section 5002.1 for the definition of “Safety can” and Table 5003.1.1(1), Note e.

**5003.10 Handling and transportation.** In addition to the requirements of Section 5003.2, the handling and transportation of hazardous materials in *corridors* or enclosures for stairways and ramps shall be in accordance with Sections 5003.10.1 through 5003.10.3.6.

❖ This section deals with the handling and transportation of hazardous chemicals in corridors or exit enclosures.

**5003.10.1 Valve protection.** Hazardous material gas containers, cylinders and tanks in transit shall have their protective caps in place. Containers, cylinders and tanks of highly toxic or toxic *compressed gases* shall have their valve outlets capped or plugged with an *approved* closure device in accordance with Chapter 53.

❖ Whenever a cylinder or tank of hazardous gases is transported, it can have a protective cover on the outlet valves or be plugged with an approved closure valve as stated in Section 5303.4.

**5003.10.2 Carts and trucks required.** Liquids in containers exceeding 5 gallons (19 L) in a *corridor* or enclosure for a stairway or ramp shall be transported on a cart or truck. Containers of hazardous materials having a hazard ranking of 3 or 4 in accordance with NFPA 704 and transported within *corridors* or interior exit stairways and ramps, shall be on a cart or truck. Where carts and trucks are required for transporting hazardous materials, they shall be in accordance with Section 5003.10.3.

**Exceptions:**

1. Two hazardous material liquid containers that are hand carried in acceptable safety carriers.
  2. Not more than four drums not exceeding 55 gallons (208 L) each that are transported by suitable drum trucks.
  3. Containers and cylinders of *compressed gases* that are transported by *approved* hand trucks, and containers and cylinders not exceeding 25 pounds (11 kg) that are hand carried.
  4. Solid hazardous materials not exceeding 100 pounds (45 kg) that are transported by *approved* hand trucks, and a single container not exceeding 50 pounds (23 kg) that is hand carried.
- ❖ This section limits the amount of hazardous liquid that can be transported by hand in approved containers to 5 gallons (19 L) or less. Containers with hazardous liquids exceeding 5 gallons (19 L) must be transported using approved carts or trucks that meet the construction requirements of Section 5003.10.3. This section addresses not only hand push-type carts and trucks, but also gas carts, motorized hand trucks and specialized industrial trucks. Additional guidance on the approved use and construction of motorized hand trucks and electrical industrial trucks can be found in

NFPA 505. This section prohibits the transportation of more than the MAQ of any material within an exit. The movement of hazardous materials through exit enclosures within a building is undesirable. However, it may also be unavoidable in multistory buildings. This section is intended to limit the amount of hazardous materials within an exit at any time.

Exception 1 recognizes that two safety carriers can be hand carried.

Exception 2 recognizes that a maximum of four drums with a capacity of 55 gallons (208 L) or less can be transported using an approved drum truck.

Exception 3 recognizes that some containers and cylinders of compressed gases can be transported if they are secured on approved hand trucks. Also, the hand carrying of containers and cylinders is approved when they weigh no more than 25 pounds (11 kg).

Exception 4 recognizes that solid hazardous materials not exceeding 100 pounds (45 kg) can be transported using approved hand trucks. Single containers weighing no more than 50 pounds (23 kg) may be hand carried.

**5003.10.3 Carts and trucks.** Carts and trucks required by Section 5003.10.2 to be used to transport hazardous materials shall be in accordance with Sections 5003.10.3.1 through 5003.10.3.6.

❖ Where carts and trucks are required, they must be designed in accordance with Sections 5003.10.3.1 through 5003.10.3.6.

**5003.10.3.1 Design.** Carts and trucks used to transport hazardous materials shall be designed to provide a stable base for the commodities to be transported and shall have a means of restraining containers to prevent accidental dislodgement. *Compressed gas* cylinders placed on carts and trucks shall be individually restrained.

❖ Carts and trucks must be of an inherently stable design to minimize tipping, rolling or other uncontrolled movement. They must also be equipped with a means to restrain cylinders or other containers from falling, tipping or rolling.

**5003.10.3.2 Speed-control devices.** Carts and trucks shall be provided with a device that will enable the operator to control safely movement by providing stops or speed-reduction devices.

❖ Carts and trucks must be equipped with speed control devices, brakes, steering stops or other controls for use when uncontrolled movements occur.

**5003.10.3.3 Construction.** Construction materials for hazardous material carts or trucks shall be compatible with the material transported. The cart or truck shall be of substantial construction.

❖ The surface of the cart or truck must be compatible with the material transported. Although this section only clarifies that the cart or truck be made of substantial construction, trucks are built of noncombustible materials. The cart or truck should not be a contributing factor in a fire.

**5003.10.3.4 Spill control.** Carts and trucks transporting liquids shall be capable of containing a spill from the largest single container transported.

❖ Each cart or hand truck used must be able to control the spill of the largest container it transports.

**5003.10.3.5 Attendance.** Carts and trucks used to transport materials shall not obstruct or be left unattended within any part of a *means of egress*.

❖ When transporting material through a corridor or exit enclosure, the material must not be left unattended.

**5003.10.3.6 Incompatible materials.** *Incompatible materials* shall not be transported on the same cart or truck.

❖ As has been stated throughout the code, incompatible materials must not be mixed during transport.

**5003.11 Group M storage and display and Group S storage.** The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials stored and displayed within a single *control area* of a Group M occupancy, or an outdoor *control area*, or stored in a single *control area* of a Group S occupancy, is allowed to exceed the *maximum allowable quantity per control area* indicated in Section 5003.1 where in accordance with Sections 5003.11.1 through 5003.11.3.11.

❖ This section names three specific use or storage areas in which limits on nonflammable solid and nonflammable or noncombustible liquid chemicals may be exceeded:

1. When they are being stored or displayed in a Group M occupancy.
2. When they are being stored in a single control area of a Group S occupancy.
3. When they are in an outdoor control area.

MAQs can be exceeded when the area is protected as required by Sections 5003.11.1 through 5003.11.3.10.

**5003.11.1 Maximum allowable quantity per control area in Group M or S occupancies.** The aggregate amount of nonflammable solid and nonflammable or noncombustible liquid hazardous materials stored and displayed within a single *control area* of a Group M occupancy or stored in a single *control area* of a Group S occupancy shall not exceed the amounts set forth in Table 5003.11.1.

❖ The amounts of nonflammable solid and nonflammable or noncombustible liquid hazardous material stored and displayed in inside areas may not exceed the MAQs shown in Table 5003.11.1 unless a footnote allows an increase.

**TABLE 5003.11.1.** See page 50-40.

❖ Table 5003.11.1 lists the hazardous materials eligible for the mercantile and storage occupancy option and the corresponding MAQs depending on the extent of protection provided. The permitted quantities of each listed material are independent of each other, as well

as the various classes or physical state of a specific material. For example, a given control area could contain up to the permitted maximum quantity of Class 2 solid oxidizers, Class 3 solid oxidizers and Class 2 liquid oxidizers, in addition to the permitted quantities of corrosive materials.

Notes b and c would allow the listed maximum quantity in Table 5003.11.1 to be increased due to the use of sprinklers or approved hazardous materials storage cabinets, or both. The notes are intended to be cumulative in that up to four times the listed amount may be allowed per control area, if the building is fully sprinklered and approved cabinets are utilized, without classifying the building as Group H.

Note d simply refers to Table 5003.8.3.2 for the design and permitted number of control areas. Note b of Table 5003.8.3.2 limits mercantile and storage occupancies utilizing this option to two control areas.

The 100-percent increase in MAQs for outdoor control areas permitted by Note f is based on the reduced exposure hazard to the building and its occupants. The increase encourages exterior storage applications without mandating sprinkler protection or approved hazardous material storage cabinets.

Notes g and h recognize that Class 2 and 3 solid oxidizers include several disinfectants that are commonly used in recreational, potable and waste water treatment. Without these exceptions, the tabular MAQs allowed in Group M and S occupancies would not be sufficient to sustain trade demand during times of peak usage. Because small containers of these materials have not been involved in losses, the exceptions permit additional containers of 10 pounds (5 kg) or less. Note that Section 5003.11.3.6 limits the tabular quantities to individual containers of 100 pounds (45 kg) or less, whereas these exceptions give the retailer/wholesaler the option of increasing quantities on the shelves when the packaging sizes are limited to 10 pounds (5 kg) or less.

Note i recognizes the inherently higher level of protection and safety afforded by a sprinkler system and that, by definition, the only hazard presented by Class 1 oxidizers is they slightly increase the burning rate of combustible materials they may contact with during a fire. Materials with such properties present nowhere near the level of hazard of many ordinary commodities that might be found in a Group M or S occupancy, such as foam plastics. To put this matter into perspective, Class 1 oxidizers are materials with a degree of hazard similar to that of toilet bowl cleaner crystals. Note i also provides correlation with Note f of Table 5003.1.1(1).

Note j further recognizes the lesser hazard of Class 1 oxidizers and the inherent safety of storing hazardous materials outdoors by allowing quantities to be unlimited in outdoor control areas. Note j also provides correlation with Table 5003.1.1(3).

**5003.11.2 Maximum allowable quantity per outdoor control area in Group M or S occupancies.** The aggregate

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amount of nonflammable solid and nonflammable or non-combustible liquid hazardous materials stored and displayed within a single outdoor *control area* of a Group M occupancy shall not exceed the amounts set forth in Table 5003.11.1.

❖ The amounts of storage of nonflammable solid and nonflammable or noncombustible liquid hazardous material stored and displayed in outside areas may not exceed the MAQs given in Table 5003.11.1.

**5003.11.3 Storage and display.** Storage and display shall be in accordance with Sections 5003.11.3.1 through 5003.11.3.11.

❖ Storage and display of nonflammable solid and nonflammable or noncombustible liquid chemicals must comply with Sections 5003.11.3.1 through 5003.11.3.10.

**5003.11.3.1 Density.** Storage and display of solids shall not exceed 200 pounds per square foot (976 kg/m<sup>2</sup>) of floor area actually occupied by solid merchandise. Storage and display

of liquids shall not exceed 20 gallons per square foot (0.50 L/m<sup>2</sup>) of floor area actually occupied by liquid merchandise.

❖ The key element to this section is the phrase “floor area actually occupied by solid or liquid merchandise.” As an example, if 10 square feet (0.9 m<sup>2</sup>) of floor area is to be used for storage or display, the limit allowed would be 2,000 pounds (908 kg) (200 pounds × 10 square feet) of solid material or 200 gallons (757 L) (20 gallons × 10 square feet) of liquid material.

**5003.11.3.2 Storage and display height.** Display height shall not exceed 6 feet (1829 mm) above the finished floor in display areas of Group M occupancies. Storage height shall not exceed 8 feet (2438 mm) above the finished floor in storage areas of Group M and Group S occupancies.

❖ This section limits Group M display height to 6 feet (1829 mm). In storage areas of Group M occupancies and Group S occupancies, the storage height is increased to 8 feet (2438 mm) in recognition of the fact that these areas are not normally open to the

**TABLE 5003.11.1  
MAXIMUM ALLOWABLE QUANTITY PER INDOOR AND OUTDOOR CONTROL AREA IN GROUP M  
AND S OCCUPANCIES—NONFLAMMABLE SOLIDS, NONFLAMMABLE AND NONCOMBUSTIBLE LIQUIDS<sup>d, e, f</sup>**

CONDITION		MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA	
Material <sup>a</sup>	Class	Solids pounds	Liquids gallons
<b>A. HEALTH-HAZARD MATERIALS—NONFLAMMABLE AND NONCOMBUSTIBLE SOLIDS AND LIQUIDS</b>			
1. Corrosives <sup>b, c</sup>	Not Applicable	9,750	975
2. Highly Toxics	Not Applicable	20 <sup>b, c</sup>	2 <sup>b, c</sup>
3. Toxics <sup>b, c</sup>	Not Applicable	1,000	100
<b>B. PHYSICAL-HAZARD MATERIALS—NONFLAMMABLE AND NONCOMBUSTIBLE SOLIDS AND LIQUIDS</b>			
1. Oxidizers <sup>b, c</sup>	4	Not Allowed	Not Allowed
	3	1,150 <sup>e</sup>	115
	2	2,250 <sup>h</sup>	225
	1	18,000 <sup>i, j</sup>	1,800 <sup>i, j</sup>
2. Unstable (Reactives) <sup>b, c</sup>	4	Not Allowed	Not Allowed
	3	550	55
	2	1,150	115
	1	Not Limited	Not Limited
3. Water Reactives	3 <sup>b, c</sup>	550	55
	2 <sup>b, c</sup>	1,150	115
	1	Not Limited	Not Limited

For SI: 1 pound = 0.454 kg, 1 gallon = 3.785 L, 1 cubic foot = 0.02832 m<sup>3</sup>.

- a. Hazard categories are as specified in Section 5001.2.2.
- b. Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note c also applies, the increase for both notes shall be applied accumulatively.
- c. Maximum allowable quantities shall be increased 100 percent where stored in approved storage cabinets in accordance with Section 5003.8. Where Note b also applies, the increase for both notes shall be applied accumulatively.
- d. See Table 5003.8.3.2 for design and number of control areas.
- e. Maximum allowable quantities for other hazardous material categories shall be in accordance with Section 5003.1.
- f. Maximum allowable quantities shall be increased 100 percent in outdoor control areas.
- g. Maximum allowable quantities shall be increased to 2,250 pounds where individual packages are in the original sealed containers from the manufacturer or packager and do not exceed 10 pounds each.
- h. Maximum allowable quantities shall be increased to 4,500 pounds where individual packages are in the original sealed containers from the manufacturer or packager and do not exceed 10 pounds each.
- i. Quantities are unlimited where protected by an automatic sprinkler system.
- j. Quantities are unlimited in an outdoor control area.

public. These areas are also subject to the density requirements of Section 5003.11.3.1.

**5003.11.3.3 Container location.** Individual containers less than 5 gallons (19 L) or less than 25 pounds (11 kg) shall be stored or displayed on pallets, racks or shelves.

❖ When the capacity of individual containers is less than either 5 gallons (19 L) or 25 pounds (11 kg), they must be displayed on pallets, racks or shelves.

**5003.11.3.4 Racks and shelves.** Racks and shelves used for storage or display shall be in accordance with Section 5003.9.9.

❖ The design of racks and shelves must meet the requirements of Section 5003.9.9. See also Chapter 32 for high-piled combustible storage and rack storage over 12 feet in height.

**5003.11.3.5 Container type.** Containers shall be *approved* for the intended use and identified as to their content.

❖ Containers must be approved for the storage or display conditions.

**5003.11.3.6 Container size.** Individual containers shall not exceed 100 pounds (45 kg) for solids or 10 gallons (38 L) for liquids in storage and display areas.

❖ The individual containers may not exceed 10 gallons (38 L) for liquids or 100 pounds (45 kg) for solids.

**5003.11.3.7 Incompatible materials.** *Incompatible materials* shall be separated in accordance with Section 5003.9.8.

❖ Incompatible materials may not be stored together unless separated in accordance with Section 5003.9.8.

**5003.11.3.8 Floors.** Floors shall be in accordance with Section 5004.12.

❖ Floors in storage and display areas must meet the requirements of Section 5004.12. See the commentary for that section.

**5003.11.3.9 Aisles.** Aisles 4 feet (1219 mm) in width shall be maintained on three sides of the storage or display area.

❖ The storage or display area must be surrounded on at least three sides with an aisle that is at least 4 feet (1219 mm) wide.

**5003.11.3.10 Signs.** Hazard identification signs shall be provided in accordance with Section 5003.5.

❖ Signs meeting the requirements of NFPA 704 and Section 5003.5 must be installed.

**5003.11.3.11 Storage plan.** A storage plan illustrating the intended storage arrangement, including the location and dimensions of aisles, and storage racks shall be provided.

❖ This section makes it clear that all racks and other arrays for merchandise and storage must be shown in order to do a complete and accurate plan review, especially with respect to verifying the adequacy of the means of egress and arrangement of aisles for fire protection of rack systems. These types of plans are often part of the fixture plan prepared after the

construction documents have been submitted but are no less important in the plan review process.

**5003.12 Outdoor control areas.** Outdoor *control areas* for hazardous materials in amounts not exceeding the maximum allowable quantity per outdoor *control area* shall be in accordance with the following:

1. Outdoor *control areas* shall be kept free from weeds, debris and common combustible materials not necessary to the storage. The area surrounding an outdoor *control area* shall be kept clear of such materials for not less than 15 feet (4572 mm).
2. Outdoor control areas shall be located not closer than 20 feet (6096 mm) from a lot line that can be built upon, public street, public alley or public way.

**Exceptions:**

1. For solid and liquid hazardous materials, a 2-hour fire-resistance-rated wall without openings extending not less than 30 inches (762 mm) above and to the sides of the storage area shall be allowed in lieu of such distance.
  2. For compressed gas hazardous materials, unless otherwise specified, the minimum required distances shall not apply where *fire barriers* without openings or penetrations having a minimum *fire-resistance rating* of 2 hours interrupt the line of sight between the storage and the exposure. The configuration of the *fire barrier* shall be designed to allow natural ventilation to prevent the accumulation of hazardous gas concentrations.
  3. Where a property exceeds 10,000 square feet (929 m<sup>2</sup>), a group of two outdoor *control areas* is allowed where *approved* and where each *control area* is separated by a minimum distance of 50 feet (15 240 mm).
  4. Where a property exceeds 35,000 square feet (3252 m<sup>2</sup>), additional groups of outdoor *control areas* are allowed where *approved* and where each group is separated by a minimum distance of 300 feet (91 440 mm).
- ❖ This section lists four requirements for an outdoor control area:

Item 1 requires that outdoor control areas be kept clear of combustible materials for a minimum of 15 feet (4572 mm) around the control area.

Item 2 requires the control area to either be 20 feet (6096 mm) from the lot lines, street, alley or public way or have a 2-hour blank wall extending a minimum of 30 inches (762 mm) above and to either side of the storage area, if the distance requirement cannot be met. Exception 1 allows encroachment on lot lines, public streets, public alleys or public ways through the use of a protective 2-hour fire-resistance-rated wall, which acts as a shield between the storage and the exposure. Recognition of the protection thus provided can also be found in Section 5904.2.1, which contains comparable provisions for flammable solids identifying the use of a protective structure as a

means to allow encroachment on lot lines, public streets, public alleys or public ways. For gases, Exception 2 allows encroachment on property lines, public streets, public ways, etc., through the use of an unpenetrated protective 2-hour fire barrier (constructed as required by IBC Section 707), which acts as a shield between the storage and the exposure. This recognizes that a 2-hour fire-barrier provides an equivalent means of achieving the objective of spatial separation. Where a separation assembly is used instead of a physical separation distance, the wall must interrupt the line of sight between storage and exposure and be configured so as to prevent a hazardous accumulation of gas.

Item 3 allows two control areas on properties larger than 10,000 square feet (929 m<sup>2</sup>) when they are separated by at least 50 feet (15 240 mm). The 20-foot (6096 mm) distance from the lot lines, street, alley or public way is still in effect.

Item 4 allows for more than two control areas when the property exceeds 35,000 square feet (3252 m<sup>2</sup>). Each group must be separated by a minimum distance of 300 feet (91 440 mm) to reduce the likelihood of simultaneous involvement of multiple outdoor control areas in a single incident.

## SECTION 5004 STORAGE

**5004.1 Scope.** Storage of hazardous materials in amounts exceeding the *maximum allowable quantity per control area* as set forth in Section 5003.1 shall be in accordance with Sections 5001, 5003 and 5004. Storage of hazardous materials in amounts not exceeding the *maximum allowable quantity per control area* as set forth in Section 5003.1 shall be in accordance with Sections 5001 and 5003. Retail and wholesale storage and display of nonflammable solid and nonflammable and noncombustible liquid hazardous materials in Group M occupancies and Group S storage shall be in accordance with Section 5003.11.

❖ This scope paragraph considers four storage situations: storage of quantities exceeding the maximum, storage of quantities within the allowable limits, retail and wholesale storage and display in Group M occupancies and storage areas in Group S occupancies. Section references are given for each of the four storage and use situations.

**5004.2 Spill control and secondary containment for liquid and solid hazardous materials.** Rooms, buildings or areas used for the storage of liquid or solid hazardous materials shall be provided with spill control and secondary containment in accordance with Sections 5004.2.1 through 5004.2.3.

**Exception:** Outdoor storage of containers on approved containment pallets in accordance with Section 5004.2.3.

❖ This section introduces the specific requirements for spill control and secondary containment for solid and liquid hazardous materials. The exception recognizes the innovation of containment pallets and their suit-

ability for preventing the spread of hazardous materials spills in outdoor control areas (see commentary, Section 5004.2.3).

### 5004.2.1 Spill control for hazardous material liquids.

Rooms, buildings or areas used for the storage of hazardous material liquids in individual vessels having a capacity of more than 55 gallons (208 L), or in which the aggregate capacity of multiple vessels exceeds 1,000 gallons (3785 L), shall be provided with spill control to prevent the flow of liquids to adjoining areas. Floors in indoor locations and similar surfaces in outdoor locations shall be constructed to contain a spill from the largest single vessel by one of the following methods:

1. Liquid-tight sloped or recessed floors in indoor locations or similar areas in outdoor locations.
2. Liquid-tight floors in indoor locations or similar areas in outdoor locations provided with liquid-tight raised or recessed sills or dikes.
3. Sumps and collection systems.
4. Other *approved* engineered systems.

Except for surfacing, the floors, sills, dikes, sumps and collection systems shall be constructed of noncombustible material, and the liquid-tight seal shall be compatible with the material stored. Where liquid-tight sills or dikes are provided, they are not required at perimeter openings having an open-grate trench across the opening that connects to an approved collection system.

❖ The requirement for spill control in a room or area is based on two items. The first is that the storage container(s) have a capacity of more than 55 gallons (208 L). The second is that the aggregate capacity of multiple vessels be more than 1,000 gallons (3785 L). The area, once determined to require spill control, must be protected so that the containment area will handle the release from the largest container in the area. This section recommends four methods of containment:

1. Liquid-tight sloped or recessed floors. The chemicals being stored or used in the area must be evaluated to ensure that the method of making the floor liquid tight will not cause a reaction with the chemicals.
2. Liquid-tight floors with a containment sill or trench around the area. To determine the volume of the containment sill or dike, the following procedure is recommended:
  - Determine the greatest amount of liquid that can be released from the largest tank or container within the containment area.
  - If more than one tank or group of containers are in the containment area, the volume of the tank or group of containers below the height of the containment sill or dike can be subtracted from the volume of the containment sill or dike.

- The following is the equation for determining the volumetric capacity of a tank:

$$V = \frac{3.1416(d)^2h}{4}$$

where:

$V$  = Tank capacity, in gallons.

$d$  = Diameter of tank, in feet.

$h$  = Height of tank, in feet.

- Determine whether the containment sill or dike is of sufficient size to control the spill.
- The following is the equation for determining the volumetric capacity of the containment sill or dike:

$$V = a \cdot h$$

where:

$V$  = Volumetric capacity of dike, in gallons.

$a$  = Area of storage floor, in square feet.

$h$  = Height of sill, in feet.

#### Example:

There is a sprinklered first-floor inside storage room that is 20 feet by 15 feet (6096 mm by 4572 mm). Storage consists of 32 drums [55 gallon (208 L)] of a Class II combustible liquid stacked two pallets high. The containment sill is 4 inches (102 mm) high. Is this height adequate for spill containment?

The largest tank is 55 gallons (208 L). It is 36 inches (914 mm) tall and 22 inches (559 mm) wide, and has a volumetric capacity of:

$$V = \frac{3.1416(22/12)^2(36/12)}{4}$$

(Convert inches to feet)

$V = 7.91$  cubic feet (0.22 m<sup>3</sup>) of spill from a 55-gallon (208 L) drum.

There are four pallets that are 54 inches by 54 inches square (1372 mm by 1372 mm) and 4 inches (102 mm) tall.

$$V = (54/12) \times (54/12) \times 4/12 \text{ inches}$$

$$V = 6.68 \text{ cubic feet (0.2 m}^3\text{) per pallet.}$$

$6.68 \times 4$  (pallets) = 26.73 cubic feet (0.76 m<sup>3</sup>) of space taken up in the containment area.

The room has a containment area of 20 feet by 15 feet by 4/12 or 99 cubic feet (3 m<sup>3</sup>).

When the volume of the pallets is subtracted, there is 72.27 cubic feet (0.2

m<sup>3</sup>) of containment. The largest container [55-gallon (208 L) drum] would produce a spill volume of 7.91 cubic feet (0.2 m<sup>3</sup>). Thus, the secondary containment of a 20-foot by 15-foot (6096 mm by 4572 mm) room with a 4-inch (102 mm) curb would contain the spill from the largest container.

- Sumps and collection systems that can consist of floor drains to a remote collection tank. Oil/water separators would also be required by Section 1003.4 of the *International Plumbing Code*<sup>®</sup> (IPC<sup>®</sup>) for floor drains that discharge into the building drainage system or other point of disposal.
- Any other approved engineered systems. Any system that has been engineered and evaluated for the hazards present can be accepted by the fire code official.

**5004.2.2 Secondary containment for hazardous material liquids and solids.** Where required by Table 5004.2.2 buildings, rooms or areas used for the storage of hazardous materials liquids or solids shall be provided with secondary containment in accordance with this section where the capacity of an individual vessel or the aggregate capacity of multiple vessels exceeds both of the following:

- Liquids: Capacity of an individual vessel exceeds 55 gallons (208 L) or the aggregate capacity of multiple vessels exceeds 1,000 gallons (3785 L).
- Solids: Capacity of an individual vessel exceeds 550 pounds (250 kg) or the aggregate capacity of multiple vessels exceeds 10,000 pounds (4540 kg).

❖ Table 5004.2.2 specifies requirements for secondary containment according to the type of material and method of storage. In addition, the capacity of an individual container must exceed 55 gallons (208 L) of liquid or the aggregate capacity of multiple containers must exceed 1,000 gallons (3785 L). If the chemical is in solid form and the capacity of an individual container exceeds 550 pounds (250 kg) or the cumulative capacity of multiple containers exceeds 10,000 pounds (4540 kg), secondary containment is required when called for in Table 5004.2.2.

**TABLE 5004.2.2.** See page 50-44.

❖ This table is divided into three main columns: material, indoor storage and outdoor storage. Indoor and outdoor storage is further divided into two subcolumns: solids and liquids. This table indicates when secondary containment is required.

**5004.2.2.1 Containment and drainage methods.** The building, room or area shall contain or drain the hazardous materials and fire protection water through the use of one of the following methods:

- Liquid-tight sloped or recessed floors in indoor locations or similar areas in outdoor locations.

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2. Liquid-tight floors in indoor locations or similar areas in outdoor locations provided with liquid-tight raised or recessed sills or dikes.
  3. Sumps and collection systems.
  4. Drainage systems leading to an *approved* location.
  5. Other *approved* engineered systems.
- ❖ The five methods of containment and drainage for secondary containment in this section are similar to those of spill control.

Method 1 consists of liquid-tight sloped or recessed floors. The chemicals being stored or used in the area must be evaluated to ensure that the method of making the floor liquid tight will not cause a reaction

with the chemicals.

Method 2 consists of liquid-tight floors with a containment sill or trench around the area.

To determine the height of the containment sill or dike, the following procedure is recommended:

- Determine the greatest amount of liquid that can be released from the largest tank or container within the containment area.
- If more than one tank or group of containers are in the containment area, the volume of the tank or group of containers below the height of the containment sill or dike must be subtracted from the volume of the containment sill or dike.

**TABLE 5004.2.2  
REQUIRED SECONDARY CONTAINMENT—HAZARDOUS MATERIAL SOLIDS AND LIQUIDS STORAGE**

MATERIAL		INDOOR STORAGE		OUTDOOR STORAGE	
		Solids	Liquids	Solids	Liquids
<b>1. Physical-hazard materials</b>					
Combustible liquids	Class II	Not Applicable	See Chapter 57	Not Applicable	See Chapter 57
	Class IIIA		See Chapter 57		See Chapter 57
	Class IIIB		See Chapter 57		See Chapter 57
Cryogenic fluids	See Chapter 55		See Chapter 55		
Explosives		See Chapter 56		See Chapter 56	
Flammable liquids	Class IA	Not Applicable	See Chapter 57	Not Applicable	See Chapter 57
	Class IB		See Chapter 57		See Chapter 57
	Class IC		See Chapter 57		See Chapter 57
Flammable solids		Not Required	Not Applicable	Not Required	Not Applicable
Organic peroxides	Unclassified Detonable	Required	Required	Not Required	Not Required
	Class I				
	Class II				
	Class III				
	Class IV				
	Class V	Not Required	Not Required	Not Required	Not Required
Oxidizers	Class 4	Required	Required	Not Required	Not Required
	Class 3				
	Class 2	Not Required	Not Required	Not Required	Not Required
	Class 1				
Pyrophorics		Not Required	Required	Not Required	Required
Unstable (reactives)	Class 4	Required	Required	Required	Required
	Class 3				
	Class 2				
	Class 1	Not Required	Not Required	Not Required	Not Required
Water reactives	Class 3	Required	Required	Required	Required
	Class 2				
	Class 1	Not Required	Not Required	Not Required	Not Required
<b>2. Health-hazard materials</b>					
Corrosives		Not Required	Required	Not Required	Required
Highly toxics		Required	Required	Required	Required
Toxics					

- The following is the equation for determining the volumetric capacity of a tank:

$$V = \frac{3.1416(d)^2h}{4}$$

- Determine whether the containment sill or dike is of sufficient size to control a spill and the fire-fighting water, as required.

The following is the equation for determining the volumetric capacity of a containment sill or dike:

$$V = (a) (h)$$

where:

$V$  = Volume of the containment, in cubic feet.

$a$  = Area of the containment, in square feet.

$h$  = Height of the sill or dike, in feet.

#### Example:

There is a sprinklered first floor inside storage room that is 20 feet by 15 feet (6096 mm by 4572 mm). Stored in this area are 32 drums [55 gallons (208 L)] of a Class II combustible liquid stacked two pallets high. The containment sill is 4 inches (102 mm) high. Will this provide secondary containment?

The largest tank is 55 gallons (208 L). It has dimensions of 36 inches (914 mm) tall and 22 inches (539 mm) wide, and has a volumetric capacity of:

$$V = \frac{3.1416(22/12)^2(36/12)}{4}$$

(Convert inches to feet)

$$V = 7.91 \text{ cubic feet (0.2 m}^3\text{) of spill from a 55-gallon (208 L) drum.}$$

There are four pallets with a size of 54 inches by 54 inches (1372 mm by 1372 mm) and 4 inches (102 mm) tall.

$$V = (54/12)(54/12) (4/12)$$

$$V = 6.68 \text{ cubic feet (0.2 m}^3\text{) per pallet}$$

$6.68 \times 4$  (pallets) = 26.73 cubic feet (0.76 m<sup>3</sup>) of space taken up in the containment area.

The room has a containment area of 20 feet by 15 feet by 4 inches (6096 mm by 4572 mm by 102 mm) or 99 cubic feet (3 m<sup>3</sup>).

When the volume of the pallets is subtracted, there is 72.27 cubic feet (2 m<sup>3</sup>) of containment. The largest container [55-gallon (208 L) drum] would produce a spill of 7.91 cubic feet (0.2 m<sup>3</sup>). Thus, the secondary containment of a 20-foot by 15-foot (6096 mm by 4572 mm) room with a 4-inch (102 mm) curb would contain the spill from the largest container. Now the requirements of the fire-fighting water from the

sprinkler system as required by Section 5004.2.2.3 must be factored in. From NFPA 13 Chapter 11, the design density is 0.2. This design density of 0.2 times the fire area of 300 square feet (28 m<sup>2</sup>) equals 60 gallons (227 L) per minute discharge. The sprinkler discharge will be 60 gallons (227 L) × 20 minutes (as required by Section 5004.2.2.3) or 1,200 gallons (4542 L) of fire-fighting water.

The conversion factor from gallon to cubic foot is 0.1335805. Therefore, 1,200 gallons (4542 L) of fire-fighting water × 0.1335805 = 167.79 cubic feet (5 m<sup>3</sup>) of containment area required.

The largest tank volume is 7.91 cubic feet (0.2 m<sup>3</sup>).

The volume of the pallets is 26.73 cubic feet (0.8 m<sup>3</sup>).

The volume for fire-fighting water is 167.79 cubic feet (5 m<sup>3</sup>).

Total cubic feet required for secondary containment is 202.43 cubic feet (6 m<sup>3</sup>).

In this case, the secondary containment does not have enough capacity. Although the 4-inch (102 mm) sill does give enough capacity for spill containment, with the requirement of fire-fighting water there is now no proper secondary containment.

Method 3 recommends sumps and collection systems, which can consist of floor drains to remote collection tanks. It is important to remember that oil/water separators are required by IPC Section 1003.4 for floor drains that discharge into the building drainage system or other point of disposal.

Method 4 is a drainage system leading to an approved location. If water is being used as the automatic extinguishing agent for the area, a large containment area will be required to hold the runoff of the sprinkler water and the spill.

Method 5 is any other approved engineered system. Any system that has been engineered and evaluated for the hazards present can be accepted by the fire code official.

**5004.2.2.2 Incompatible materials.** *Incompatible materials* used in *open systems* shall be separated from each other in the secondary containment system.

- ❖ Different containment areas cannot be manifolded if the products in the different areas are incompatible. Even in containment of a spill in a single area, incompatible materials must be kept separated.

**5004.2.2.3 Indoor design.** Secondary containment for indoor storage areas shall be designed to contain a spill from the largest vessel plus the design flow volume of fire protection water calculated to discharge from the fire-extinguishing system over the minimum required system design area or area of the room or area in which the storage is located, whichever is

smaller. The containment capacity shall be designed to contain the flow for a period of 20 minutes.

- ❖ Secondary containment must be sized to hold the release of the largest container in the area plus the design flow volume of the fire protection for a 20-minute period.

For example, there is a 500-square-foot (46 m<sup>2</sup>) flammable liquid storage area that is sprinklered. Section 5004.5 states that the minimum design of the sprinkler system is an ordinary hazard Group 2 with the minimum design area of 3,000 square feet (279 m<sup>2</sup>). From NFPA 13 Chapter 11, the design density is 0.2. This design density of 0.2 times the fire area of 500 square feet (46 m<sup>2</sup>) equals 100-gallon-per-minute (6 L/s) discharge.

The largest tank in the fire area is 100 gallons (379 L). The secondary containment must be sized to hold the 100 gallons (379 L) plus the sprinkler discharge of 100 gallons (379 L) for 20 minutes, or 2,100 gallons (7949 L). This must be the minimum capacity of the secondary containment.

**5004.2.2.4 Outdoor design.** Secondary containment for outdoor storage areas shall be designed to contain a spill from the largest individual vessel. If the area is open to rainfall, secondary containment shall be designed to include the volume of a 24-hour rainfall as determined by a 25-year storm and provisions shall be made to drain accumulations of groundwater and rainwater.

- ❖ In addition to holding the volume of the largest container, if the area is open to rainfall, the secondary containment must include the volume of a 24-hour rainfall, as determined by a 25-year storm. Drains must be sized to carry off accumulations of ground water and rainwater. See IPC Section 1106.1 for information on rainfall maps.

**5004.2.2.5 Monitoring.** An *approved* monitoring method shall be provided to detect hazardous materials in the secondary containment system. The monitoring method is allowed to be visual inspection of the primary or secondary containment, or other *approved* means. Where secondary containment is subject to the intrusion of water, a monitoring method for detecting water shall be provided. Where monitoring devices are provided, they shall be connected to *approved* visual or audible alarms.

- ❖ Visual inspection of the primary or secondary containment system is permitted; otherwise, an electronic monitoring system must be installed. These electronic systems must be connected to both audible and visual alarms.

**5004.2.2.6 Drainage system design.** Drainage systems shall be in accordance with the *International Plumbing Code* and all of the following:

1. The slope of floors to drains in indoor locations, or similar areas in outdoor locations shall be not less than 1 percent.

2. Drains from indoor storage areas shall be sized to carry the volume of the fire protection water as determined by the design density discharged from the automatic fire-extinguishing system over the minimum required system design area or area of the room or area in which the storage is located, whichever is smaller.
3. Drains from outdoor storage areas shall be sized to carry the volume of the fire flow and the volume of a 24-hour rainfall as determined by a 25-year storm.
4. Materials of construction for drainage systems shall be compatible with the materials stored.
5. *Incompatible materials* used in *open systems* shall be separated from each other in the drainage system.
6. Drains shall terminate in an *approved* location away from buildings, valves, *means of egress*, fire access roadways, adjoining property and storm drains.

- ❖ Drainage systems for hazardous materials must meet the requirements of IPC Section 1003, in addition to the six elements listed in this section:

1. The slope of the floor may not be more than 1 percent.
2. The drains for an indoor storage area must be sized to carry the automatic fire-extinguishing agent from the room. If an agent other than a liquid is used, no additional volume will be needed for calculations.
3. The drains for outdoor storage must be sized to carry the volume of fire flow and the volume of a 24-hour rainfall.
4. The piping and other elements of the system must be chosen to be compatible with the chemicals and extinguishing agents that will be flowing through the drainage system.
5. Incompatible materials pose a great hazard both in use and when an emergency occurs. This section requires that incompatible materials, when used in open systems, be separated into different drainage systems.
6. Drains must terminate in safe locations so that they do not pose additional threats to lives and property.

**5004.2.3 Containment pallets.** Where used as an alternative to spill control and secondary containment for outdoor storage in accordance with the exception in Section 5004.2, containment pallets shall comply with all of the following:

1. A liquid-tight sump accessible for visual inspection shall be provided.
2. The sump shall be designed to contain not less than 66 gallons (250 L).
3. Exposed surfaces shall be compatible with material stored.

4. Containment pallets shall be protected to prevent collection of rainwater within the sump.

❖ Another option now available is the use of containment pallets. This type of pallet is designed to contain a leak should one occur. This section specifies the minimum design for the pallet.

**5004.3 Ventilation.** Indoor storage areas and storage buildings shall be provided with mechanical exhaust ventilation or natural ventilation where natural ventilation can be shown to be acceptable for the materials as stored.

**Exception:** Storage areas for flammable solids complying with Chapter 59.

❖ Indoor storage areas and buildings must be ventilated either mechanically or naturally so that the level of vapors is maintained below the LFL or PEL. Keeping the area/building at these levels maintains a level of safety for the area. Storage areas for flammable solids that meet the requirements of Chapter 59 are exempted from this requirement.

**5004.3.1 System requirements.** Exhaust ventilation systems shall comply with all of the following:

1. Installation shall be in accordance with the *International Mechanical Code*.
2. Mechanical ventilation shall be at a rate of not less than 1 cubic foot per minute per square foot [ $0.00508 \text{ m}^3/(\text{s} \cdot \text{m}^2)$ ] of floor area over the storage area.
3. Systems shall operate continuously unless alternative designs are *approved*.
4. A manual shutoff control shall be provided outside of the room in a position adjacent to the access door to the room or in an *approved* location. The switch shall be a break-glass or other *approved* type and shall be *labeled*: VENTILATION SYSTEM EMERGENCY SHUTOFF.
5. Exhaust ventilation shall be designed to consider the density of the potential fumes or vapors released. For fumes or vapors that are heavier than air, exhaust shall be taken from a point within 12 inches (305 mm) of the floor. For fumes or vapors that are lighter than air, exhaust shall be taken from a point within 12 inches (305 mm) of the highest point of the room.
6. The location of both the exhaust and inlet air openings shall be designed to provide air movement across all portions of the floor or room to prevent the accumulation of vapors.
7. Exhaust air shall not be recirculated to occupied areas if the materials stored are capable of emitting hazardous vapors and contaminants have not been removed. Air contaminated with explosive or flammable vapors, fumes or dusts; flammable, highly toxic or toxic gases; or radioactive materials shall not be recirculated.

❖ The exhaust ventilation system must comply with all of the seven requirements of this section:

1. Systems must be installed as required by IMC Chapter 5.

2. The minimum rate for mechanical ventilation is listed here; however, the MSDS must also be reviewed. The ventilation needed to maintain a safe environment could require a much higher flow rate.
3. The exhaust system must provide continuous ventilation in the area.
4. The entry door into the area must be equipped with an emergency shutoff that can be used to disable the ventilation system in case of a fire.
5. The system design must consider the vapor density of the chemicals being stored. The vapor density for the chemicals can be found in the MSDS.
6. The system must provide air movement across the entire area being protected.
7. Item 7 recognizes the possibility for contaminant control and energy conservation for hazardous exhaust systems through air-recovery systems. Some energy conservation opportunities use the exhausted air for heat recovery, makeup air, or recirculation to occupied areas. Those systems incorporate a variety of contaminant control strategies, including water mist sprays, activated carbon filters and oxidizing pellet filters.

Air contaminated with explosive or flammable vapors, fumes or dusts; flammable or toxic gases; or radioactive material must be exhausted to the outdoors and, therefore, cannot be recirculated or transferred to any other space. Note that the recirculation of exhaust in any form is in direct conflict with IMC Section 510.1, which requires hazardous exhaust to discharge to the outdoors.

**5004.4 Separation of incompatible hazardous materials.** *Incompatible materials* shall be separated in accordance with Section 5003.9.8.

❖ Incompatible materials must be kept separated so that accidental mixing of chemicals in an emergency does not create a more dangerous incident.

**5004.5 Automatic sprinkler systems.** Indoor storage areas and storage buildings shall be equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1. The design of the sprinkler system shall be not less than that required for Ordinary Hazard Group 2 with a minimum design area of 3,000 square feet (279 m<sup>2</sup>). Where the materials or storage arrangement are required by other regulations to be provided with a higher level of sprinkler system protection, the higher level of sprinkler system protection shall be provided.

❖ This section requires a sprinkler system for indoor storage areas and buildings. The system must comply with NFPA 13 and provide a minimum density as required for an Ordinary Hazard Group 2. The MSDS should be consulted for compatibility with water. If the

materials are incompatible, other methods of automatic extinguishing should be used.

**5004.6 Explosion control.** Indoor storage rooms, areas and buildings shall be provided with explosion control in accordance with Section 911.

❖ Storage rooms and use areas must be provided with explosion control in accordance with Table 911.1. The design of the explosion control must meet the requirements of Section 911.

**5004.7 Standby or emergency power.** Where mechanical ventilation, treatment systems, temperature control, alarm, detection or other electrically operated systems are required, such systems shall be provided with an emergency or standby power in accordance with Section 604.

For storage areas for highly toxic or toxic materials, see Sections 6004.2.2.8 and 6004.3.4.2.

❖ A backup emergency power source is considered essential for required systems monitoring and serving hazardous materials; therefore, when limit controls, detection systems or mechanical ventilation is required for a specific hazardous material, an emergency electrical system or standby power system is required.

**5004.7.1 Exempt applications.** Standby or emergency power is not required for mechanical ventilation systems for any of the following:

1. Storage of Class IB and Class IC flammable and *combustible liquids* in closed containers not exceeding 6½ gallons (25 L) capacity.
2. Storage of Class 1 and 2 oxidizers.
3. Storage of Class II, III, IV and V organic peroxides.
4. Storage of asphyxiant, irritant and radioactive gases.

❖ Exempt application 1 correlates with industry treatment of portable container storage. Notably, storage of small, closed containers does not pose a risk that warrants ventilation for these materials. FM Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers*, does not require mechanical ventilation for flammable liquids in closed containers of not greater than 6½-gallon (25 L) individual capacity, with a flash point of not greater than 100°F (38°C) and a boiling point equal to or greater than 100°F (38°C). NFPA 30 also recognizes that closed container storage does not pose a risk that warrants ventilation (ventilation is required if there is open dispensing). These materials are in sealed containers in storage. Any loss of power would require an immediate cessation of operations, which would eliminate spill risk. By limiting the container size, the potential for accidental spills is significantly reduced.

Exempt applications 2 and 3 address low-hazard oxidizers and organic peroxides that do not present a severe fire or reactivity hazard. Highly toxic and toxic materials (see Exception 5) must conform to applicable requirements of Chapter 37. For example, emergency power may be required for treatment systems

utilized to process the accidental release of highly toxic or toxic compressed gases caused by a leak or rupture in storage cylinders or tanks. Without emergency power, all required monitoring systems, including the treatment system for neutralizing potential leaking gas, would be rendered inoperative if a power failure or other electrical system failure occurred.

Exempt application 4 exempts storage areas for asphyxiant, irritant or radioactive gases because, unlike the requirements for other hazard categories, which use the MAQ as a trigger threshold, the requirement for ventilation in storage areas containing these gases is not quantity based. The construction of compressed gas containers is robust compared to the containers used for other materials that may be of glass, plastic or paper. The integrity of the containers alone represents a major safeguard against likely failure. While leakage from containers is a consideration, the concern over reestablishing power to the ventilation system within 60 seconds is not warranted given the facts that the requirement could be imposed for insignificant quantities of the gas, and that occupancy of a storage area during power outage is not the norm.

**5004.7.2 Fail-safe engineered systems.** Standby power for mechanical ventilation, treatment systems and temperature control systems shall not be required where an *approved* fail-safe engineered system is installed..

❖ This section recognizes the use of an engineered system designed to always fail in the appropriate design mode without human intervention in lieu of the emergency power system. The intent of the exception is to permit alternative systems that are not subject to power interruptions. Note that this exception does not apply to detection and alarm systems, but addresses those systems essential to the removal of hazardous fumes and vapors from potentially occupied areas.

**5004.8 Limit controls.** Limit controls shall be provided in accordance with Sections 5004.8.1 and 5004.8.2.

❖ Based on the MSDS, limit controls may be required to protect the chemicals.

**5004.8.1 Temperature control.** Materials that must be kept at temperatures other than normal ambient temperatures to prevent a hazardous reaction shall be provided with an approved means to maintain the temperature within a safe range. Redundant temperature control equipment that will operate on failure of the primary temperature control system shall be provided. Where *approved*, alternative means that prevent a hazardous reaction are allowed.

❖ When a chemical is temperature sensitive, a temperature control system with a redundant backup is required.

**5004.8.2 Pressure control.** Stationary tanks and equipment containing hazardous material liquids that can generate pressures exceeding design limits because of exposure fires or internal reaction shall have some form of construction or other *approved* means that will relieve excessive internal

pressure. The means of pressure relief shall vent to an *approved* location or to an exhaust scrubber or treatment system where required by Chapter 60.

- ❖ Emergency vents must be installed when the vapor density of a chemical could cause a boiling liquid expanding vapor explosion (BLEVE) during a fire.

**5004.9 Emergency alarm.** An *approved* manual emergency alarm system shall be provided in buildings, rooms or areas used for storage of hazardous materials. Emergency alarm-initiating devices shall be installed outside of each interior *exit* or *exit access* door of storage buildings, rooms or areas. Activation of an emergency alarm-initiating device shall sound a local alarm to alert occupants of an emergency situation involving hazardous materials.

- ❖ A manual emergency alarm system that meets the requirements of Section 908 must be installed (see commentary, Sections 908.1 through 908.6).

**5004.10 Supervision and monitoring.** Emergency alarm, detection and automatic fire-extinguishing systems required by Section 5004 shall be electrically supervised and monitored by an *approved* supervising station or, where approved, shall initiate an audible and visual signal at a constantly attended on-site location.

- ❖ Emergency alarm systems, detection systems and automatic extinguishing systems must be supervised by an approved central, proprietary or remote station system. Where a facility has an on-site, “constantly attended location” (as defined in Chapter 2) staffed by qualified personnel who can respond to signals in a timely fashion, the fire code official may approve the monitoring of audible and visual signals by such an attended location in lieu of off-site transmission to an approved supervising station.

**5004.11 Clearance from combustibles.** The area surrounding an outdoor storage area or tank shall be kept clear of combustible materials and vegetation for a minimum distance of 25 feet (7620 mm).

- ❖ Vegetation and other combustible materials must be cut back for a distance of at least 25 feet (7620 mm) from outdoor storage to minimize the exposure to the storage area in the event of a fire in the combustible materials. Note that Section 5005.3.8 requires an additional 5 feet (1524 mm) of clearance due to the fact that in use, dispensing and handling scenarios, vapors may be present, whereas in storage, containers or tanks are closed and vapors are contained.

**5004.12 Noncombustible floor.** Except for surfacing, floors of storage areas shall be of noncombustible construction.

- ❖ The floor of hazardous occupancies must be of noncombustible construction.

**5004.13 Weather protection.** Where overhead noncombustible construction is provided for sheltering outdoor hazardous material storage areas, such storage shall not be considered indoor storage where the area is constructed in accordance

with the requirements for weather protection as required by the *International Building Code*.

**Exception:** Storage of *explosive* materials shall be considered as indoor storage.

- ❖ This section allows for the construction of noncombustible covers over outdoor storage areas for weather protection. This area is not considered inside storage, except when explosive materials are stored under the noncombustible roof. IBC Section 414.6.1 contains the specific requirements for weather-protection construction.

## SECTION 5005 USE, DISPENSING AND HANDLING

**5005.1 General.** Use, dispensing and handling of hazardous materials in amounts exceeding the *maximum allowable quantity per control area* set forth in Section 5003.1 shall be in accordance with Sections 5001, 5003 and 5005. Use, dispensing and handling of hazardous materials in amounts not exceeding the *maximum allowable quantity per control area* set forth in Section 5003.1 shall be in accordance with Sections 5001 and 5003.

- ❖ The section references two conditions: when the amount of chemicals exceeds the MAQ; and when the amount of chemicals is within the MAQ.

**5005.1.1 Separation of incompatible materials.** Separation of *incompatible materials* shall be in accordance with Section 5003.9.8.

- ❖ When using, dispensing or handling incompatible materials, care must be taken to ensure that the chemicals do not mix.

**5005.1.2 Noncombustible floor.** Except for surfacing, floors of areas where liquid or solid hazardous materials are dispensed or used in *open systems* shall be of noncombustible, liquid-tight construction.

- ❖ When chemicals are used in an open system, the floors must be both liquid tight and of noncombustible construction.

**5005.1.3 Spill control and secondary containment for hazardous material liquids.** Where required by other provisions of Section 5005, spill control and secondary containment shall be provided for hazardous material liquids in accordance with Section 5004.2.

- ❖ If required by Section 5005, the spill control and secondary containment must meet the requirements of Section 5004.2.

**5005.1.4 Limit controls.** Limit controls shall be provided in accordance with Sections 5005.1.4.1 through 5005.1.4.4.

- ❖ Limit controls required in use, dispensing and handling areas are described in the four subsections to this section.

**5005.1.4.1 High-liquid-level control.** Open tanks in which liquid hazardous materials are used shall be equipped with a

liquid-level limit control or other means to prevent overflowing of the tank.

- ❖ When there is a danger of overflowing a tank, especially in open systems, liquid-level controls are required.

**5005.1.4.2 Low-liquid-level control.** *Approved* safeguards shall be provided to prevent a low-liquid level in a tank from creating a hazardous condition, including but not limited to, overheating of a tank or its contents.

- ❖ If the method of storage can allow for the collapse of the tank or other types of failure as a result of a low level of chemicals, low-liquid-level controls are required.

**5005.1.4.3 Temperature control.** Temperature control shall be provided in accordance with Section 5004.8.1.

- ❖ See Section 5004.8.1 for requirements for temperature controls.

**5005.1.4.4 Pressure control.** Pressure control shall be provided in accordance with Section 5004.8.2.

- ❖ See Section 5004.8.2 for requirements for pressure control systems.

**5005.1.5 Standby or emergency power.** Where mechanical ventilation, treatment systems, temperature control, manual alarm, detection or other electrically operated systems are required by this code, such systems shall be provided with emergency or standby power in accordance with Section 604.

- ❖ Mechanical ventilation, treatment systems, temperature controls or other important safety controls must be connected to an emergency electrical system or standby power as required by Section 604 to enhance their reliability in emergency situations.

**5005.1.5.1 Exempt applications.** Standby power for mechanical ventilation, treatment systems and temperature control systems shall not be required where an *approved* fail-safe engineered system is installed.

- ❖ This section recognizes the use of an engineered system that is designed to always fail in the appropriate design mode without human intervention in lieu of the emergency power system. The exception is intended to permit alternative systems that are not subject to power interruptions. Note that this exception does not apply to detection and alarm systems, but addresses those systems essential to the removal of hazardous fumes and vapors from potentially occupied areas.

**5005.1.6 Supervision and monitoring.** Manual alarm, detection and automatic fire-extinguishing systems required by other provisions of Section 5005 shall be electrically supervised and monitored by an *approved* supervisory service or, where *approved*, shall initiate an audible and visual signal at a constantly attended on-site location.

- ❖ Manual fire alarm systems, detection systems and automatic extinguishing systems must be supervised by an approved central, proprietary or remote station

system. Where a facility has an on-site, “constantly attended location” (as defined in Chapter 2) staffed by qualified personnel who can respond to signals in a timely fashion, the fire code official may approve the monitoring of audible and visual signals by such a location in lieu of off-site transmission to an approved supervising station.

**5005.1.7 Lighting.** Adequate lighting by natural or artificial means shall be provided.

- ❖ All areas must be adequately lighted.

**5005.1.8 Fire-extinguishing systems.** Indoor rooms or areas in which hazardous materials are dispensed or used shall be protected by an automatic fire-extinguishing system in accordance with Chapter 9. Sprinkler system design shall be not less than that required for Ordinary Hazard, Group 2, with a minimum design area of 3,000 square feet (279 m<sup>2</sup>). Where the materials or storage arrangement are required by other regulations to be provided with a higher level of sprinkler system protection, the higher level of sprinkler system protection shall be provided.

- ❖ An automatic sprinkler system is required in use, dispensing and handling areas. Special attention must be paid to chemical/water compatibility.

**5005.1.9 Ventilation.** Indoor dispensing and use areas shall be provided with exhaust ventilation in accordance with Section 5004.3.

**Exception:** Ventilation is not required for dispensing and use of flammable solids other than finely divided particles.

- ❖ Exhaust ventilation meeting the requirements of Section 5004.3 must be installed in indoor use and dispensing areas so that the level of vapors is maintained below the LFL or the PEL. Keeping the area/building at these levels provides a level of safety for the area.

**5005.1.10 Liquid transfer.** Liquids having a hazard ranking of 3 or 4 in accordance with NFPA 704 shall be transferred by one of the following methods:

1. From safety cans complying with UL 30.
2. Through an *approved* closed piping system.
3. From containers or tanks by an approved pump taking suction through an opening in the top of the container or tank.
4. From containers or tanks by gravity through an approved self-closing or automatic-closing valve where the container or tank and dispensing operations are provided with spill control and secondary containment in accordance with Section 5004.2. Highly toxic liquids shall not be dispensed by gravity from tanks.
5. *Approved* engineered liquid transfer systems.

**Exceptions:**

1. Liquids having a hazard ranking of 4 where dispensed from approved containers not exceeding 1.3 gallons (5 L).

2. Liquids having a hazard ranking of 3 or 4 dispensed from approved containers not exceeding 5.3 gallons (20 L).

❖ Liquids having a hazard rating of 3 or 4 in NFPA 704 must be transferred using one of the five methods listed in this section. Exceptions include liquids having a hazard ranking of 4 being dispensed from approved containers not exceeding 1.3 gallons (5 L) and liquids having a hazard ranking of 3 when dispensed from approved containers not exceeding 5.3 gallons (20 L).

**5005.1.11 Design.** Systems shall be suitable for the use intended and shall be designed by persons competent in such design. Controls shall be designed to prevent materials from entering or leaving the process or reaction system at other than the intended time, rate or path. Where failure of an automatic control could result in a dangerous condition or reaction, the automatic control shall be fail-safe.

❖ This section provides requirements that govern the use and dispensing of hazardous materials in quantities that exceed the MAQ by relocating a provision that previously only applied to indoor dispensing and use activities to the general provisions. This is a significant improvement because it now requires process design and safety controls to be considered for outdoor processes using quantities of hazardous materials that exceed the outdoor control area MAQs. A variety of hazardous processes are performed outside of buildings because of the physical size of the process or to avoid constructing a building to the IBC and code requirements for a Group H occupancy. By locating this provision as a general requirement, outdoor hazardous materials processes are now subject to design requirements that ensure process variables, such as time, rate, pressure, temperature, flow rate or sequencing the order of chemicals being blended, are considered.

This section requires that automatic process controls be “fail-safe,” as defined in Section 202. A fail-safe design can include an automatic emergency shutoff valve that is designed to close upon loss of power or a process upset condition. It may include an excess flow control valve or feature, which is designed to stop the flow of a gas or liquid when a preset flow rate is exceeded. In most cases, the fail-safe condition would stop the movement or processing of hazardous materials. However, some processes require staged shutdown to be safely stopped, and in these cases, a process hazard analysis is necessary to determine the true fail-safe mode.

**5005.2 Indoor dispensing and use.** Indoor dispensing and use of hazardous materials shall be in buildings complying with the *International Building Code* and in accordance with Section 5005.1 and Sections 5005.2.1 through 5005.2.2.4.

❖ Indoor dispensing and use areas must be constructed to meet the requirements of the IBC along

with Section 5005.1 and Sections 5005.2.1 through 5005.2.2.4 of the code.

**5005.2.1 Open systems.** Dispensing and use of hazardous materials in open containers or systems shall be in accordance with Sections 5005.2.1.1 through 5005.2.1.4.

❖ See the commentary to the definition of “Open systems” in Chapter 2.

**5005.2.1.1 Ventilation.** Where gases, liquids or solids having a hazard ranking of 3 or 4 in accordance with NFPA 704 are dispensed or used, mechanical exhaust ventilation shall be provided to capture gases, fumes, mists or vapors at the point of generation.

**Exception:** Gases, liquids or solids that can be demonstrated not to create harmful gases, fumes, mists or vapors.

❖ Areas where gases, liquids or solids having a ranking of 3 or 4 in accordance with NFPA 704 are used or dispensed must have a mechanical exhaust system to capture vapors at the point of generation unless the chemicals do not produce harmful fumes, mists or vapors.

**5005.2.1.2 Explosion control.** Explosion control shall be provided in accordance with Section 5004.6 where an explosive environment can occur because of the characteristics or nature of the hazardous materials dispensed or used, or as a result of the dispensing or use process.

❖ Based on the requirements of Section 5004.6, explosion control must be provided when the dispensing or use of a chemical could cause an explosion.

**5005.2.1.3 Spill control for hazardous material liquids.** Buildings, rooms or areas where hazardous material liquids are dispensed into vessels exceeding a 1.3-gallon (5 L) capacity or used in *open systems* exceeding a 5.3-gallon (20 L) capacity shall be provided with spill control in accordance with Section 5004.2.1.

❖ When dispensing hazardous materials into containers larger than 1.3 gallons (5 L) or in an open system with a capacity of 5.3 gallons (20 L), spill control must be provided.

**5005.2.1.4 Secondary containment for hazardous material liquids.** Where required by Table 5005.2.1.4, buildings, rooms or areas where hazardous material liquids are dispensed or used in *open systems* shall be provided with secondary containment in accordance with Section 5004.2.2 where the capacity of an individual vessel or system or the capacity of multiple vessels or systems exceeds the following:

1. Individual vessel or system: greater than 1.3 gallons (5 L).
2. Multiple vessels or systems: greater than 5.3 gallons (20 L).

❖ Table 5005.2.1.4 lists conditions where secondary spill containment is required. The containment must meet the requirements of Section 5004.2.2 where the capacity of a single vessel exceeds 1.3 gallons (5 L) or multiple vessels exceed 5.3 gallons (20 L).

**TABLE 5005.2.1.4.** See below.

❖ This table specifies when secondary containment is required. The table is divided into three columns: material, indoor use and outdoor use. Subcolumns of solids and liquids further divide the table. By finding the type of material in question, the physical state and the method of use, one can determine whether secondary containment is required.

**5005.2.2 Closed systems.** Use of hazardous materials in closed containers or systems shall be in accordance with Sections 5005.2.2.1 through 5005.2.2.4.

❖ See the definition of “Closed systems” in Chapter 2.

**5005.2.2.1 Ventilation.** Where *closed systems* are designed to be opened as part of normal operations, ventilation shall be provided in accordance with Section 5005.2.1.1.

❖ See Section 5005.2.1.1 for requirements on ventilation of areas with closed systems.

**5005.2.2.2 Explosion control.** Explosion control shall be provided in accordance with Section 5004.6 where an explosive environment exists because of the hazardous materials dispensed or used, or as a result of the dispensing or use process.

**Exception:** Where process vessels are designed to contain fully the worst-case explosion anticipated within the ves-

**TABLE 5005.2.1.4  
REQUIRED SECONDARY CONTAINMENT—HAZARDOUS MATERIAL LIQUIDS USE**

MATERIAL	INDOOR LIQUIDS USE	OUTDOOR LIQUIDS USE	
<b>1. Physical-hazard materials</b>			
Combustible liquids	Class II	See Chapter 57	See Chapter 57
	Class IIIA	See Chapter 57	See Chapter 57
	Class IIIB	See Chapter 57	See Chapter 57
Cryogenic fluids		See Chapter 55	See Chapter 55
Explosives		See Chapter 56	See Chapter 56
Flammable liquids	Class IA	See Chapter 57	See Chapter 57
	Class IB	See Chapter 57	See Chapter 57
	Class IC	See Chapter 57	See Chapter 57
Flammable solids		Not Applicable	Not Applicable
Organic peroxides	Unclassified Detonable	Required	Required
	Class I	Required	Required
	Class II		
	Class III		
	Class IV		
Class V	Not Required	Not Required	
Oxidizers	Class 4	Required	Required
	Class 3		
	Class 2		
	Class 1		
Pyrophorics		Required	Required
Unstable (reactives)	Class 4	Required	Required
	Class 3		
	Class 2		
	Class 1	Not Required	Required
Water reactives	Class 3	Required	Required
	Class 2	Not Required	Required
	Class 1		
<b>2. Health-hazard materials</b>			
Corrosives	Required	Required	
Highly toxics			
Toxics			

sel under process conditions based on the most likely failure.

- ❖ If the use or process could produce an explosion and the vessels are not rated as explosionproof, explosion control must meet the requirements of Section 5004.6. The exception covers process vessels designed to contain potential explosions.

**5005.2.2.3 Spill control for hazardous material liquids.** Buildings, rooms or areas where hazardous material liquids are used in individual vessels exceeding a 55-gallon (208 L) capacity shall be provided with spill control in accordance with Section 5004.2.1.

- ❖ In addition to the other requirements that have been covered, if an individual vessel exceeds 55 gallons (208 L), spill control is required.

**5005.2.2.4 Secondary containment for hazardous material liquids.** Where required by Table 5005.2.1.4, buildings, rooms or areas where hazardous material liquids are used in vessels or systems shall be provided with secondary containment in accordance with Section 5004.2.2 where the capacity of an individual vessel or system or the capacity of multiple vessels or systems exceeds the following:

1. Individual vessel or system: greater than 55 gallons (208 L).
2. Multiple vessels or systems: greater than 1,000 gallons (3785 L).

- ❖ Secondary containment must be installed where required by Table 5005.2.1.4, where the capacity of an individual vessel is over 55 gallons (208 L) or where multiple vessels have a combined capacity greater than 1,000 gallons (3785 L).

**5005.3 Outdoor dispensing and use.** Dispensing and use of hazardous materials outdoors shall be in accordance with Sections 5005.3.1 through 5005.3.9.

- ❖ The following sections refer to outdoor storage. It is important to note that a noncombustible shed without sides is also considered outdoor storage.

**5005.3.1 Quantities exceeding the maximum allowable quantity per control area.** Outdoor dispensing or use of hazardous materials, in either closed or open containers or systems, in amounts exceeding the *maximum allowable quantity per control area* indicated in Tables 5003.1.1(3) and 5003.1.1(4) shall be in accordance with Sections 5001, 5003, 5005.1 and 5005.3.

- ❖ Once the quantities in storage exceed the MAQs of Table 5003.1.1(3) and Section 5003.11(4), the storage must meet the requirements of Sections 5001, 5003, 5005.1 and 5005.3.

**5005.3.2 Quantities not exceeding the maximum allowable quantity per control area.** Outdoor dispensing or use of hazardous materials, in either closed or open containers or systems, in amounts not exceeding the *maximum allowable*

*quantity per control area* indicated in Tables 5003.1.1(3) and 5003.1.1(4) shall be in accordance with Sections 5001 and 5003.

- ❖ Where quantities in storage do not exceed the MAQs of Tables 5003.1.1(3) and 5003.1.1(4), the storage must meet the requirements of Sections 5001 and 5003.

**5005.3.3 Location.** Outdoor dispensing and use areas for hazardous materials shall be located as required for outdoor storage in accordance with Section 5004.

- ❖ See the commentary to Section 5004 for the location of storage.

**5005.3.4 Spill control for hazardous material liquids in open systems.** Outdoor areas where hazardous material liquids are dispensed in vessels exceeding a 1.3-gallon (5 L) capacity or used in *open systems* exceeding a 5.3-gallon (20 L) capacity shall be provided with spill control in accordance with Section 5004.2.1.

- ❖ The dispensing and use areas of open systems located outdoors also require spill controls when the individual containers being filled exceed 1.3 gallons (5 L) or the combined vessels or systems exceed 5.3 gallons (20 L).

**5005.3.5 Secondary containment for hazardous material liquids in open systems.** Where required by Table 5005.2.1.4, outdoor areas where hazardous material liquids are dispensed or used in *open systems* shall be provided with secondary containment in accordance with Section 5004.2.2 where the capacity of an individual vessel or system or the capacity of multiple vessels or systems exceeds the following:

1. Individual vessel or system: greater than 1.3 gallons (5 L).
2. Multiple vessels or systems: greater than 5.3 gallons (20 L).

- ❖ Dispensing and use areas of open systems located outdoors also require secondary spill controls when the requirements of Table 5005.2.1.4 are met and the individual containers being filled exceed 1.3 gallons (5 L) or the combined vessels or systems exceed 5.3 gallons (20 L).

**5005.3.6 Spill control for hazardous material liquids in closed systems.** Outdoor areas where hazardous material liquids are used in *closed systems* exceeding 55 gallons (208 L) shall be provided with spill control in accordance with Section 5004.2.1.

- ❖ Outdoor closed systems with a liquid capacity of over 55 gallons (208 L) must have spill control.

**5005.3.7 Secondary containment for hazardous material liquids in closed systems.** Where required by Table 5005.2.1.4, outdoor areas where hazardous material liquids are dispensed or used in *closed systems* shall be provided

with secondary containment in accordance with Section 5004.2.2 where the capacity of an individual vessel or system or the capacity of multiple vessels or systems exceeds the following:

1. Individual vessel or system: greater than 55 gallons (208 L).
  2. Multiple vessels or systems: greater than 1,000 gallons (3785 L).
- ❖ Dispensing and use areas of closed systems located outdoors also require secondary spill controls when the individual containers being filled exceed 55 gallons (208 L) or the combined vessels or systems exceed 1,000 gallons (3785 L).

**5005.3.8 Clearance from combustibles.** The area surrounding an outdoor dispensing or use area shall be kept clear of combustible materials and vegetation for a minimum distance of 30 feet (9144 mm).

- ❖ Vegetation and other combustible materials must be cut back for a distance of at least 30 feet (9144 mm) from outdoor storage to minimize the exposure to the dispensing or use area in the event of a fire in the combustible materials. Note that this section requires an additional 5 feet (1524 mm) of clearance beyond that required by Section 5004.11 due to the fact that in use, dispensing and handling scenarios, vapors may be present, whereas in storage, containers are closed and vapors are contained.

**5005.3.9 Weather protection.** Where overhead noncombustible construction is provided for sheltering outdoor hazardous material use areas, such use shall not be considered indoor use where the area is constructed in accordance with the requirements for weather protection as required in the *International Building Code*.

**Exception:** Use of *explosive* materials shall be considered as indoor use.

- ❖ This section allows for the construction of noncombustible covers over outdoor dispensing and use areas for weather protection. This area is not considered inside dispensing or use, except when explosive materials are dispensed or used under the noncombustible roof. IBC Section 414.6.1 contains the specific requirements for weather-protection construction.

**5005.4 Handling.** Handling of hazardous materials shall be in accordance with Sections 5005.4.1 through 5005.4.4.

- ❖ The handling of hazardous materials must meet the requirements of the following sections.

**5005.4.1 Quantities exceeding the maximum allowable quantity per control area.** Handling of hazardous materials in indoor and outdoor locations in amounts exceeding the *maximum allowable quantity per control area* indicated in Tables 5003.1.1(1) through 5003.1.1(4) shall be in accordance with Sections 5001, 5003, 5005.1 and 5005.4.

- ❖ When the indoor and outdoor storage amounts of chemicals are below the MAQs per control area, the

area must meet the requirements of Sections 5001, 5003, 5005.1 and 5005.4.

**5005.4.2 Quantities not exceeding the maximum allowable quantity per control area.** Handling of hazardous materials in indoor locations in amounts not exceeding the *maximum allowable quantity per control area* indicated in Tables 5003.1.1(1) and 5003.1.1(2) shall be in accordance with Sections 5001, 5003 and 5005.1. Handling of hazardous materials in outdoor locations in amounts not exceeding the *maximum allowable quantity per control area* indicated in Tables 5003.1.1(3) and 5003.1.1(4) shall be in accordance with Sections 5001 and 5003.

- ❖ When the indoor storage amounts of chemicals exceed the MAQ, the area must meet the requirements of Sections 5001, 5003 and 5005.1. When outdoor storage exceeds the MAQs listed in Tables 5003.1.1(3) and 5003.1.1(4), the area must meet the requirements of Sections 5001 and 5003.

**5005.4.3 Location.** Outdoor handling areas for hazardous materials shall be located as required for outdoor storage in accordance with Section 5004.

- ❖ Outdoor handling areas must meet the requirements of Section 5004.

**5005.4.4 Dispensing, use and handling.** Where hazardous materials having a hazard ranking of 3 or 4 in accordance with NFPA 704 are transported through *corridors*, interior *exit stairways* or *ramps* or *exit passageways*, there shall be an emergency telephone system, a local manual alarm station or an approved alarm-initiating device at not more than 150-foot (45 720 mm) intervals and at each *exit* and *exit access* doorway throughout the transport route. The signal shall be relayed to an approved central, proprietary or remote station service or constantly attended on-site location and shall also initiate a local audible alarm.

- ❖ When exit access corridors or exit enclosures are used to transport hazardous materials with a ranking of 3 or 4, a supervised emergency telephone system, local manual alarm or approved alarm-initiating device must be installed at intervals of no more than 150 feet (45 720 mm). In addition, these devices must be located at each exit and exit access doorway throughout the transport route.

## Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

2012 *International Code Interpretations*. Washington, DC: International Code Council, 2011.

*Code Changes Resource Collection—2015 International Fire Code*. Washington, DC: International Code Council, 2014.

FM Global Property Loss Prevention Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers*. Johnston, RI: FM Global Research, April 2012.

# Chapter 51: Aerosols

## General Comments

The adequacy of aerosol storage protection became a major concern in the late 1970s and early 1980s because of a few major warehouse fires in which the involvement of aerosol products was a primary factor. These fire-loss incidents showed that, although these buildings were fully sprinklered, the level of sprinkler protection was inadequate and strict storage limitations for aerosol products were necessary.

The fire losses prompted extensive large-scale fire tests to develop protection requirements for aerosol product storage. The results of these tests led to the development, in 1990, of NFPA 30B, which is the basis for the provisions of this chapter. NFPA 30B recognizes that aerosol products represent a wide range of flammability and that classification criteria are necessary for all aerosol products to determine the desired level of protection. Prior to the development of NFPA 30B, flammable aerosols were classified as Class IA flammable liquids in accordance with NFPA 30; however, this classification was based primarily on a flame extension test designed to assess the in-use aerosol flammability hazard, but had little relevance to warehouse storage conditions.

Increased sprinkler water density and sprinkler head sensitivity, along with adequate separation and quantity control, are the most important factors in controlling aerosol product fires. Increased water density requirements improve the capability of the system to suppress the fire, as opposed to just controlling its spread, by applying more water to the base of the fire. Increased sprinkler activation speed also provides additional benefits. Early suppression fast-response (ESFR) sprinklers are specifically listed for high-challenge fire hazards. Increased sensitivity of ESFR sprinklers allows them to activate in response to a cardboard-carton packaging fire before aerosol cans rupture.

## Purpose

These requirements address the prevention, control and extinguishment of fires and explosions in facilities where retail aerosol products are displayed or stored. They impact both life safety and property protection from a fire; however, historically, aerosol product fires have caused property loss more frequently than loss of life.

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## SECTION 5101 GENERAL

**5101.1 Scope.** The provisions of this chapter, the *International Building Code* and NFPA 30B shall apply to the manufacturing, storage and display of aerosol products. Manufacturing of aerosol products using hazardous materials shall also comply with Chapter 50.

- ❖ In addition to the provisions of this chapter, NFPA 30B is referenced for storing and displaying aerosol products because it was the original source document for this chapter. The requirements in Chapter 50 must also be complied with where applicable.

Although this chapter deals primarily with the storage and retail display of aerosol products, Chapter 50, the *International Building Code*® (IBC®) and NFPA 30B must be consulted for guidance on facilities involved in the manufacture of aerosol-containing products. For example, aerosol-charging operations that use flammable aerosols require special design considerations and operating procedures. An aerosol-charging room is where the aerosol containers are filled with the propellant. These rooms are either

located in a separate building or are separated within a building and in spaces that have explosion venting because of the deflagration potential of the products being handled. See the commentary to Section 5107.1 for further information.

**5101.2 Permit required.** Permits shall be required as set forth in Section 105.6.

- ❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before a permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit, Section 105.6.1 for a discussion of specific quantity-based operational permits for the materials regulated in this chapter and Section 105.7 for a general discussion of activities requiring a construction permit. The permit process also notifies the fire department of the need for prefire planning for hazardous properties.

## AEROSOLS

**5101.3 Material Safety Data Sheets.** Material Safety Data Sheet (MSDS) information for aerosol products displayed shall be kept on the premises at an *approved* location.

- ❖ This section gives the fire code official the authority to designate or approve the location where the Material Safety Data Sheets (MSDS) covering aerosol materials are kept for use by authorized personnel and first responders in case of an emergency.

**5101.4 Containers.** Metal aerosol containers shall be limited to a maximum size of 33.8 fluid ounces (1000 ml). Plastic aerosol containers shall be limited to a maximum 4 fluid ounces (118 ml) except as provided in Section 5104.1.1. Glass aerosol containers shall be limited to a maximum 4 fluid ounces (118 ml).

- ❖ Design criteria for aerosol containers, including the maximum size and minimum strength, are set by the U.S. Department of Transportation (DOTn 49 CFR). These container regulations are necessary for the safe transportation of aerosol products. These container design criteria were formerly contained in the definition of “aerosol container” in Chapter 2 but were moved since they are technical requirements that belong with the subject matter they regulate.

### SECTION 5102 DEFINITIONS

**5102.1 Definitions.** The following terms are defined in Chapter 2:

#### AEROSOL.

Level 1 aerosol products.

Level 2 aerosol products.

Level 3 aerosol products.

#### AEROSOL CONTAINER.

#### AEROSOL WAREHOUSE.

#### PROPELLANT.

#### RETAIL DISPLAY AREA.

- ❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

### SECTION 5103 CLASSIFICATION OF AEROSOL PRODUCTS

**5103.1 Classification levels.** Aerosol products shall be classified as Level 1, 2 or 3 in accordance with Table 5103.1 and NFPA

30B. Aerosol products in cartons that are not identified in accordance with this section shall be classified as Level 3.

- ❖ Because of the wide range of flammability of aerosol products, a classification system was established to determine the required level of fire protection. Categories are defined according to the aerosol’s chemical heat of combustion expressed in British thermal units per pound (Btu/lb) [kilojoules/gram (kJ/g)] (see the commentary to Table 5103.1 for additional discussion of factors affecting classification).

Three categories determine the level of fire protection required (see Chapter 4 of NFPA 30B for fire protection requirements). Aerosol product classification Levels 1, 2 and 3 are used to avoid confusion with flammable and combustible liquid classifications (Classes I, II and III). Table 5103.1 shows the three aerosol classifications. Appendices A and C of NFPA 30B also contain additional background information on the development of the classification system.

This section also recognizes the importance of identifying the level of aerosols in storage cartons. Unless cartons are marked to identify their contents, it is difficult to determine the allowable quantity and fire protection requirements. Where cartons are not marked, there is no alternative but to consider the aerosol storage as Level 3 and apply the code requirements for that level (see commentary, Section 5106.1).

TABLE 5103.1  
CLASSIFICATION OF AEROSOL PRODUCTS

CHEMICAL HEAT OF COMBUSTION		AEROSOL CLASSIFICATION
Greater than (Btu/lb)	Less than or equal to (Btu/lb)	
0	8,600	1
8,600	13,000	2
13,000	—	3

For SI: 1 British thermal unit per pound = 0.002326 kJ/g.

- ❖ Table 5103.1 shows how to classify aerosol products based on their “chemical heat of combustion,” a term defined in Section 3.3.16.1 of NFPA 30B. NFPA 30B contains tables giving the heat of combustion (expressed in kJ/g) for representative materials and gives examples for calculating the chemical heat of combustion for aerosol products. Heat of combustion is determined using the method in ASTM D240. Factory Mutual Research Corporation (FMRC) correlated the chemical heat of combustion with the results of full-scale pallet tests to provide a classification method based on chemical heat of combustion that is more consistent than the original classification based on weight percentages. Examples are given in NFPA 30B for calculating the heat of combustion for aerosol products that contain a number of components so that they can be classified using Table 5103.1.

Examples of Level 1 aerosol products include air

fresheners, shaving gels and whipped cream. Fire tests involving Level 1 aerosols have demonstrated that they pose a fire hazard no greater than that of Class III commodities as defined in NFPA 13. Consequently, Level 1 aerosols are not regulated as a hazardous material and are essentially exempt from the requirements of this chapter.

Examples of Level 2 aerosol products include some hair sprays and insect repellents, based on the values in Table 5103.1.

Level 3 aerosol products, such as carburetor cleaner and other petroleum-based aerosols, require the highest level of fire protection.

**5103.2 Identification.** Cartons shall be identified on not less than one side with the classification level of the aerosol products contained within the carton as follows:

LEVEL \_\_\_\_\_ AEROSOLS

❖ Aerosol products are generally stored and transported in cardboard cartons that must be clearly marked with the level of aerosol products they contain so that the proper storage arrangements and fire protection are provided. The product label on the aerosol container may define whether the product is flammable or extremely flammable, but does not need to explain the actual classification level. If cartons are discarded or not marked, classification may be obtained from the submitted MSDS (see Section 5101.3). Fire protection requirements for the highest level of aerosols must be used where storage is mixed or unknown (see Section 5103.1).

## SECTION 5104

### INSIDE STORAGE OF AEROSOL PRODUCTS

**5104.1 General.** The inside storage of Level 2 and 3 aerosol products shall comply with Sections 5104.2 through 5104.7 and NFPA 30B. Level 1 aerosol products and those aerosol products covered by Section 5104.1.1 shall be considered equivalent to a Class III commodity and shall comply with the requirements for palletized or rack storage in NFPA 13.

❖ Sections 5104.1.1 through 5104.7, the applicable requirements in NFPA 30B and the applicable provisions of Chapter 32 regulate the inside storage of aerosol products. Permissible quantities, separation and fire protection depend on the occupancy type (see Sections 5104.2 and 5104.7) and storage condition, such as a general purpose warehouse (see Section 5104.3), aerosol warehouse (see Section 5104.4), inside flammable-liquid storage room (see Section 5104.5) or liquid warehouse (see Section 5104.6).

This section also specifies the level of protection required for Level 1 aerosols. The fire hazard associated with Level 1 aerosols has been demonstrated to be equivalent to Class III commodities as defined in Section 202 and NFPA 13. Therefore, Sections 5104.2 through 5104.7, and the applicable provisions of Chapter 32, apply only to Level 2 and 3 aerosol products. Level 2 aerosol products are classified as a

Group IV commodity in Section 3203.5; while aerosols, including Level 3 aerosols, are not regulated as hazardous materials, for the purpose of occupancy classification, Level 3 aerosols would still be considered a high-hazard commodity in accordance with Section 3203.6.

**5104.1.1 Plastic containers.** Aerosol products in plastic containers larger than 4 fluid ounces (118 ml), but not to exceed 33.8 fluid ounces (1000 ml), shall be allowed only where in accordance with this section. The commodity classification shall be Class III commodities, as defined in NFPA 13 where any of the following conditions are met:

1. Base product has no fire point where tested in accordance with ASTM D92, and nonflammable propellant.
  2. Base product has no sustained combustion as tested in accordance with Appendix H, "Method of Testing for Sustained Combustibility," in DOTn 49 CFR Part 173, and nonflammable propellant.
  3. Base product contains up to 20 percent by volume (15.8 percent by weight) of ethanol and/or isopropyl alcohol in an aqueous mix, and nonflammable propellant.
  4. Base product contains 4 percent by weight or less of an emulsified flammable liquefied gas propellant within an aqueous base. The propellant shall remain emulsified for the life of the product. Where such propellant is not permanently emulsified, the propellant shall be nonflammable.
- ❖ This section provides criteria for accepting certain aerosol product compositions in previously prohibited plastic containers. It also provides correlation with the referenced standard, NFPA 30B.

A significant amount of new research has been completed on aerosol products in plastic containers, clearly defining a "low hazard" version of the product that can be stored in general purpose warehouses without significantly increasing the fire hazard. The following discussions, excerpted from NFPA 308, provide an overview of the work done and the conclusions drawn that resulted in the criteria in this section:

**1. Aerosol Products in Plastic Containers – Propellant: Nonflammable; Base: Liquid Content that Does not Support Combustion:** The fire hazard created by aerosol products in metal containers is driven by their propellant and the liquid content. An aerosol product that contains a nonflammable propellant and a liquid content that does not support combustion would have a chemical heat of combustion of 0 kJ/g and be classified as a Level 1 aerosol product. Level 1 aerosols are protected using the same protection criteria needed for Class III commodities provided by NFPA 13.

The fire hazard of an aerosol product in plastic containers cannot be directly compared to aerosol products in metal containers. However, using commodity classification information for plastic containers filled with liquids that do not burn supports proposing a protection level for equivalent

aerosol products. In this case, the content of the aerosol would not contribute to a fire. Only the primary (plastic container) and secondary (carton) packaging would contribute. If the aerosol was not pressurized, it would directly compare to products listed in NFPA 13 Annex A, Table A.5.6.3 and FM Global Property Loss Prevention Data Sheet 8-1, Section 2.2.2.2. Both standards treat a plastic container filled with a liquid that does not burn as a Class I commodity. The addition of a nonflammable propellant to a plastic container will not change the burning properties of the commodity (it may result in a violent rupture with no change in burning rates or severity). The above discussion would point to classifying the aerosol products in plastic containers charged with a nonflammable propellant and liquid that does not burn as a Class I commodity. However, in an effort to provide consistency in the protection of aerosols, the protection proposal targets using the same protection currently recommended for Level 1 aerosols.

**2. Aerosol Products in Plastic Containers – Propellant: Nonflammable; Base: Liquid Content Consists of up to 20 percent Ethanol or Isopropyl Alcohol in Aqueous Solution:** An aerosol product in a plastic container that contains a liquid that burns will create a fire hazard at least as severe as the same liquid in an unpressurized plastic container. The fire hazard may increase because the container is pressurized and will definitely increase if it is pressurized with a flammable propellant. As the fire hazard of the aerosol's content increases, the fire hazard of the actual aerosol will increase as well. If, on the other hand, the aerosol product in a plastic container was charged with liquid components that can easily be protected in an unpressurized plastic container, similar to the discussion under Item 1, there is a good chance that the aerosol products in plastic containers can be similarly protected.

FM Global has developed protection criteria for several alcohol water mixtures in plastic bottles. The alcohols used in the testing were ethanol and isopropyl alcohol. The mixtures ranged from 100-percent alcohol (approximate) down to 20-percent alcohol/80-percent water by volume. Cartons of the 20-percent alcohol/80-percent water mixture in a plastic bottle were tested in a full-scale array. This alcohol/water mixture does have a definable fire point; however, it produces unstable burning.

Based on the results of this test, FM Global has recommended protecting 20-percent alcohol/80-percent water mixtures by volume in plastic bottles with the same protection recommended for liquids that do not burn in plastic containers, i.e., Class I commodities. A final question is whether pressurizing a plastic container filled with a 20-percent alcohol/80-percent water mixture by volume with nonflammable propellant will change the burning properties of the product.

Since the propellant will not burn, the only real opportunity to change the burning behavior would be to cause the alcohol/water mixture to burn more severely (e.g., possibly produce fireballs when the mixture is ejected from the container under pressure). To evaluate this potential, a small-scale test series was contracted with Underwriters Laboratories (UL) to investigate the impact of pressurizing aerosol products in plastic containers, filled with a 20-percent alcohol/80-percent water mixture by volume with nonflammable propellants. In the five tests that were run, two filling methods were investigated: direct fill (liquid and propellant in same space) and bag-on-valve (liquid in one compartment, propellant in outer compartment). UL reported the number of container failures. The overall fire behavior was provided through direct observation. The tests looked at two cases of six containers arranged with a 6-inch (15 cm) flue between them and a point igniter in the flue space. The cases were in a small pan.

None of the tests produced a pool fire or fireball. In all five tests, portions of the aerosol products in plastic containers and cardboard cases remained unburned. Based on these tests, it appears that the fire properties of the alcohol/water mixture remained unchanged when pressurized and that using Class III commodity protection will provide fully adequate protection for the aerosol products in plastic containers.

**3. Aerosol Products in Plastic Containers – Propellant: 4 percent by Weight Nonflammable Propellant or Flammable Propellant that is Emulsified in Liquid Base; Base: Aqueous Base with no Fire Point:** An emulsion, in an aerosol product, would be a mixture of two or more liquids in which one is present as droplets, of microscopic or ultramicroscopic size, distributed throughout the other. Emulsions are formed from the component liquids either spontaneously or, more often, by mechanical means, such as agitation, provided that the liquids that are mixed have no (or a very limited) mutual solubility. Emulsions are stabilized by agents that form films at the surface of the droplets (e.g., soap molecules) or that impart to them a mechanical stability (e.g., colloidal carbon or bentonite). Colloidal distributions or suspension of one or more liquid(s) with another will have a shelf life that varies with the efficiency of the recipe used.

A Level 1 aerosol (metal can) was defined by the fire performance of shave cream. This product had limited amounts of flammable liquefied gas propellant to eject the mixture and to cause foaming of the mixture. In a fire, the hydrocarbon propellant would be ejected and burn, but the large quantities of foam mix and water tended to produce a very limited fire severity. A similar product was evaluated when placed in a plastic aerosol container.

The product consisted of several liquid components that do not support combustion mixed with water and a maximum of 4 percent by weight flammable liquefied gas propellant. The liquefied gas was held within the liquid mixture as an emulsion. The gas would eject the liquid product and cause the liquid mixture to foam. Since the liquid components do not burn, the main concern centers around the flammable liquefied gas propellant. The evaluation used small, intermediate, and full-scale fire testing to evaluate the fire hazard created by this product. All of the testing was completed at UL.

The large-scale test used the 12-pallet aerosol classification test protocol. This methodology only applies to metal aerosol products but, lacking any test data, it was considered a good starting point. The 12 pallet load palletized array operated four sprinklers in 10 seconds at around a minute and a half after ignition. The fire was quickly knocked down. The test was run for 32 minutes. The liquid product was released during the test and did not contribute to the fire. The flammable liquefied gas did create brief flare-ups of the fire when released and continued to create small fireballs throughout the test. The high sprinkler discharge density [0.79 gpm/ft<sup>2</sup> (32 mm/min)] easily extinguished the majority of the array and limited the fire spread to the ignition flue located in the center of the array. The fire test seemed to demonstrate that the limited amount of flammable liquefied gas in the product would not produce a severe fire; however, the high water density does not permit easy comparison to a Class III commodity fire.

An intermediate-scale test was run under the calorimeter at UL to evaluate the effect of a significantly lower water density [0.25 gpm/ft<sup>2</sup> (10 mm/min)] on this product. The product was placed in a double-row rack with a storage height of 15 feet (4.6 m). Four open sprinklers were located 10 feet (3 m) above the top of the array and arranged to deliver a water density of 0.25 gallon per minute per square foot (10 mm/min). The sprinklers were activated at approximately 1 minute after ignition. The test was terminated at 4 minutes since the fire was extinguished. The percent damage was not provided in the UL report; however the pictures indicate that the fire was again confined to the ignition flue.

NFPA 13 requires a water density of 0.25 gallon per minute per square foot (10 mm/min) to protect a 15-foot-high (4.6 m) double-row rack storage of Class III commodity in a 25-foot (7.6 m) high building using low temperature ceiling sprinklers [NFPA 13, Table 16.2.1.3.2, Figure 16.2.1.3.2(c) curves E & F, Figure 16.2.1.3.4.1]. The intermediate-scale test indicates that this same protection level easily controlled/extinguished a fire involving the foam shave cream in a plastic aerosol container.

In addition to the intermediate and large-scale

fire test, a number of small-scale tests were also done to provide a visual documentation on how a plastic aerosol container with a shave foam-type product behaves when exposed to fire without sprinkler protection. These tests consisted of placing two cases of six containers on each side of a standard igniter. The containers were packed in a cardboard box. A shave cream and a hair mousse were tested.

Test 9 used a product that was very similar to what was tested in the intermediate and large-scale testing. It was a shave cream product that had a small percentage of a flammable liquefied gas that was in a stable emulsion with a multi-component liquid mixture. The liquid mixture did not support combustion. The product in Test 10 had a higher weight percent flammable liquefied gas that did not form a stable emulsion in the bottle. A liquefied gas layer formed in the container. It was not clear what the liquid mixture was made up of. In both products, the flammable liquefied gas was used to eject the liquid mixture out of the container and cause the liquid product to create foam.

In Test 9, all but two of the containers failed. The shave foam covered the cases, containers and pan after the test. The product burned weakly and extinguished the igniter used in the test. The product used in Test 10 did appear to burn more vigorously. Container failure produced momentary fireballs. While this limited-scale test cannot predict the behavior of a product in a full-scale arrangement, it did demonstrate that there were differences between the shave cream and the hair mousse, and that the hair mousse produced a more vigorous fire.

The results of the intermediate-scale testing, the full-scale testing and the small-scale testing indicate that an aerosol product in a plastic container filled with a liquid mixture that does not support combustion and no more than 4 percent by weight flammable liquefied gas in a stable emulsion with the liquid mixture can be protected using criteria recommended for a Class III commodity.

**5104.2 Storage in Groups A, B, E, F, I and R.** Storage of Level 2 and 3 aerosol products in occupancies in Groups A, B, E, F, I and R shall be limited to the following maximum quantities:

1. A net weight of 1,000 pounds (454 kg) of Level 2 aerosol products.
2. A net weight of 500 pounds (227 kg) of Level 3 aerosol products.
3. A combined net weight of 1,000 pounds (454 kg) of Level 2 and 3 aerosol products.

The maximum quantity shall be increased 100 percent where the excess quantity is stored in storage cabinets in accordance with Section 5704.3.2.

❖ This section strictly limits quantities of aerosols in buildings of Groups A, B, E, F, I and R because these

occupancy types will have higher occupant loads and host many activities not related to the storage of aerosol products. Storage exceeding the maximum permitted quantities would result in the building being classified as a high-hazard, Group H occupancy in accordance with the IBC. The indicated maximum quantities are applicable per building area and not per control area (see commentary, Section 5003).

This section would also allow the maximum quantities to be increased by 100 percent, if the quantities exceeding those indicated for Level 2 and 3 aerosol products are stored in approved storage cabinets in accordance with Section 5704.3.2, which contains specific requirements for the design, construction and capacity of storage cabinets.

**5104.2.1 Excess storage.** Storage of quantities exceeding the maximum quantities indicated in Section 5104.2 shall be stored in separate inside flammable liquid storage rooms in accordance with Section 5104.5.

❖ This section recognizes that in certain occupancies, the maximum quantities listed in Section 5104.2 may be exceeded. Any Level 2 or 3 aerosol product exceeding the maximum quantities specified in Section 5104.2, including the exception for approved storage cabinets, must be stored in a separate, inside, flammable liquid storage room to maintain a Group A, B, E, F, I or R occupancy classification for the building.

For example, 1,000 pounds (454 kg) of Level 2 aerosols are allowed in a building classified in occupancy Group B. An additional 1,000 pounds (454 kg) of Level 2 aerosols are also allowed, if the product is stored in approved storage cabinets (see Section 5104.2). If additional storage is desired, 1,000 pounds (454 kg) of Level 2 aerosols would be allowed in an inside, flammable liquid storage room having a floor area of 500 square feet (46 m<sup>2</sup>) or less, in accordance with Section 5104.5.1. Therefore, as much as 3,000 pounds (1362 kg) of Level 2 aerosols could be stored in a building of Group B occupancy, if all excess storage is in approved storage cabinets and in an inside, flammable liquid storage room having a floor area of no more than 500 square feet (46 m<sup>2</sup>). If an inside, flammable liquid storage room exceeding 500 square feet (46 m<sup>2</sup>) were used for the excess storage, the allowable quantity of Level 2 aerosols in the room could be increased to 2,500 pounds (1135 kg). The increased allowed quantities in the larger storage room results from the presence of an automatic sprinkler system. Compliance with these requirements would maintain the Group B occupancy classification for the building (see commentary, Section 5104.5).

**5104.3 Storage in general purpose warehouses.** Aerosol storage in general purpose warehouses utilized only for warehousing-type operations involving mixed commodities shall comply with Section 5104.3.1 or 5104.3.2.

❖ General purpose warehouses are used for storing general commodities and aerosol products (i.e.,

“mixed commodities”). Aerosol product storage located in general purpose warehouses is classified as either nonsegregated storage (see Section 5104.3.1) or segregated storage (see Section 5104.3.2).

Distribution warehouses for major department store chains containing large amounts of aerosols and various common mercantile commodities are typical of buildings classified as general purpose warehouses. Proper protection and separation of aerosol product storage areas are essential to protect ordinary storage commodities from the hazards of aerosol products in these types of buildings.

**5104.3.1 Nonsegregated storage.** Storage consisting of solid pile, palletized or rack storage of Level 2 and 3 aerosol products not segregated into areas utilized exclusively for the storage of aerosols shall comply with Table 5104.3.1.

❖ Nonsegregated storage is located in a general purpose warehouse in which Level 2 and 3 aerosol products are not physically or spatially separated from other commodities. The maximum quantity of Level 2 and 3 aerosol products that can be located in nonsegregated storage areas is specified in Table 5104.3.1.

**TABLE 5104.3.1  
NONSEGREGATED STORAGE OF LEVEL 2 AND 3 AEROSOL  
PRODUCTS IN GENERAL PURPOSE WAREHOUSES<sup>b</sup>**

AEROSOL LEVEL	MAXIMUM NET WEIGHT PER FLOOR (pounds) <sup>b</sup>			
	Palletized or solid-pile storage		Rack storage	
	Unprotected	Protected <sup>a</sup>	Unprotected	Protected <sup>a</sup>
2	2,500	12,000	2,500	24,000
3	1,000	12,000	1,000	24,000
Combination 2 and 3	2,500	12,000	2,500	24,000

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg, 1 square foot = 0.0929 m<sup>2</sup>.

a. Approved automatic sprinkler system protection and storage arrangements shall comply with NFPA 30B. Sprinkler system protection shall extend 20 feet beyond the storage area containing the aerosol products.

b. Storage quantities indicated are the maximum permitted in any 50,000-square-foot area.

❖ Table 5104.3.1 lists the maximum quantities of Level 2 and 3 aerosols permitted in general purpose warehouses with nonsegregated storage. Maximum quantities of aerosol products depend on the type of storage condition and the level of sprinkler protection.

Unprotected storage refers to areas that have no sprinkler protection or in which the sprinkler system does not meet specific NFPA 30B design requirements; therefore, protected storage refers only to areas in which sprinkler protection meets NFPA 30B design parameters for solid pile, palletized and rack structure storage conditions.

The “Maximum Net Weight” referred to in the table consists of the base aerosol product plus the propellant, as defined in NFPA 30B.

**5104.3.2 Segregated storage.** Storage of Level 2 and 3 aerosol products segregated into areas utilized exclusively for the

storage of aerosols shall comply with Table 5104.3.2 and Sections 5104.3.2.1 and 5104.3.2.2.

- ❖ Special requirements for storing aerosol products to prevent mixing with other commodities recognize that, without proper sprinkler protection and separation, fires involving Level 2 and 3 aerosols are difficult to control. Storage areas can be segregated by fire-resistance-rated interior walls, a chain-link fence enclosure or the establishment of a separation area. All aerosol product storage areas in segregated storage must have sprinkler protection in accordance with NFPA 30B. The maximum quantity of Level 2 and 3 aerosol products that can be placed in segregated storage is specified in Table 5104.3.2.

**TABLE 5104.3.2  
SEGREGATED STORAGE OF LEVEL 2 AND 3 AEROSOL  
PRODUCTS IN GENERAL PURPOSE WAREHOUSES**

STORAGE SEPARATION	MAXIMUM SEGREGATED STORAGE AREA <sup>a</sup>		SPRINKLER REQUIREMENTS
	Percentage of building area (percent)	Area limitation (square feet)	
Separation area <sup>e, f</sup>	15	20,000	Notes b, c
Chain-link fence enclosure <sup>d</sup>	20	20,000	Notes b, c
1-hour fire-resistance-rated interior walls	20	30,000	Note b
2-hour fire-resistance-rated interior walls	25	40,000	Note b
3-hour fire-resistance-rated interior walls	30	50,000	Note b

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>.

- a. The maximum segregated storage area shall be limited to the smaller of the two areas resulting from the percentage of building area limitation and the area limitation.
- b. Automatic sprinkler system protection in aerosol product storage areas shall comply with NFPA 30B and be approved. Building areas not containing aerosol product storage shall be equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1.
- c. Automatic sprinkler system protection in aerosol product storage areas shall comply with NFPA 30B and be approved. Sprinkler system protection shall extend a minimum 20 feet beyond the aerosol storage area.
- d. Chain-link fence enclosures shall comply with Section 5104.3.2.1.
- e. A separation area shall be defined as an area extending outward from the periphery of the segregated aerosol product storage area as follows.
  1. The limits of the aerosol product storage shall be clearly marked on the floor.
  2. The separation distance shall be not less than 25 feet and maintained clear of all materials with a commodity classification greater than Class III in accordance with Section 903.3.1.1.
- f. Separation areas shall only be permitted where approved.

- ❖ Table 5104.3.2 lists maximum quantities of Level 2 and 3 aerosols allowed in general purpose warehouses with segregated storage. Storage areas can be segregated using either fire-resistance-rated interior walls, a chain-link fence enclosure (see Section 5104.3.2.1) or a separation area.

As indicated in Note e, a minimum separation dis-

tance of 25 feet (7620 mm) from commodity classifications greater than Class III must be maintained when using the separation area option (for additional guidance on commodity classifications, see NFPA 13).

Depending on the separation type provided, the segregated storage area is limited by both a percentage of the building area and a maximum area limitation, as indicated in Note a. The allowable area of segregated storage increases with the increased degree of separation. Segregated storage areas of Level 2 and 3 aerosols must have sprinkler protection in accordance with NFPA 30B.

**5104.3.2.1 Chain-link fence enclosures.** Chain-link fence enclosures required by Table 5104.3.2 shall comply with the following:

1. The fence shall not be less than No. 9 gage steel wire, woven into a maximum 2-inch (51 mm) diamond mesh.
2. The fence shall be installed from the floor to the underside of the roof or ceiling above.
3. Class IV and high-hazard commodities shall be stored outside of the aerosol storage area and not less than 8 feet (2438 mm) from the fence.
4. Access openings in the fence shall be provided with either self- or automatic-closing devices or a labyrinth opening arrangement preventing aerosol containers from rocketing through the access openings.
5. Not less than two *means of egress* shall be provided from the fenced enclosure.

- ❖ Table 5104.3.2 establishes limits on the use of a chain-link fence as a means of segregated storage of Level 2 and 3 aerosol products. A chain-link fence enclosure is intended to reduce the potential hazard of "rocketing" aerosol cans in a fire. Both fire tests and loss history have shown that ruptured aerosol cans in fires will "rocket" through the warehouse storage area, resulting in multiple ignition locations and overtaxing of the fire protection systems. Chain-link fence construction details as indicated in this section, in combination with proper sprinkler protection as specified in Notes b and c of Table 5104.3.2, provide a measure of additional safety, allowing increased storage quantities over that permitted where no physical barrier exists.

The No. 9 gage steel requirement for the chain-link fence is similar to a standard, industrial-grade chain-link gage that is commonly used for fencing property. This chain-link gage is considered the lightest acceptable fencing and is capable of restraining flying aerosol containers. A labyrinth opening arrangement in the fencing essentially works as an entryway maze. In place of a door, the access area to the chain-link fence enclosure would be constructed of other fencing, which is usually located at right angles, and through its arrangement, would obstruct the opening to prevent the aerosol containers from rocketing through the access opening.

**5104.3.2.2 Aisles.** The minimum aisle requirements for segregated storage in general purpose warehouses shall comply with Table 5104.3.2.2.

- ❖ Fires involving aerosol products can spread across aisles located between two rows of racks or palletized and solid pile storage. If the fire is severe enough, the radiant energy may ignite combustible cartons across an aisle, or a fireball from a rupturing container may be large enough to engulf adjacent storage. Table 5104.3.2.2 gives aisle requirements for segregated storage of Level 2 and 3 aerosol products located in general purpose warehouses.

**TABLE 5104.3.2.2  
SEGREGATED STORAGE AISLE WIDTHS AND DISTANCE TO  
AISLES IN GENERAL PURPOSE WAREHOUSES**

STORAGE CONDITION	MINIMUM AISLE WIDTH (feet)	MAXIMUM DISTANCE FROM STORAGE TO AISLE (feet)
Solid pile or palletized <sup>a</sup>	4 feet between piles	25
Racks with ESFR sprinklers <sup>a</sup>	4 feet between racks and adjacent Level 2 and 3 aerosol product storage	25
Racks without ESFR sprinklers <sup>a</sup>	8 feet between racks and adjacent Level 2 and 3 aerosol product storage	25

For SI: 1 foot = 304.8 mm.

a. Sprinklers shall comply with NFPA 30B.

- ❖ Table 5104.3.2.2 shows a minimum aisle width and a 25-foot-maximum (7620 mm) separation distance from aerosol storage to aisles where aerosols cannot be stored for segregated storage of Level 2 and 3 aerosol products located in general purpose warehouses. The minimum aisle width depends on the storage condition and the level of sprinkler protection. The 25-foot (7620 mm) distance between the storage and aisle not only isolates aerosols but also limits travel distances within the storage area.

Note a is intended to require the design of the automatic sprinkler system to meet the requirements of NFPA 30B. If the automatic sprinkler system is not designed in accordance with the conditions for ESFR sprinklers in NFPA 30B, then aisles must be 8 feet (2438 mm) wide when storing Level 2 or 3 aerosol products in rack structures. The storage area must be configured so that storage is no more than 25 feet (7620 mm) from the aisle, thus providing a storage footprint of 50 feet (15 240 mm) on a side.

**5104.4 Storage in aerosol warehouses.** The total quantity of Level 2 and 3 aerosol products in a warehouse utilized for the storage, shipping and receiving of aerosol products shall not be restricted in structures complying with Sections 5104.4.1 through 5104.4.4.

- ❖ Buildings classified as aerosol warehouses are detached buildings or a separate portion of a building used exclusively for storing and handling aerosol products. This section does not limit the quantity of Level 2 and 3 aerosol products in a building classified

as an aerosol warehouse complying with the provisions of Sections 5104.4.1 through 5104.4.4.

**5104.4.1 Automatic sprinkler system.** Aerosol warehouses shall be protected by an *approved wet-pipe automatic sprinkler system* in accordance with NFPA 30B. Sprinkler protection shall be designed based on the highest classification level of aerosol product present.

- ❖ The automatic sprinkler system for aerosol warehouses must be designed in accordance with NFPA 30B. The sprinkler protection must be designed for Level 3 aerosol products if both Level 2 and 3 aerosols are stored in the aerosol warehouse. With the approval of the fire code official, sprinkler protection can be omitted from an aerosol warehouse where a minimum separation distance of 100 feet (30 480 mm) from a lot line or structure is maintained and exposure protection is provided. Exposure protection would include either a public fire department or plant fire brigade that could apply cooling water streams on adjacent properties or structures. Exposure protection is not required where the distance is 200 feet (60 960 mm) or more to other buildings or lot lines.

**5104.4.2 Pile and palletized storage aisles.** Solid pile and palletized storage shall be arranged so the maximum travel distance to an aisle is 25 feet (7620 mm). Aisles shall have a minimum width of 4 feet (1219 mm).

- ❖ The maximum travel distance of 25 feet (7620 mm) to an aisle provides an adequate means of egress if an emergency occurs. This results in an allowable storage area of 50 feet by 50 feet (15 240 mm by 15 240 mm) surrounded by 4-foot (1219 mm) aisles for palletized and pile storage. The 4-foot (1219 mm) aisle width, in conjunction with a sprinkler system and in accordance with NFPA 30B, reduces the chance of fire spread across aisles involving pile and palletized storage.

**5104.4.3 Rack storage aisles.** Rack storage shall be arranged with a minimum aisle width of 8 feet (2438 mm) between rows of racks and 8 feet (2438 mm) between racks and adjacent solid pile or palletized storage. Where early suppression fast-response (ESFR) sprinklers provide automatic sprinkler protection, the minimum aisle width shall be 4 feet (1219 mm).

- ❖ The requirements in this section are similar to those in Table 5104.3.2.2 for segregated storage in general purpose warehouses. This section requires 8-foot (2438 mm) aisles between rows of racks or between racks and adjacent piles or palletized storage when the area is protected with sprinkler systems designed in accordance with NFPA 30B.

The 8-foot (2438 mm) minimum aisle width allows two unimpeded parallel columns of egressing occupants to travel in opposite directions, in addition to anticipating other obstructions occurring during an emergency situation. These obstructions could be in the form of a lift truck, or idle pallets or even the result of unstable commodities falling into the aisle. In addi-

tion, the 96-inch (2438 mm) width further reduces the hazard of aisle jumps (radiant heat from a burning rack or pile causing the rack or pile across the aisle to ignite) in case of a fire and provides the fire department with greater maneuvering capabilities during a fire, essentially providing an additional safety factor where aerosols are stored.

The second sentence of this section is an exception that recognizes the increased safety of the higher level of sprinkler protection provided by an ESFR system designed in accordance with NFPA 30B by allowing for a 50-percent reduction in aisle width. The maximum travel distance to an aisle is intended to be 25 feet (7620 mm), as indicated in Table 5104.3.2.2.

**5104.4.4 Combustible commodities.** Combustible commodities other than flammable and *combustible liquids* shall be permitted to be stored in an aerosol warehouse.

**Exception:** Flammable and *combustible liquids* in 1-quart (946 mL) metal containers and smaller shall be permitted to be stored in an aerosol warehouse.

❖ Based on the full-scale aerosol product fire tests discussed in earlier sections of the commentary, this section allows ordinary combustible commodities to be stored in aerosol warehouses, provided that the fire protection system for the entire facility is based on the appropriate fire protection design table from NFPA 30B and Section 5104.4.1. This is consistent with and correlates with Section 6.3.6.7 of NFPA 30B. See the commentary to Section 3203 for information on the classification of combustible commodities.

The exception allows small, 1 quart [32 ounce (0.95 L)] metal containers of flammable and combustible liquids to be stored in aerosol warehouses, along with the ordinary combustible commodities discussed in the previous paragraph, provided that the fire protection system for the entire facility is based on the appropriate fire protection design table from NFPA 30B. This is consistent with and correlates with Section 6.3.6.8 of NFPA 30B.

**5104.5 Storage in inside flammable liquid storage rooms.** Inside flammable liquid storage rooms shall comply with Section 5704.3.7. The maximum quantities of aerosol products shall comply with Section 5104.5.1 or 5104.5.2.

❖ This section recognizes another option for storing Level 2 and 3 aerosols. Depending on the anticipated quantities, storage in a Group H-3 inside flammable liquid storage room meeting the requirements of Section 5704.3.7 may be more economical.

Sections 5104.5.1 and 5104.5.2 limit maximum quantities of Level 2 and 3 aerosols that can be stored in an inside flammable liquid storage room depending on the size of the room and the degree of fire-resistance-rated separation and automatic sprinkler protection installed. Indicated maximum quantities of aerosol products are the same quantities listed in Section 5104.2. See the commentary to Section 202 for the definition of "Liquid storage room."

Storage of aerosols exceeding the quantities indi-

cated in Sections 5104.5.1 and 5104.5.2, and the storage of flammable and combustible liquids exceeding maximum allowable quantities (MAQs), must be classified as high-hazard Group H occupancies.

**5104.5.1 Storage rooms of 500 square feet or less.** The storage of aerosol products in flammable liquid storage rooms less than or equal to 500 square feet (46 m<sup>2</sup>) in area shall not exceed the following quantities:

1. A net weight of 1,000 pounds (454 kg) of Level 2 aerosol products.
2. A net weight of 500 pounds (227 kg) of Level 3 aerosol products.
3. A combined net weight of 1,000 pounds (454 kg) of Level 2 and 3 aerosol products.

❖ This section limits the amount of Level 2 and 3 aerosols that can be stored in an inside flammable liquid storage room 500 square feet (46 m<sup>2</sup>) or less in area that complies with NFPA 30. The degree of fire-resistance-rated construction depends on room size. Sprinkler protection may or may not be required depending on the quantity of other flammable and combustible liquids in the inside storage room (see commentary, Section 5104.2.1).

**5104.5.2 Storage rooms greater than 500 square feet.** The storage of aerosol products in flammable liquid storage rooms greater than 500 square feet (46 m<sup>2</sup>) in area shall not exceed the following quantities:

1. A net weight of 2,500 pounds (1135 kg) of Level 2 aerosol products.
2. A net weight of 1,000 pounds (454 kg) of Level 3 aerosol products.
3. A combined net weight of 2,500 pounds (1135 kg) of Level 2 and 3 aerosol products.

The maximum aggregate storage quantity of Level 2 and 3 aerosol products permitted in separate inside storage rooms protected by an *approved automatic sprinkler system* in accordance with NFPA 30B shall be 5,000 pounds (2270 kg).

❖ This section allows an increase in the quantity of Level 2 and 3 aerosols for inside, flammable, liquid storage rooms exceeding 500 square feet (46 m<sup>2</sup>) in area. These provisions assume that the storage room complies with fire-resistance-rated construction and the fire protection requirements of NFPA 30. Increased quantities compared to Section 5104.5.1 for rooms less than 500 square feet (46 m<sup>2</sup>) in area are based on having an automatic sprinkler system throughout the building in accordance with NFPA 13. The additional quantities allowed by the last paragraph of this section require the sprinkler system to comply with NFPA 30B (see commentary, Section 5104.2.1).

**5104.6 Storage in liquid warehouses.** The storage of Level 2 and 3 aerosol products in liquid warehouses shall comply with NFPA 30B. The storage shall be located within segre-

## AEROSOLS

gated storage areas in accordance with Section 5104.3.2 and Sections 5104.6.1 through 5104.6.3.

❖ This section contains requirements for storing Level 2 and 3 aerosol products in warehouses used primarily for storing flammable and combustible liquids. The aerosol product storage area is required to meet the segregated storage requirements of Section 5104.3.2, Sections 5104.6.1 through 5104.6.3 and NFPA 30B. This section is intended to address only protection for the segregated aerosol product storage area. NFPA 30 addresses protection for the flammable and combustible liquids in the liquid warehouse.

**5104.6.1 Containment.** Spill control or drainage shall be provided to prevent the flow of liquid to within 8 feet (2438 mm) of the segregated storage area.

❖ To reduce the potential for the segregated aerosol storage area to become involved in an emergency created by the flammable and combustible liquids stored elsewhere in the building, an approved means of spill control and drainage must be provided. The spill-control and drainage system is intended to keep the liquids away from the aerosols. Section 5004.2 contains additional guidance on the means of spill control and drainage for flammable and combustible liquids.

**5104.6.2 Sprinkler design.** Sprinkler protection shall be designed based on the highest level of aerosol product present.

❖ Design requirements for the sprinkler system are based on the highest level of aerosol products stored and the anticipated storage condition. The sprinkler system must be designed for Level 3 aerosol products where both Level 2 and 3 aerosol products are stored.

**5104.6.3 Opening protection into segregated storage areas.** Fire doors or gates opening into the segregated storage area shall either be self-closing or provided with automatic-closing devices activated by sprinkler water flow or an *approved* fire detection system.

❖ Openings for access to and from segregated storage areas must provide the intended degree of protection. Chain-link fence enclosures can have either self-closing or automatic-closing gates. If the segregated storage opening is protected with automatic-closing fire doors or gates, the closing device must be activated by water flow from the sprinkler system or by an approved fire detection system.

**5104.7 Storage in Group M occupancies.** Storage of Level 2 and 3 aerosol products in occupancies in Group M shall comply with Table 5104.7. Retail display shall comply with Section 5106.

❖ Both this section and Table 5104.7 contain storage limitations for Level 2 and 3 aerosol products in the storage area of a mercantile occupancy that is physically separated from the sales area and not accessible to the public. These areas are generally referred

to as “back-stock” storage areas. The storage limitation for aerosol products located in the retail sales area of mercantile occupancies is specified in Section 5106.

**TABLE 5104.7  
MAXIMUM QUANTITIES OF LEVEL 2 AND 3 AEROSOL  
PRODUCTS IN RETAIL STORAGE AREAS**

MAXIMUM NET WEIGHT PER FLOOR (pounds)			
Floor	Nonsegregated storage <sup>a, b</sup>	Segregated storage	
		Storage cabinets <sup>b</sup>	Separated from retail area <sup>c</sup>
Basement	Not Permitted	Not Permitted	Not Permitted
Ground floor	2,500	5,000	Note d
Upper floors	500	1,000	Note d

For SI: 1 pound = 0.454 kg, 1 square foot = 0.0929 m<sup>2</sup>.

a. The total aggregate quantity on display and in storage shall not exceed the maximum retail display quantity indicated in Section 5106.3.

b. Storage quantities indicated are the maximum permitted in any 50,000-square-foot area.

c. The storage area shall be separated from the retail area with a 1-hour fire-resistance-rated assembly.

d. See Table 5104.3.2.

❖ Table 5104.7 shows the maximum quantity limitations for Level 2 and 3 aerosol products in the back-stock storage areas of mercantile occupancies in both nonsegregated and segregated conditions. In nonsegregated storage, the aerosol product storage is neither separated from the retail display by a fire-resistance-rated barrier nor stored in approved flammable liquid storage cabinets. When the storage is nonsegregated, the quantity of Level 2 and 3 aerosols is the total quantity in the back-stock storage and display areas combined. Level 2 and 3 aerosol products would be limited to 2,500 pounds (1135 kg) and 500 pounds (227 kg) on the ground and upper floors, respectively, in any 50,000-square-foot (4645 m<sup>2</sup>) area. In the case of segregated back-stock storage using approved, flammable-liquid storage cabinets, the total aerosol product storage is independent of the displayed quantities. The back-stock storage area quantities can be increased to those specified in Table 5104.3.2.2 for segregated storage in general purpose warehouses where the storage has been separated from the retail sales area by no less than 1-hour fire-resistance-rated construction.

## SECTION 5105 OUTSIDE STORAGE

**5105.1 General.** The outside storage of Level 2 and 3 aerosol products, including storage in temporary storage trailers, shall be separated from exposures in accordance with Table 5105.1.

❖ Outside storage of Level 2 and 3 aerosol products must be separated from buildings, lot lines, public ways and other outside combustible storage as shown in Table 5105.1 to minimize potential exposure hazards to the aerosols. Temporary storage trailers must also be located a minimum of 50 feet (15 240 mm)

from buildings and other outside storage. Minimum separation distances are consistent with NFPA 30B and NFPA 80A. Areas surrounding outdoor aerosol storage areas also should be maintained free of miscellaneous combustible materials and vegetation for a distance of at least 20 feet (6096 mm) to avoid exposing the aerosols being stored to ignition or damage from unwanted fire involving rubbish, wind-borne debris and dry vegetation.

**TABLE 5105.1**  
**DISTANCE TO EXPOSURES FOR OUTSIDE STORAGE**  
**OF LEVEL 2 AND 3 AEROSOL PRODUCTS**

EXPOSURE	MINIMUM DISTANCE FROM AEROSOL STORAGE (feet) <sup>a</sup>
Public alleys, public ways, public streets	20
Buildings	50
Exit discharge to a public way	50
Lot lines	20
Other outside storage	50

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. The minimum separation distance indicated is not required where exterior walls having a 2-hour fire-resistance rating without penetrations separate the storage from the exposure. The walls shall extend not less than 30 inches above and to the sides of Level 2 and 3 aerosol products.

❖ Table 5105.1 specifies minimum separation requirements for the outside storage of Level 2 and 3 aerosol products for various exposure conditions.

In place of the minimum separation distance requirement, Note a allows the use of a minimum 2-hour fire-resistance-rated wall without openings or penetrations as the means of exposure protection. The wall with the required extensions beyond the aerosol product storage area is intended to act as an effective shield to protect the exposed area from the Level 2 and 3 aerosol products, equivalent to the spatial separations shown in the table.

## SECTION 5106

### RETAIL DISPLAY

**5106.1 General.** This section shall apply to the retail display of 500 pounds (227 kg) or more of Level 2 and 3 aerosol products.

❖ This section establishes the applicability of Section 5106 to the retail display of Level 2 and 3 aerosol products with a net weight exceeding 500 pounds (227 kg) in retail and wholesale stores classified in Group M in accordance with IBC Section 309.1.

Quantities of Level 1 aerosol products are not limited in Group M mercantile display areas because of their low content of flammable product or propellant.

**5106.2 Aerosol display and normal merchandising not exceeding 8 feet (2438 mm) high.** Aerosol display and nor-

mal merchandising not exceeding 8 feet (2438 mm) in height shall be in accordance with Sections 5106.2.1 through 5106.2.4.

❖ Prior to about 1990, the typical mercantile store displayed merchandise to heights of about 8 feet (2438 mm). In the years since, merchandising techniques have changed substantially so that item displays now exceed 8 feet (2438 mm) in what are called “big box” stores. Section 5106.2 and its subsections regulate the more traditional type of stores where display and merchandising of Level 2 and 3 aerosol products do not exceed 8 feet (2438 mm) in height. See the commentary to Section 5106.3 for information on displays greater than 8 feet (2438 mm) in height.

**5106.2.1 Maximum quantities in retail display areas.** Aerosol products in retail display areas shall not exceed quantities needed for display and normal merchandising and shall not exceed the quantities in Table 5106.2.1.

❖ This section is intended to restrict the quantities of aerosol products in display areas where the public would be exposed to them and where they might not be protected by fire barriers or sprinkler systems, as they would be in approved storage areas.

**TABLE 5106.2.1**  
**MAXIMUM QUANTITIES OF LEVEL 2 AND 3 AEROSOL**  
**PRODUCTS IN RETAIL DISPLAY AREAS**

MAXIMUM NET WEIGHT PER FLOOR (pounds) <sup>b</sup>			
Floor	Unprotected <sup>a</sup>	Protected in accordance with Section 5106.2 <sup>a,c</sup>	Protected in accordance with Section 5106.3 <sup>c</sup>
Basement	Not allowed	500	500
Ground	2,500	10,000	10,000
Upper	500	2,000	Not allowed

For SI: 1 pound = 0.454 kg, 1 square foot = 0.0929 m<sup>2</sup>.

a. The total quantity shall not exceed 1,000 pounds net weight in any one 100-square-foot retail display area.

b. Per 25,000-square-foot retail display area.

c. Minimum Ordinary Hazard Group 2 wet-pipe automatic sprinkler system throughout the retail sales occupancy.

❖ This table establishes quantity limits for display areas that are protected by sprinklers as well as those that are not. Note a deals only with product display in accordance with Section 5106.2. Note b deals with the entire table and does allow these quantities for each 25,000 square feet (2323 m<sup>2</sup>) of retail display area. This provides adequate separation of the quantities while allowing the display of various product types, such as paint, insect control and personal care products. Note c deals with Sections 5106.2 and 5106.3, and does require, at a minimum, an Ordinary Hazard Group 2 wet pipe sprinkler system throughout the retail sales occupancy, except where higher levels of protection are required, such as in Level 2 and 3 aerosol display areas.

**5106.2.2 Display of containers.** Level 2 and 3 aerosol containers shall not be stacked more than 6 feet (1829 mm) high from the base of the aerosol array to the top of the aerosol array unless the containers are placed on fixed shelving or otherwise secured in an *approved* manner. Where storage or retail display is on shelves, the height of such storage or retail display to the top of aerosol containers shall not exceed 8 feet (2438 mm).

❖ Restricting display heights of Level 2 and 3 aerosol containers where NFPA 30B protection tables are not followed serves three purposes. The first is, obviously, to limit the quantity of aerosols that can be housed in a given area; the second is to make certain the displays are stable and not likely to topple; and the third is to make certain the piles are not so high that they would be likely to interfere with the efficient operation of area sprinklers.

**5106.2.3 Combustible cartons.** Aerosol products located in retail display areas shall be removed from combustible cartons.

**Exceptions:**

1. Display areas that use a portion of combustible cartons that consist of only the bottom panel and not more than 2 inches (51 mm) of the side panel are allowed.
  2. When the display area is protected in accordance with Tables 6.3.2.7(a) through 6.3.2.7(l) of NFPA 30B, storage of aerosol products in combustible cartons is allowed.
- ❖ Removing combustible cartons from display areas reduces the potential fuel supply in case of a fire and also removes the combustible material that would surround the aerosol containers and heat them to the point that they could ignite, “rocket” or explode. It also keeps the display more open so that sprinklers can reach the individual containers more easily to help keep them below dangerous temperatures, as well as control or extinguish fire in other surrounding combustibles.

Exception 1 allows cut-down cartons in displays because they represent a somewhat reduced fuel load for a fire and also leave the sides of the aerosol containers exposed so that sprinkler water can reach them. The carton bottoms also help stabilize stacks in displays to keep them from toppling.

Exception 2 allows use of cartons in aerosol display and merchandising areas, which are protected in accordance with Tables 6.3.2.7(a) through 6.3.2.7(l) of NFPA 30B in accordance with Section 5106.3.

**5106.2.4 Retail display automatic sprinkler system.** Where an *automatic sprinkler system* is required for the protected retail display of aerosol products, the wet-pipe *automatic sprinkler system* shall be in accordance with Section 903.3.1.1. The minimum system design shall be for an Ordinary Hazard Group 2 occupancy. The system shall be provided throughout the retail display area.

❖ The reference to Section 903.3.1.1 indicates that the sprinkler system must meet the requirements of NFPA 13, which classifies mercantile groups used for retail display as an Ordinary Hazard Group 2 occupancy. This would require a minimum sprinkler design density of 0.20 gallon per minute (gpm) per square foot (8.14 L/min/m<sup>2</sup>) applied over the hydraulically most remote 1,500 square feet (139 m<sup>2</sup>) of system coverage, which is common for most mercantile occupancies. In areas that are equipped with a sprinkler system conforming to NFPA 13, this section limits the quantity of aerosols on display to 2 pounds per square foot (psf) (10 kg/m<sup>2</sup>) of the gross sales floor area with a maximum weight of 1,000 pounds (454 kg) of aerosols in any 10-foot by 10-foot (3048 mm by 3048 mm) area of the sales floor.

If more aerosol product storage is desired or anticipated, Section 5106.3 must be followed.

**5106.3 Aerosol display and normal merchandising exceeding 8 feet (2438 mm) high.** Aerosol display and merchandising exceeding 8 feet in height shall be in accordance with Sections 5106.3.1 through 5106.3.3.

❖ Many modern stores classified in Group M are included in the family of stores commonly known as “big box” or “warehouse”-type stores (Section 309.1 of the IBC calls them “wholesale stores”), so called because of their high-density, high-piled display and storage of products at heights greater than 8 feet (2438 mm) in areas accessible to the public. This section describes the requirements for displaying and merchandising Level 2 and 3 aerosol products where they exceed 8 feet (2438 mm) in height.

**5106.3.1 Maximum quantities in retail display areas.** Aerosol products in retail display areas shall not exceed quantities needed for display and normal merchandising and shall not exceed the quantities in Table 5106.2.1, with fire protection in accordance with Section 5106.3.2.

❖ This section is intended, as is Section 5106.2.1, to restrict the quantities of hazardous materials in display areas where the public would be exposed to them.

**5106.3.2 Automatic sprinkler protection.** Aerosol display and merchandising areas shall be protected by an *automatic sprinkler system* based on the requirements set forth in Tables 6.3.2.7(a) through 6.3.2.7(l) of NFPA 30B and the following:

1. Protection shall be based on the highest level of aerosol product in the array and the packaging method of the storage located more than 6 feet (1829 mm) above the finished floor.
2. Where using the cartoned aerosol tables of NFPA 30B, uncartoned or display-cut Level 2 and 3 aerosols shall be permitted not more than 6 feet (1829 mm) above the finished floor.

- 3. The design area for Level 2 and 3 aerosols shall extend not less than 20 feet (6096 mm) beyond the Level 2 and 3 aerosol display and merchandising areas.
- 4. Where ordinary and high-temperature ceiling sprinkler systems are adjacent to each other, noncombustible draft curtains shall be installed at the interface.

❖ This section describes the automatic sprinkler protection requirements for Level 2 and 3 aerosol products where pile heights exceed 8 feet (2438 mm) in height. The sprinkler protection is the same as that required in a warehouse and must follow the appropriate requirements in Tables 6.3.2.7(a) through 6.3.2.7(l) of NFPA 30B. See Commentary Figure 5106.3.2. The protection table to be used is based on:

- The highest level of aerosol product found in the array.
- The packaging method of product located more than 6 feet (1829 mm) above the floor; that is, whether the product is in cartons or is uncartoned.
- The display/storage method: bulk, palletized or rack.

When using the tables for cartoned product, all product above the 6-foot (1829 mm) level must be cartoned. This is to increase the likelihood that the sprinkler protection will properly protect the storage array.

The design area for the ceiling sprinklers for the Level 2 or 3 aerosols must extend at least 20 feet (6096 mm) beyond the display and merchandising area. This is to provide the outer part of the aerosol area with adequate ceiling sprinkler water distribution regardless of whether the fire is internal or external to the aerosols.

Noncombustible draft curtains are to be installed at interfaces between ordinary- and high-temperature ceiling sprinkler systems in order to prevent a fire

beneath high-temperature sprinklers from activating ordinary-temperature sprinklers located away from the fire. This could put a strain on water availability in the fire area.

**5106.3.3 Separation of Level 2 and 3 aerosol areas.** Separation of Level 2 and 3 aerosol areas shall comply with the following:

- 1. Level 2 and 3 aerosol display and merchandising areas shall be separated from each other by not less than 25 feet (7620 mm). See Table 5106.2.1.
- 2. Level 2 and 3 aerosol display and merchandising areas shall be separated from flammable and *combustible liquids* storage and display areas by one or a combination of the following:
  - 2.1. Segregating areas from each other by horizontal distance of not less than 25 feet (7620 mm).
  - 2.2. Isolating areas from each other by a noncombustible partition extending not less than 18 inches (457 mm) above the merchandise.
  - 2.3. In accordance with Section 5106.5.
- 3. Where Item 2.2 is used to separate Level 2 or 3 aerosols from flammable or *combustible liquids*, and the aerosol products are located within 25 feet (7620 mm) of flammable or *combustible liquids*, the area below the noncombustible partition shall be liquid tight at the floor to prevent spilled liquids from flowing beneath the aerosol products.

❖ As indicated in Table 5106.2.1, Note b, the maximum net weight shown is for each 25,000 square feet (2323 m<sup>2</sup>) of sales display area. This section provides for the separation of aerosols in any one of these areas from those in any other area. This 25-foot (7620 mm) separation prevents back-to-back, 10,000-pound (4540 kg) arrays of product, which would defeat the purpose of the MAQs.

Separation of Level 2 and 3 aerosol products from

TABLE 6.3.2.7 SUFFIX	STORAGE METHOD		PACKAGING TYPE		AEROSOL LEVEL	
	Pallet or Solid Pile	Rack Storage	Cartoned	Uncartoned	Level 2	Level 3
(a) Metric (b) English	X		X		X	X
(c) Metric (d) English	X			X	X	
(e) Metric (f) English		X	X		X	
(g) Metric (h) English		X	X			X
(i) Metric (j) English		X		X	X	
(k) Metric (l) English		X		X		X

a. There Are Two Versions Of Each Table, One That Uses Si Units (Metric) And One That Uses English Units.

**Figure 5106.3.2**  
**GUIDE TO CONTENTS OF NFPA 30B TABLES 6.3.2.7(a) through (l)**

flammable and combustible liquids is required in order to prevent a liquid spill fire from immediately involving the aerosol products. The burning liquid could easily overwhelm the automatic sprinkler protection provided for the aerosol products, thus increasing the size of the loss.

The separation can be accomplished in any one or a combination of three ways:

1. Separation by a horizontal distance of at least 25 feet (7620 mm). This will prevent immediate involvement of the aerosols; and, if the burning liquid does eventually flow toward the aerosols, the in-rack sprinklers or fast-response sprinklers should activate so as to provide prewetting of the area.
2. A noncombustible partition between the products to prevent liquid flow into the aerosol area. When the partition is used and the aerosols and liquids are within 25 feet (7620 mm) of one another, this partition is to be liquid tight at the floor to prevent spilled liquids from flowing under the aerosol products.
3. A special protection design in accordance with Section 5106.5.

**5106.4 Maximum quantities in storage areas.** Aerosol products in storage areas adjacent to retail display areas shall not exceed the quantities in Table 5106.4.

❖ This section establishes quantity limits on aerosol products held in storage areas adjacent to retail sales floors. The limits are given in Table 5106.4, except for those in the right-hand column. Table 5104.7 designates this column as applying to areas that are separated from the retail sales area. The requirement for a barrier having a 1-hour fire-resistance rating is given in the notes to Table 5104.7. Applicable quantities for that storage condition are given in Table 5104.3.2. In the case of Table 5106.4, the separation is called a “1-hour occupancy separation,” which, within the IBC, would be considered a fire barrier constructed in accordance with Section 707. The quantity limits are as found in NFPA 30B.

**TABLE 5106.4.** See below.

❖ The quantities stated in this table are the same as those in Table 5104.7 (see commentary, Table 5104.7).

**5106.5 Special protection design for Level 2 and 3 aerosols adjacent to flammable and combustible liquids in double-row racks.** The display and merchandising of Level 2 and 3 aerosols adjacent to flammable and *combustible liquids* in double-row racks shall be in accordance with Sections 5106.5.1 through 5106.5.8 or Section 5106.3.3.

❖ This is the third method referred to in Section 5106.3.3, Item 2.3, for the separation of Level 2 and 3 aerosol display and merchandising areas from flammable and combustible liquid storage and display areas.

This special protection design is based on large-scale fire testing, with the storage arrays and sprinkler protection based on that testing. Rather than requiring the separation of aerosols and liquids in retail display and merchandising, it is a specific method to allow some of these products to be adjacent to one another.

**5106.5.1 Fire protection.** Fire protection for the display and merchandising of Level 2 and 3 aerosols in double-row racks shall be in accordance with Table 7.4.1 and Figure 7.4.1 of NFPA 30B.

❖ This specific method requires that the aerosols be in double-row racks, and that the fire protection be in accordance with Table 7.4.1 and Figure 7.4.1 of NFPA 30B. This fire protection scheme is based on a successful large-scale fire test.

**5106.5.2 Cartoned products.** Level 2 and 3 aerosols displayed or merchandised more than 8 feet (2438 mm) above the finished floor shall be in cartons.

❖ The Level 2 and 3 aerosols displayed or merchandised up to 8 feet (2438 mm) in height are allowed to be uncartoned or in display-cut cartons. All aerosols stored or displayed higher than 8 feet (2438 mm) must be in cartons to satisfy this special method.

**5106.5.3 Shelving.** Shelving in racks shall be limited to wire mesh shelving having uniform openings not more than 6 inches (152 mm) apart, with the openings comprising not less than 50 percent of the overall shelf area.

❖ All shelving in the racks for this special protection design must be wire mesh, with openings as prescribed in this section. This open wire mesh will allow sprinkler water flow between shelves and will not allow early collapse of the shelves.

**TABLE 5106.4**  
**MAXIMUM STORAGE QUANTITIES FOR STORAGE AREAS ADJACENT TO RETAIL DISPLAY OF LEVEL 2 AND 3 AEROSOLS**

MAXIMUM NET WEIGHT PER FLOOR (pounds)			
Floor	Unseparated <sup>a,b</sup>	Separated	
		Storage Cabinets <sup>b</sup>	1-hour Occupancy Separation
Basement	Not Allowed	Not Allowed	Not Allowed
Ground	2,500	5,000	In accordance with Sections 6.3.4.3 and 6.3.4.4 of NFPA 30B
Upper	500	1,000	In accordance with Sections 6.3.4.3 and 6.3.4.4 of NFPA 30B

For SI: 1 pound = 0.454 kg, 1 square foot = 0.0929 m<sup>2</sup>.

a. The aggregate quantity in storage and retail display shall not exceed the quantity limits for retail display.

b. In any 50,000-square-foot area.

**5106.5.4 Aisles.** Racks shall be arranged so that aisles not less than 7½ feet (2286 mm) wide are maintained between rows of racks and adjacent solid-piled or palletized merchandise.

❖ Aisles of at least 7½ feet (2286 mm) in width must be maintained. This is based on the successful large-scale fire test and is to help prevent fire spread.

**5106.5.5 Flue spaces.** Flue spaces in racks shall comply with the following:

1. Transverse flue spaces—Nominal 3-inch (76 mm) transverse flue spaces shall be maintained between merchandise and rack uprights.
2. Longitudinal flue spaces—Nominal 6-inch (152 mm) longitudinal flue spaces shall be maintained.

❖ This section requires nominal 3-inch (76 mm) transverse flue spaces and nominal 6-inch (152 mm) longitudinal flue spaces. These flue spaces are provided to allow sprinkler discharge water to freely flow between rack levels. As in Section 5106.5.3, the flue spaces are necessary so that lower levels of the array have adequate protection.

**5106.5.6 Horizontal barriers.** Horizontal barriers constructed of minimum ¾-inch-thick (10 mm) plywood or minimum 0.034-inch (0.086 mm) (No. 22 gage) sheet metal shall be provided and located in accordance with Table 7.4.1 and Figure 7.4.1 of NFPA 30B where in-rack sprinklers are installed.

❖ Whenever in-rack sprinklers are used, horizontal barriers of the thickness and materials indicated in this section are to be provided directly above the in-rack sprinklers. Their location shall be in accordance with Table 7.4.1 and Figure 7.4.1 of NFPA 30B. Their presence above the in-rack sprinkler will trap heat and ensure that these sprinklers, closest to any fire, will properly activate in a timely manner.

**5106.5.7 Class I, II, III, IV and plastic commodities.** Class I, II, III, IV and plastic commodities located adjacent to Level 2 and 3 aerosols shall be protected in accordance with NFPA 13.

❖ Class I through IV and plastic commodities located adjacent to the aerosols in this array must be protected in accordance with NFPA 13.

**5106.5.8 Flammable and combustible liquids.** Class I, II, III A and III B Liquids shall be allowed to be located adjacent to Level 2 and 3 aerosol products where both of the following conditions are met:

1. Class I, II, IIIA and IIIB liquid containers: Containers for Class I, II, IIIA and IIIB liquids shall be limited to 1.06-gallon (4 L) metal-relieving and nonrelieving style containers and 5.3-gallon (20 L) metal-relieving style containers.

2. Fire protection for Class I, II, IIIA and IIIB Liquids: Automatic sprinkler protection for Class I, II, IIIA and IIIB liquids shall be in accordance with Chapter 57.

❖ This section identifies the maximum size and style of metal containers that must be used for flammable and combustible liquids stored adjacent to the aerosols. Section 6.8.1.3 and Appendix A-6.8.1.3 of NFPA 30 provide information on relieving- and nonrelieving-type metal containers.

No plastic containers of flammable or combustible liquids are allowed for this special protection design. Fire protection for the flammable and combustible liquids must be in accordance with Chapter 57.

## SECTION 5107 MANUFACTURING FACILITIES

**5107.1 General.** Manufacturing facilities shall be in accordance with NFPA 30B.

❖ The hazards of aerosol manufacturing are significantly different from those of a storage facility where aerosols are stored in cartons in their individual steel or aluminum containers. The manufacturing process involves the hazards of handling flammable and combustible liquids under pressure and potentially in aerosol form, which is an even greater fire hazard. Since the manufacturing of aerosol products is not included in the list of exceptions to a Group H occupancy classification found in IBC Section 307.1, Exception 11, such facilities could warrant a Group H classification. See the commentary to Section 5101.1 for further information.

The code relies upon the referenced standard, NFPA 30B, for the regulation of aerosol manufacturing facilities. Chapter 5 of that standard includes basic requirements for manufacturing facilities, including, among others, requirements for the protection and separation of propellant-charging areas and pump rooms, explosion and deflagration venting, special ventilation requirements, electrical requirements, control of static electricity and fire protection systems.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

ASTM D240—07, *Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter*. West Conshohocken, PA: ASTM International, 2007.

## AEROSOLS

*Code Changes Resource Collection—2015 International Fire Code*. Washington, DC: International Code Council, 2014.

Fredrickson, David L. "Manufacture and Storage of Aerosol Products." Section 6, Chapter 20, *Fire Protection Handbook*, 19th ed. Quincy, MA: National Fire Protection Association, 2003.

**CHAPTER 52**  
**RESERVED**



# Chapter 53: Compressed Gases

## General Comments

This chapter regulates the storage, use and handling of all flammable and nonflammable compressed gases, such as those that are used in medical facilities, air separation plants, industrial plants, agricultural equipment and similar occupancies. Standards for the design, construction and marking of compressed gas cylinders and pressure vessels are referenced. Compressed gases used in welding and cutting, cryogenic liquids and liquefied petroleum gases (LP-gases) are also regulated under Chapters 35, 55 and 61, respectively. Compressed gases that are classified as hazardous materials are also regulated in Chapter 50, which includes general requirements.

## Purpose

Chapter 53 sets requirements for the storage, handling and use of all compressed gases, whether flammable or nonflammable.

## Flammable compressed gases

The principal hazard posed by flammable compressed gas is its ready ignitability, or even explosivity, when mixed with air in the proper proportions. The question in a flammable gas release usually is not if the mixture will ignite, but rather when or how it will ignite if not controlled. Consequently, occupancies storing or handling more than 1,000 cubic feet (28 m<sup>3</sup>) of flammable compressed gases or 30 gallons (114 L) of liquefied flammable gases per control area are classified as Group H-2 (high hazard) by the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>).

## Nonflammable compressed gases

The principal danger in the case of nonflammable compressed gas is its toxicity, reactivity or the ability to support combustion. Many gases do not fall into any of these categories; however, oxygen, perhaps the most abundant compressed gas, obviously does. Gaseous commodities containing oxygen, such as oxygen-helium and oxygen-nitrogen mixtures, oxides (e.g., nitrous oxide) and peroxides, all support the combustion. Fluorine (F<sub>2</sub>) and chlorine (Cl<sub>2</sub>) may also support the combustion of certain materials. Saacke and Associates (1990) discussed some of the properties of these two gases. Since these commodities are stored under pressure, their release from a cylinder causes them to expand to many times their initial volume. In confined and poorly ventilated spaces, this will cause certain gases to create an oxygen-enriched atmosphere that will accelerate burning. The release of other gases dis-

places atmospheric oxygen, thereby creating a dangerous, oxygen-deficient atmosphere. Many materials that do not burn in atmospheric concentrations of oxygen (19 to 21 percent) will support combustion at elevated levels. Chapter 60 contains specific provisions for highly toxic and toxic compressed gases.

## Container supports

The one common danger presented by all compressed gases is the enormous amount of energy released by container or fitting failures. For this reason, Sections 5303.5 and 5303.5.2 require all compressed gas cylinders to be properly secured as a means of protection against physical or mechanical damage. Containers should always be checked for obvious physical damage. Dented, bulging, gouged or corroded cylinders should be returned to the gas supplier for inspection and, if necessary, retesting.

## Overpressure protection

All compressed gas storage vessels, except those containing highly toxic materials, are equipped with pressure relief devices as a measure of protection against catastrophic container failure. These devices operate when compressed gas pressure, temperature or both exceed safe limits. Fusible discs and plugs, bimetallic "snap" discs, spring-operated valves or a combination of these methods are used to vent excess gas to the atmosphere. Some of these devices self-restore and stop the release of container contents; others do not. The fire code official should check pressure relief devices to see that they have not been painted, removed, damaged, contaminated, obstructed or otherwise impaired. Additionally, temperature extremes in the operating area [greater than 120°F (49°C) and less than 20°F (-7°C)] should be avoided.

## Housekeeping

Check valves, filters, flash arrestors and other gas system apparatus must be maintained in good operating condition. Dirt is the primary enemy of any gas system: debris can clog filters and block valves; damaged valves may permit the gradual release of tank contents and accumulations of grease and other organic materials become a fire hazard in the presence of oxidizing gases. Combustibles should be kept clear of all compressed gas installations, especially oxidizing gases. External fires involving accumulated combustibles can cause containers to fail.

## Separation

Separating gas system installations and incompatible gases (flammables and oxidizers) to minimize exposures is one of the simplest safeguards to implement. If possible, a suitable fire barrier should be constructed around container installations. The best location for compressed gas container installations is outside of buildings. In such cases, adequate access and weather protection should be provided to facilitate maintenance and emergency response.

## Ignition sources

Controlling ignition sources around both flammable compressed gas and oxidizing gas installations is the most important and most difficult safeguard to implement. Sparks, frictional heat, electrical arcs, static electricity, smoking materials and hot surfaces are only a few of the potential ignition sources. Every reasonable effort must be made to eliminate these sources or limit the adverse impact of an unintentional ignition. Smoking, welding, cutting and other obvious sources of ignition must be prohibited in the vicinity of compressed gases, and steps must be taken to prevent the accumulation of static electricity. Compressed gas cylinders should never be permitted to come into contact with energized electrical equipment.

## SECTION 5301 GENERAL

**5301.1 Scope.** Storage, use and handling of *compressed gases* in *compressed gas* containers, cylinders, tanks and systems shall comply with this chapter and NFPA 55, including those gases regulated elsewhere in this code. Partially full *compressed gas* containers, cylinders or tanks containing residual gases shall be considered as full for the purposes of the controls required.

Liquefied natural gas for use as a vehicular fuel shall also comply with NFPA 52 and NFPA 59A.

*Compressed gases* classified as hazardous materials shall also comply with Chapter 50 for general requirements and chapters addressing specific hazards, including Chapters 58 (Flammable Gases), 60 (Highly Toxic and Toxic Materials), 63 (Oxidizers, Oxidizing Gases and Oxidizing Cryogenic Fluids) and 64 (Pyrophoric Materials).

Compressed hydrogen (CH<sub>2</sub>) for use as a vehicular fuel shall also comply with Chapters 23 and 58 of this code, the *International Fuel Gas Code* and NFPA 2.

Cutting and welding gases shall also comply with Chapter 35.

LP-gas shall also comply with Chapter 61 and the *International Fuel Gas Code*.

### Exceptions:

1. Gases used as refrigerants in refrigeration systems (see Section 606).
  2. Compressed natural gas (CNG) for use as a vehicular fuel shall comply with Chapter 23, NFPA 52 and the *International Fuel Gas Code*.
  3. *Cryogenic fluids* shall comply with Chapter 55.
- ❖ This section establishes the scope of Chapter 53 with respect to the storage, use and handling of compressed gases, containers, cylinders, tanks and sys-

tems. The requirements of this chapter and the referenced standards are applicable, in addition to the general storage requirements of Chapter 50 for hazardous materials.

**5301.2 Permits.** Permits shall be required as set forth in Section 105.6.

- ❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit; Section 105.6.9 for a discussion of specific quantity-based operational permits for the materials regulated in this chapter; and Section 105.7 for a general discussion of activities requiring a construction permit. The permit process also notifies the fire department of the need for prefire planning for hazardous properties.

## SECTION 5302 DEFINITIONS

**5302.1 Definitions.** The following terms are defined in Chapter 2:

**COMPRESSED GAS.**

**COMPRESSED GAS CONTAINER.**

**COMPRESSED GAS SYSTEM.**

**NESTING.**

**TUBE TRAILER.**

- ❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chap-

ter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201 through 201.4).

### SECTION 5303 GENERAL REQUIREMENTS

**5303.1 Containers, cylinders and tanks.** *Compressed gas* containers, cylinders and tanks shall comply with this section. *Compressed gas* containers, cylinders or tanks that are not designed for refillable use shall not be refilled after use of the original contents.

❖ This section addresses protection from physical damage and prevents the gas containers, cylinders and tanks from being tampered with and otherwise damaged. It also requires marking for identification of the contents and the hazard degree. Only compressed gas containers, cylinders and tanks designed to be refillable may be done so after the original contents have been used.

**5303.2 Design and construction.** *Compressed gas* containers, cylinders and tanks shall be designed, fabricated, tested, marked with the specifications of manufacture and maintained in accordance with the regulations of DOTn 49 CFR Parts 100-185 or the ASME *Boiler and Pressure Vessel Code*, Section VIII.

❖ This section establishes basic requirements for the construction of pressure vessels. These requirements are in harmony with standards used by the suppliers of compressed gases and also correlate the code with standards promulgated by the Compressed Gas Association (CGA) as adopted by the Occupational Safety and Health Administration (OSHA). Manufacturing pressure vessels to standards is an essential element of safety that is warranted for materials of the type to be contained. Department of Transportation (DOTn) specification containers are used for pressure vessels in transport; while American Society of Mechanical Engineers (ASME) design specifications are typically used for stationary installations or where the pressure vessel is not designed as a transport vessel. By providing these requirements in the code, users who otherwise might devise a noncompliant system will be guided to appropriate standards of design.

**5303.3 Pressure relief devices.** Pressure relief devices shall be in accordance with Sections 5303.3.1 through 5303.3.5.

❖ Pressure relief devices are essential for compressed gases because of the high pressures at which they are maintained. Pressure relief devices provide a method of relieving overpressures and avoiding a hazardous situation. Sections 5303.3.1 through 5303.3.5 contain requirements related to accessibility for maintenance, general sizing, installation require-

ments and freeze protection for pressure relief devices.

**5303.3.1 Where required.** Pressure relief devices shall be provided to protect containers, cylinders and tanks containing *compressed gases* from rupture in the event of overpressure.

**Exception:** Cylinders, containers and tanks where exempt from the requirements for pressure relief devices specified by the standards of design *listed* in Section 5303.3.2.

❖ All compressed gas containers, cylinders and tanks must be equipped with pressure relief protection to reduce the likelihood of catastrophic vessel failure because of an overpressure condition. The exception recognizes that under certain conditions, the referenced design standards may not require pressure relief devices for certain vessels.

**5303.3.2 Design.** Pressure relief devices to protect containers shall be designed and provided in accordance with CGA S-1.1, CGA S-1.2, CGA S-1.3 or the ASME *Boiler and Pressure Vessel Code*, Section VIII, as applicable.

❖ There are two forms of pressure relief devices (PRDs): reusable devices or sacrificial devices. The type of PRD selected is based on the size of the gas container and the characteristics and hazards of the stored gas. The reusable form of a PRD is a spring-loaded safety relief valve that has the ability to open and close as excess pressures are relieved. Sacrificial PRDs are either a rupture disk or a fusible plug. When a sacrificial PRD operates, it cannot reclose; thus, its operation expels the entire contents of the gas container. Sacrificial PRDs operate when the device's pressure or temperature limits are exceeded.

Heat-activated PRDs are manufactured using fusible relief valves, known as fusible plugs. Frangible plugs operate when they are subjected to direct heating or heat from an exposure fire. Fusible plugs are normally set to operate at 212-350°F and are manufactured with metals with extremely reliable and predictable melting temperatures. Heat-activated PRDs operate when they are heated by direct fire contact or radiant and convective energies of an exposure fire.

Pressure-activated PRDs are known as burst discs or rupture discs. A burst disc is an engineered device that uses a metal or graphite disc weakened by scoring. Scoring is a mechanical process where the metal is partially cut to cause a predictable failure at the opening pressure of the burst disc. The disc's size, geometry and material of construction governs its opening or "burst" pressure. When a burst disc operates, it opens like a flower, and the gas is released into the atmosphere.

Pressure relief devices are to be designed in accordance with established engineering principles. Three CGA standards that cover the full range of container types, from portable to stationary, are referenced in this section, along with the ASME code, which is also referenced in Section 5303.2 for compressed gas container, cylinder and tank design.

**5303.3.3 Sizing.** Pressure relief devices shall be sized in accordance with the specifications to which the container was fabricated and to material-specific requirements as applicable.

❖ This section contains only general language requiring that the pressure relief device be properly designed to fit the needs of the particular container, cylinder or tank. In most cases, the manufacturer will already have the devices installed on the vessel at the factory. There are cases, however, when a compressed gas system or vessel may be constructed for a specific purpose and user. In those cases, the relief valves must be sized and installed by the user.

**5303.3.4 Arrangement.** Pressure relief devices shall be arranged to discharge upward and unobstructed to the open air in such a manner as to prevent any impingement of escaping gas upon the container, adjacent structures or personnel.

**Exception:** DOTn specification containers having an internal volume of 30 cubic feet (0.855 m<sup>3</sup>) or less.

❖ Pressure relief devices must be located so as to direct vented vapors away from personnel, containers and structures, as well as enclosed spaces to prevent personal injury and property damage. The arrangement will vary from one installation to another based on the use and location of the container and the system. The exception for DOTn containers with an internal volume less than or equal to 30 cubic feet (0.855 m<sup>3</sup>) recognizes that the amount of gas released from these containers is small enough to make this section unnecessary.

**5303.3.5 Freeze protection.** Pressure relief devices or vent piping shall be designed or located so that moisture cannot collect and freeze in a manner that would interfere with the operation of the device.

❖ A concern related to the integrity of pressure relief valves is their exposure to below-freezing temperatures that, in addition to having the tendency to make materials brittle and more susceptible to failure, cause accumulated moisture to freeze and possibly obstruct the relief valve opening, increasing the potential for a catastrophic container overpressure failure. This section requires that pressure relief devices be either not subject to extreme temperatures at all or provided with an approved freeze-protection technology as an integral part of the design.

**5303.4 Marking.** Stationary and portable *compressed gas* containers, cylinders, tanks and systems shall be marked in accordance with Sections 5303.4.1 through 5303.4.3.

❖ This section introduces the marking requirements for specific systems or gas containers, cylinders and tanks, including color and labeling of the name of the gas it contains.

**5303.4.1 Stationary compressed gas containers, cylinders and tanks.** Stationary *compressed gas* containers, cylinders and tanks shall be marked with the name of the gas and in

accordance with Sections 5003.5 and 5003.6. Markings shall be visible from any direction of approach.

❖ In order to provide emergency personnel with critical information regarding potential hazard exposure, gas storage vessels are to be marked in accordance with Sections 5003.5 (that references NFPA 704) and 5003.6 (see commentary, Sections 5003.5 and 5003.6). The markings need to be readily visible from any direction of approach (see Commentary Figure 5303.4.1).

**5303.4.2 Portable containers, cylinders and tanks.** Portable *compressed gas* containers, cylinders and tanks shall be marked in accordance with CGA C-7.

❖ Portable units are to be marked in accordance with Compressed Gas Association (CGA) standard C-7. The scope of that standard is to provide guidance on the appropriate labeling of containers of compressed gases for the purpose of identifying their contents; warning personnel of the physical and health hazards of the container contents, such as flammability, corrosivity, pyrophoricity and poison, among others; and providing information regarding precautions to be taken relative to the container contents. Such labels and markings must be prominently displayed and durable, identifying the standard that governed its construction, the material of construction, its design pressure, and an indication that it is qualified for the compressed gas it contains. These requirements are based on the hazardous material regulations promulgated by the U.S. Department of Transportation (DOTn) in 49 CFR Parts 100 through 185. DOTn markings indicate the specification to which the cylinder was constructed, its type and material of construction, its service pressure measured in pounds per square inch gage (PSIG), the manufacturer's mark and the cylinder's serial number. Additional markings are required to indicate the month and year the cylinder was manufactured and the cylinder testing requirements.

A common misconception is that the color of a cylinder indicates its contents. The only means of identifying the contents of a cylinder is by labeling or marking the cylinder. Cylinders require markings in accordance with CGA C-7. These labels are located on the shoulder or wall of the cylinder. CGA C-7 requires that markings contain the name of the hazardous material and its DOTn and UN hazardous-material identification label and hazard-division identification number, which is used in the DOTn *Hazardous Materials Emergency Response Guidebook*. If the compressed gas is an inhalation hazard, warning statements about this hazard are required, as is a statement about its reportable quantity (RQ), if such a value is assigned by the DOTn.

**5303.4.3 Piping systems.** Piping systems shall be marked in accordance with ASME A13.1. Markings used for piping systems shall consist of the content's name and include a direc-

tion-of-flow arrow. Markings shall be provided at each valve; at wall, floor or ceiling penetrations; at each change of direction; and at not less than every 20 feet (6096 mm) or fraction thereof throughout the piping run.

**Exceptions:**

1. Piping that is designed or intended to carry more than one gas at various times shall have appropriate signs or markings posted at the manifold, along the piping and at each point of use to provide clear identification and warning.
  2. Piping within gas manufacturing plants, gas processing plants, refineries and similar occupancies shall be marked in an *approved* manner.
- ❖ Piping systems are to be marked in accordance with ASME A13.1 to provide information to personnel, including emergency responders, as to the piping content and flow. The marking locations indicated are intended to provide continuity of identification of the piping at valves, certain fittings and structure penetrations. Exception 1 addresses piping systems that carry more than one gas. In these cases, signs are posted at the manifold and at each point of use. This will provide a clear identification and warning. Exception 2 recognizes that gas manufacturing plants need to be evaluated individually to provide clear and adequate piping identification.

**5303.5 Security.** *Compressed gas* containers, cylinders, tanks and systems shall be secured against accidental dislodgement and against access by unauthorized personnel in accordance with Sections 5303.5.1 through 5303.5.3.

❖ Compressed gas containers, cylinders and tanks must be adequately safeguarded. A fence or other approved protection should be provided around the storage area to minimize the likelihood of someone unknowingly entering the area, as well as to deter vandalism or theft.

**5303.5.1 Security of areas.** Areas used for the storage, use and handling of *compressed gas* containers, cylinders, tanks and systems shall be secured against unauthorized entry and safeguarded in an *approved* manner.

❖ Areas such as yards, loading platforms and any area where gas containers, cylinders and tanks are used, handled or stored are to be secured and safeguarded against unauthorized access.

**5303.5.2 Physical protection.** *Compressed gas* containers, cylinders, tanks and systems that could be exposed to physical damage shall be protected. Guard posts or other *approved* means shall be provided to protect *compressed gas* containers, cylinders, tanks and systems indoors and outdoors from vehicular damage and shall comply with Section 312.

❖ Compressed gas containers, cylinders and tanks must be adequately protected against physical or mechanical damage to the container and any valves or fittings. Where damage from vehicles may occur, guard posts or other kinds of guards are required to afford protection that complies with Section 312.

**5303.5.3 Securing compressed gas containers, cylinders and tanks.** *Compressed gas* containers, cylinders and tanks shall be secured to prevent falling caused by contact, vibration or seismic activity. Securing of *compressed gas* containers, cylinders and tanks shall be by one of the following methods:

1. Securing containers, cylinders and tanks to a fixed object with one or more restraints.
2. Securing containers, cylinders and tanks on a cart or other mobile device designed for the movement of *compressed gas* containers, cylinders or tanks.
3. Nesting of *compressed gas* containers, cylinders and tanks at container filling or servicing facilities or in sellers' warehouses not accessible to the public. Nesting shall be allowed provided the nested containers, cylinders or tanks, if dislodged, do not obstruct the required *means of egress*.
4. Securing of *compressed gas* containers, cylinders and tanks to or within a rack, framework, cabinet or similar assembly designed for such use.

**Exception:** *Compressed gas* containers, cylinders and tanks in the process of examination, filling, transport or servicing.

❖ A primary safety objective in the storage of compressed gas cylinders is the prevention of accidents from cylinders being knocked over. The best method to reliably achieve this objective is somewhat dependent on the frequency of cylinders being moved in and out of storage. For operations involving the infrequent movement of cylinders, the safest operation, obviously, would include chains or other means to completely secure all cylinders in place.

Securing all cylinders in place is not necessarily efficient for high-volume operations that are not open to the public, denoted in Method 3 of this section, such as container filling or servicing facilities, or seller's warehouses. When containers, cylinders and tanks are frequently moved, a chain or other restraining device can become a safety impediment to the efficiency of the operation. The tendency in a high-volume operation might be to drop a chain to the floor and roll cylinders over it, which would increase the likelihood of tripping a cylinder. Ideally, a chain should be moved out of the way, but in high-volume operations this can become impractical. Hence, the permissibility of nesting for these cases. See the commentary to the Section 202 definition of "Nesting."

In summary, the fire code official must determine whether the frequency of cylinder movement would qualify an operation as a "seller's warehouse" and allow the nesting exception as a safe alternative to securing cylinders with chains or similar devices. This decision should be based on criteria that is uniformly applied throughout the jurisdiction but that considers the unique characteristics of each operation. For an example of restrained cylinders in a compressed gas

system, see Commentary Figure 5303.4.1.

The exception recognizes that the container will not be secure when it is being filled, examined, transported or serviced. The container should be attended and monitored by adequately trained personnel during these operations.

**5303.6 Valve protection.** *Compressed gas* container, cylinder and tank valves shall be protected from physical damage by means of protective caps, collars or similar devices in accordance with Sections 5303.6.1 and 5303.6.2.

❖ This section states that all compressed gas container, cylinder and tank valves must be protected from physical damage in accordance with Sections 5303.6.1 and 5303.6.2. Avoiding damage to the cylinder valves is extremely important because such damage could result in the cylinder being propelled by the sudden release of its contents, which are under high pressure.

**5303.6.1 Compressed gas container, cylinder or tank protective caps or collars.** *Compressed gas* containers, cylinders and tanks designed for protective caps, collars or other protective devices shall have the caps or devices in place except when the containers, cylinders or tanks are in use or are being serviced or filled.

❖ Valve protection designed into the container, cylinder or tank by the manufacturer is the best means to prevent damage that could result in a “rocketing cylinder” scenario. When the design of gas containers, cylinders or tanks includes protective caps, collars or other protective devices, it only makes sense that these devices must be in place, except when servicing or filling the container, cylinder or tank makes it impractical.

**5303.6.2 Caps and plugs.** Compressed gas containers, cylinders and tanks designed for valve protection caps or other

protective devices shall have the caps or devices in place. When outlet caps or plugs are installed, they shall be in place.

**Exception:** *Compressed gas* containers, cylinders or tanks in use, being serviced or being filled.

❖ As stated in the commentary to Section 5303.6.1, in gas containers, cylinders and tanks that are designed to include valve protection caps or other protective devices, these devices must be tightly in place except when the container, cylinder or tank is in use or connected for use.

**5303.7 Separation from hazardous conditions.** *Compressed gas* containers, cylinders and tanks and systems in storage or use shall be separated from materials and conditions that pose exposure hazards to or from each other. *Compressed gas* containers, cylinders, tanks and systems in storage or use shall be separated in accordance with Sections 5303.7.1 through 5303.7.11.2.

❖ This section recognizes the danger of improperly storing materials, which can pose an exposure hazard to surrounding materials. Compressed gas containers, cylinders and tanks must, therefore, be separated in accordance with Sections 5303.7.1 through 5303.7.11.2.

**5303.7.1 Incompatible materials.** *Compressed gas* containers, cylinders and tanks shall be separated from each other based on the hazard class of their contents. *Compressed gas* containers, cylinders and tanks shall be separated from *incompatible materials* in accordance with Section 5003.9.8.

❖ Separating gas systems to minimize exposures is one of the simplest safeguards to implement. Section 5003.9.8 provides the minimum separation requirements for incompatible materials (see commentary, Section 5003.9.8).

**5303.7.2 Combustible waste, vegetation and similar materials.** Combustible waste, vegetation and similar materials

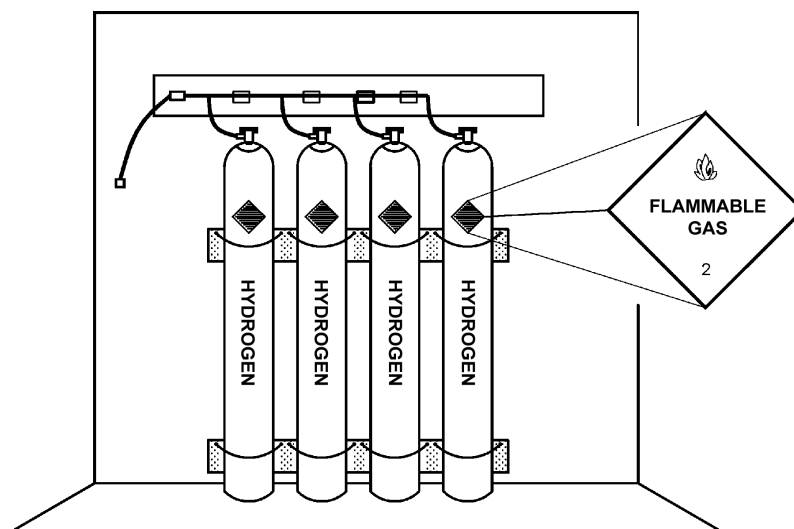


Figure 5303.4.1  
STORAGE AND LABELING OF CYLINDERS

shall be kept not less than 10 feet (3048 mm) from *compressed gas* containers, cylinders, tanks and systems. A non-combustible partition, without openings or penetrations and extending not less than 18 inches (457 mm) above and to the sides of the storage area is allowed in lieu of such distance. The wall shall either be an independent structure, or the exterior wall of the building adjacent to the storage area.

❖ This section indicates that combustible waste, vegetation and similar materials must be kept at least 10 feet (3048 mm) from compressed gas containers, cylinders and tanks because external fires involving accumulated combustibles can cause such vessels to fail. This section does permit a noncombustible partition instead of the 10-foot (3048 mm) requirement, provided the partition has no openings or penetrations and extends at least 18 inches (457 mm) above and 18 inches (457 mm) beyond the sides of the storage area. The partition must be an independent structure or may be an exterior wall of a building adjacent to the storage area. Note that no fire-resistance rating for this partition is required, only a stipulation that it be constructed of noncombustible materials.

**5303.7.3 Ledges, platforms and elevators.** *Compressed gas* containers, cylinders and tanks shall not be placed near elevators, unprotected platform ledges or other areas where falling would result in *compressed gas* containers, cylinders or tanks being allowed to drop distances exceeding one-half the height of the container, cylinder or tank.

❖ This section addresses concerns about gas containers, cylinders and tanks being damaged by a fall. Gas containers, cylinders and tanks cannot be placed on platform ledges, elevators and other areas where the container, if dropped, would fall more than one-half the height of the container.

**5303.7.4 Temperature extremes.** *Compressed gas* containers, cylinders and tanks, whether full or partially full, shall not be exposed to artificially created high temperatures exceeding 125°F (52°C) or subambient (low) temperatures unless designed for use under the exposed conditions.

❖ This section identifies the limits of the temperature extremes to which gas containers, cylinders and tanks can be exposed without creating a danger of the possibility of catastrophic failure. The section also recognizes the added safety of gas containers, cylinders and tanks that are designed to be used beyond the indicated limitations.

**5303.7.5 Falling objects.** *Compressed gas* containers, cylinders, tanks and systems shall not be placed in areas where they are capable of being damaged by falling objects.

❖ This section is similar in intent to Section 5303.5.2 for the physical protection of gas containers, cylinders and tanks, except this section addresses falling objects, which could cause physical damage.

**5303.7.6 Heating.** *Compressed gas* containers, cylinders and tanks, whether full or partially full, shall not be heated by devices that could raise the surface temperature of the con-

tainer, cylinder or tank to above 125°F (52°C). Heating devices shall comply with the *International Mechanical Code* and NFPA 70. *Approved* heating methods involving temperatures of less than 125°F (52°C) are allowed to be used by trained personnel. Devices designed to maintain individual *compressed gas* containers, cylinders or tanks at constant temperature shall be *approved* and shall be designed to be fail-safe.

❖ This section requires that any heating devices comply with the *International Mechanical Code*® (IMC®) and NFPA 70. It also requires that heating devices be used only by trained personnel and be designed to be fail-safe.

**5303.7.7 Sources of ignition.** Open flames and high-temperature devices shall not be used in a manner that creates a hazardous condition.

❖ Controlling ignition sources around compressed gas is both very important and somewhat difficult. This section addresses open flames and high-temperature devices. These ignition sources should be used only when necessary and by trained personnel, provided adequate safeguards are in place.

**5303.7.8 Exposure to chemicals.** *Compressed gas* containers, cylinders, tanks and systems shall not be exposed to *corrosive* chemicals or fumes that could damage containers, cylinders, tanks, valves or valve-protective caps.

❖ This section requires protection against corrosive chemicals or fumes that could cause damage to the container or valves and valve caps.

**5303.7.9 Exhausted enclosures.** Where exhausted enclosures are provided as a means to segregate *compressed gas* containers, cylinders and tanks from exposure hazards, such enclosures shall comply with the requirements of Section 5003.8.5.

❖ Exhausted enclosures, as defined in Section 5002.1, are one means of isolating compressed gas containers from hazardous conditions. When such equipment is utilized, performance requirements are needed and may be found in Section 5003.8.5.

**5303.7.10 Gas cabinets.** Where gas cabinets are provided as a means to separate *compressed gas* containers, cylinders and tanks from exposure hazards, such gas cabinets shall comply with the requirements of Section 5003.8.6.

❖ Gas cabinets, as defined in Section 202, are one means of isolating compressed gas containers from hazardous conditions. When such equipment is utilized, performance requirements are needed and may be found in Section 5003.8.6.

**5303.7.11 Tube trailers.** Tube trailers, including those containing compatible *compressed gases*, shall be surrounded by a clear space of not less than 3 feet (914 mm) to allow for maintenance, access and inspection.

❖ This section presents minimum requirements for siting one or more tube trailers (see Commentary Figure 5303.7.11) in an industrial plant or another setting

for the supply of compressed gases. It also provides requirements for installations at a single location delivering several compressed gases using multiple tube trailers.

A minimum clear space must be provided between tube trailers, and between tube trailers and other objects, including buildings, to allow for the access and passage of personnel involved in activities associated with the servicing and use of the trailer. At filling plants, operators must access the vehicles for maintenance and service-related work, and at user locations, access is needed to allow users unimpeded movement, including access and egress. A clear space of 36 inches (914 mm) has been selected to accommodate a “person width” of 22 inches (559 mm) while addressing the fact that there could be service-related connections or fittings that require the trailer to be attended. This is similar to Section 2306.2.6, which requires a 3-foot (914 mm) clearance around flammable liquid tanks when installed in a special enclosure inside of buildings to allow for access and maintenance.

It should also be noted that these minimum clearance requirements do not supercede or replace distances from storage to exposures contained in other chapters of the code. Siting of tube trailers will be based on the hazard classification of the compressed gas. For example, consider a six-pack tube trailer of compressed methane, a flammable gas regulated by Chapter 58, with each tube having a rated volume of 10,000 standard cubic feet (scf) (283 m<sup>3</sup>) at a design pressure of 3,000 pounds per square inch gauge (psig) (20 613 kPa) for a total volume of 60,000 scf (1699 m<sup>3</sup>). In this example, the application of Table 5804.2.1 would result in the following minimum distances from the tube trailer to exposures:

**MINIMUM DISTANCE:**

- Between storage areas: 10 feet (3048 mm).
- To lot lines of property that can be built upon: 20 feet (6096 mm).
- To public streets, public alleys or public ways: 20 feet (6096 mm).



**Figure 5303.7.11  
TUBE TRAILER**

**MINIMUM DISTANCE TO BUILDINGS ON THE SAME PROPERTY:**

- To nonrated construction or opening within 25 feet (7620 mm):  
20 feet (6096 mm).
- To 2-hour construction and no openings within 25 feet (7620 mm):  
5 feet (1524 mm).
- To 4-hour construction and no openings within 25 feet (7620 mm):  
0 feet (0 mm).

**5303.7.11.1 Individual tube trailers containing incompatible materials.** Increased separation distances between individual tube trailers containing incompatible gases shall be provided where required by Section 5303.7.1.

❖ See the commentary to the Section 202 definition of “Tube trailer,” and the commentary to Sections 5003.9.8 and 5303.7.1.

**5303.7.11.2 Connections.** Piping systems used to connect tube trailers to a user piping system shall not be viewed as an encroachment into the 3-foot (914 mm) clear space.

❖ This section clarifies that the 3-foot (914 mm) clearance in Section 5303.7.11 is to be measured from a building or object to the tube trailer itself. The extension of any piping system to the tube trailer is not viewed as an encroachment on the clearance otherwise required.

**5303.8 Wiring and equipment.** Electrical wiring and equipment shall comply with NFPA 70. *Compressed gas* containers, cylinders, tanks and systems shall not be located where they could become part of an electrical circuit. *Compressed gas* containers, cylinders, tanks and systems shall not be used for electrical grounding.

❖ This section requires that any electrical wiring and equipment comply with NFPA 70. It further requires that no compressed gas containers, cylinders or tanks be placed where they could become part of an electrical circuit. Cylinders and systems cannot be part of any electrical grounding system.

**5303.9 Service and repair.** Service, repair, modification or removal of valves, pressure-relief devices or other *compressed gas* container, cylinder or tank appurtenances shall be performed by trained personnel.

❖ This section requires individuals who service, repair or modify gas containers, cylinders and tanks, or tank appurtenances to be fully trained in the particular function they are performing.

**5303.10 Unauthorized use.** *Compressed gas* containers, cylinders, tanks and systems shall not be used for any purpose other than to serve as a vessel for containing the product that it is designed to contain.

❖ This section requires that gas containers, cylinders and tanks hold only the product they were designed to contain. These containers, cylinders and tanks may not be used for any other purpose. This section

prohibits the filling of a gas container, cylinder or tank with a gas for which it was not designed.

**5303.11 Exposure to fire.** *Compressed gas* containers, cylinders and tanks that have been exposed to fire shall be removed from service. Containers, cylinders and tanks so removed shall be handled by *approved*, qualified persons.

❖ This section requires any gas containers, cylinders and tanks that have been exposed to fire to be removed from service and be handled only by qualified persons. This is especially important because the container may still be under pressure.

**5303.12 Leaks, damage or corrosion.** Leaking, damaged or corroded *compressed gas* containers, cylinders and tanks shall be removed from service. Leaking, damaged or corroded *compressed gas* systems shall be replaced or repaired in accordance with the following:

1. *Compressed gas* containers, cylinders and tanks that have been removed from service shall be handled in an *approved* manner.
2. *Compressed gas* systems that are determined to be leaking, damaged or corroded shall be repaired to a serviceable condition or removed from service.

❖ Leaking, damaged or corroded gas containers, cylinders and tanks must be removed from service and be replaced or repaired in accordance with Items 1 and 2 of this section. Damaged gas containers, cylinders and tanks pose a potential content-release hazard. Care must be taken to determine that disposal does not present a greater hazard than the damaged container. Small gas containers, cylinders and tanks usually cannot be repaired easily. Large gas containers, cylinders and tanks, and fixed tank installations, often cannot be easily replaced and must be repaired. Temporary storage of materials during the repair of these gas containers, cylinders and tanks must comply with code requirements.

**5303.13 Surface of unprotected storage or use areas.** Unless otherwise specified in Section 5303.14, *compressed gas* containers, cylinders and tanks are allowed to be stored or used without being placed under overhead cover. To prevent bottom corrosion, containers, cylinders and tanks shall be protected from direct contact with soil or unimproved surfaces. The surface of the area on which the containers are placed shall be graded to prevent accumulation of water.

❖ This section requires that adequate protection be provided to prevent bottom corrosion of the container from direct contact with soil or unimproved surfaces. Grading is also required to eliminate the accumulation of water in the container storage area to prevent the container bottoms from being immersed. Overhead cover is not required unless extreme temperatures are present. Section 5303.14 addresses overhead protection.

**5303.14 Overhead cover.** *Compressed gas* containers, cylinders and tanks are allowed to be stored or used in the sun except in locations where extreme temperatures prevail.

Where extreme temperatures prevail, overhead covers shall be provided.

❖ This section requires that overhead cover be provided when extreme temperatures exist. Many of these structures are constructed as an attached canopy to provide ready access to materials. IBC Section 414.6 prescribes construction requirements applicable to weather protection for hazardous materials.

**5303.15 Lighting.** *Approved* lighting by natural or artificial means shall be provided.

❖ Lighting sufficient for good visibility must be maintained at all times in both inside and outside areas. Natural light for outdoor areas may be sufficient where operations are limited to daylight hours.

**5303.16 Vaults.** Generation, compression, storage and dispensing equipment for *compressed gases* shall be allowed to be located in either above- or below-grade vaults complying with Sections 5303.16.1 through 5303.16.14.

❖ This section extends the permissible use of vaults to include gaseous materials. The code previously allowed vaults to be used for the protection of all hazardous material liquids, but the protection features have been modified for inclusion in Chapter 53 to accommodate the protection of compressed gases. The provisions of the section are derived from Section 5704.2.8, which regulates vaults used for flammable and combustible liquids. The code has previously allowed gases to be stored and handled inside of buildings, and it is also appropriate to allow gas storage and handling equipment to be in vaults, given that a vault environment is unoccupied and offers fewer possible accident scenarios.

**5303.16.1 Listing required.** Vaults shall be *listed* by a nationally recognized testing laboratory.

**Exception:** Where *approved* by the *fire code official*, below-grade vaults are allowed to be constructed on site, provided that the design is in accordance with the *International Building Code* and that special inspections are conducted to verify structural strength and compliance of the installation with the *approved* design in accordance with Section 1707 of the *International Building Code*. Installation plans for below-grade vaults that are constructed on site shall be prepared by, and the design shall bear the stamp of, a professional engineer. Consideration shall be given to soil and hydrostatic loading on the floors, walls and lid; anticipated seismic forces; uplifting by ground water or flooding; and to loads imposed from above, such as traffic and equipment loading on the vault lid.

❖ Where prefabricated vaults are used, they must be listed by a testing laboratory experienced in evaluating such design and construction. While this section does not reference any particular standard to which a vault is to be listed, UL 2245 is the referenced standard in Section 5704.2.8.1 for vaults containing flammable or combustible liquid tanks and could be used to provide guidance to the fire code official.

The exception recognizes that vaults may also be site-built, provided that they are approved by the fire code official. Site-built vaults must be designed by a qualified design professional to comply with IBC Chapter 16, and the construction is to be overseen with special inspections conducted in accordance with IBC Chapter 17. Flood hazard areas are defined in IBC Section 202.

**5303.16.2 Design and construction.** The vault shall completely enclose generation, compression, storage or dispensing equipment located in the vault. There shall not be openings in the vault enclosure except those necessary for vault ventilation and access, inspection, filling, emptying or venting of equipment in the vault. The walls and floor of the vault shall be constructed of reinforced concrete not less than 6 inches (152 mm) thick. The top of an above-grade vault shall be constructed of noncombustible material and shall be designed to be weaker than the walls of the vault to ensure that the thrust of any explosion occurring inside the vault is directed upward.

The top of an at- or below-grade vault shall be designed to relieve safely or contain the force of an explosion occurring inside the vault. The top and floor of the vault and the tank foundation shall be designed to withstand the anticipated loading, including loading from vehicular traffic, where applicable. The walls and floor of a vault installed below grade shall be designed to withstand anticipated soil and hydrostatic loading. Vaults shall be designed to be wind and earthquake resistant, in accordance with the *International Building Code*.

❖ The vault is to be of noncombustible materials with openings required only for the operation and maintenance of the equipment it contains. In order to provide structural integrity, thermal exposure protection and equipment physical protection, reinforced concrete is to be used for the walls and floor. The vault top for above-grade vaults is required only to be constructed of noncombustible materials and must be designed to vent the forces of an explosion. If the vault is constructed such that the top is located below grade, or is subject to vehicular traffic, then the top must be designed to withstand vehicle loads and also contain the forces of an explosion. The structural design of the vault must also comply with IBC Chapter 16 for wind and earthquake loads, as applicable.

**5303.16.3 Secondary containment.** Vaults shall be substantially liquid-tight and there shall not be backfill within the vault. The vault floor shall drain to a sump. For premanufactured vaults, liquid tightness shall be certified as part of the listing provided by a nationally recognized testing laboratory. For field-erected vaults, liquid tightness shall be certified in an *approved* manner.

❖ The vault is to function as secondary containment for the tank in the event of a leak or spillage. Any leakage or spillage must be removed by draining to a sump in the vault floor. Premanufactured vaults are required to be listed; during this listing process, an analysis program is performed that includes an evalu-

ation of the effectiveness of secondary containment provided by a vault. It is much more difficult to accomplish a liquid-tight installation on a field-erected vault, as evidenced by the proliferation of leaky basements found throughout the country; therefore, to enhance the quality of field-erected vaults, such units must be certified for liquid tightness to the satisfaction of the fire code official. Methods that might be used include third-party inspection/evaluation and full-scale liquid retention testing.

**5303.16.4 Internal clearance.** There shall be sufficient clearance within the vault to allow for visual inspection and maintenance of equipment in the vault.

❖ Maintenance and inspection of the tank requires that the clearance between the tank and the vault be sufficient for personnel to perform these functions.

**5303.16.5 Anchoring.** Vaults and equipment contained therein shall be suitably anchored to withstand uplifting by groundwater or flooding. The design shall verify that uplifting is prevented even where equipment within the vault is empty.

❖ The tank and the vault may float if the water table is high or flooding occurs. The tank is to be anchored to the vault to prevent the tank from floating while the vault is also to be anchored to prevent it, in turn, from floating. Flood hazard areas are defined in IBC Section 202.

**5303.16.6 Vehicle impact protection.** Vaults shall be resistant to damage from the impact of a motor vehicle, or vehicle impact protection shall be provided in accordance with Section 312.

❖ Protection from the impact of vehicles is provided by guard posts or other approved barriers. Section 312 contains the specifications for guard posts or the design forces required for an approved barrier to comply with the code. Protection from vehicle impact is also required under Section 5303.5.2.

**5303.16.7 Arrangement.** Equipment in vaults shall be *listed* or *approved* for above-ground use. Where multiple vaults are provided, adjacent vaults shall be allowed to share a common wall. The common wall shall be liquid and vapor tight and shall be designed to withstand the load imposed when the vault on either side of the wall is filled with water.

❖ Tanks and equipment designed for underground use typically rely upon proper backfilling and burial in soil for their structural support and stability; therefore, tanks and equipment installed in the vault must be appropriate for above-ground use since there will be no backfill to provide support. Equipment and tanks installed in vaults are to be independent of each other and a separate vault is to be constructed for each. The individual vaults are allowed to use a common separation wall if it does not allow the gases from one vault to enter an adjacent vault. This common wall must be able to structurally resist the hydrostatic loads if the adjacent vault is flooded.

**5303.16.8 Connections.** Connections shall be provided to permit the venting of each vault to dilute, disperse and remove vapors prior to personnel entering the vault.

❖ In order to provide a safe environment for inspection or repair personnel to operate inside the vault, openings must be provided to facilitate the purging of harmful or oxygen-depleting inert gases from the vault prior to entry.

**5303.16.9 Ventilation.** Vaults shall be provided with an exhaust ventilation system installed in accordance with Section 5004.3. The ventilation system shall operate continuously or be designed to operate upon activation of the vapor or liquid detection system. The system shall provide ventilation at a rate of not less than 1 cubic foot per minute (cfm) per square foot [ $0.00508 \text{ m}^3/(\text{s} \cdot \text{m}^2)$ ] of floor area, but not less than 150 cfm (4  $\text{m}^3/\text{min}$ ). The exhaust system shall be designed to provide air movement across all parts of the vault floor for gases having a density greater than air and across all parts of the vault ceiling for gases having a density less than air. Supply ducts shall extend to within 3 inches (76 mm), but not more than 12 inches (305 mm), of the floor. Exhaust ducts shall extend to within 3 inches (76 mm), but not more than 12 inches (305 mm) of the floor or ceiling, for heavier-than-air or lighter-than-air gases, respectively. The exhaust system shall be installed in accordance with the *International Mechanical Code*.

❖ The removal of hazardous gases from a vault requires that a ventilation system be installed in accordance with Section 5004.3 and the IMC. The ventilation system must have supply and exhaust ducts 3 to 12 inches (76 to 305 mm) from the vault floor. These ducts are to provide ventilation across the entire vault floor to allow air movement across the lowest part of the vault where heavier-than-air gases could settle, remove them and provide breathable air.

**5303.16.10 Monitoring and detection.** Vaults shall be provided with *approved* vapor and liquid detection systems and equipped with on-site audible and visual warning devices with battery backup. Vapor detection systems shall sound an alarm when the system detects vapors that reach or exceed 25 percent of the lower explosive limit (LEL) or one-half the immediately dangerous to life and health (IDLH) concentration for the gas in the vault. Vapor detectors shall be located not higher than 12 inches (305 mm) above the lowest point in the vault for heavier-than-air gases and not lower than 12 inches (305 mm) below the highest point in the vault for lighter-than-air gases. Liquid detection systems shall sound an alarm upon detection of any liquid, including water. Liquid detectors shall be located in accordance with the manufacturers' instructions. Activation of either vapor or liquid detection systems shall cause a signal to be sounded at an *approved*, constantly attended location within the facility served by the tanks or at an *approved* location. Activation of vapor detection systems shall also shut off gas-handling equipment in the vault and dispensers.

❖ The vault is to have liquid and vapor detection systems that sound an alarm when either is present in

the quantities specified. The systems should have battery backup in the event of a power failure, and are to sound an alarm on the premises at a constantly attended location that is approved by the fire code official (see commentary to the Section 202 definition of "Constantly attended location").

**5303.16.11 Liquid removal.** Means shall be provided to recover liquid from the vault. Where a pump is used to meet this requirement, it shall not be permanently installed in the vault. Electric-powered portable pumps shall be suitable for use in Class I, Division I locations, as defined in NFPA 70.

❖ A method for removing liquid from the vault must be provided. This can be a gravity drain, if the site is appropriate, or manual or portable electric pumps suitable for use in hazardous locations.

**5303.16.12 Relief vents.** Vent pipes for equipment in the vault shall terminate not less than 12 feet (3658 mm) above ground level.

❖ Vent pipes must be terminated so as to direct gases and vapors into the airstream and away from the vault and any nearby buildings. Some compressed gases are normally heavier than air so they will settle to lower levels. The termination of a vent pipe, a minimum of 12 feet (3658 mm) above grade, will provide space for the gases to disperse to below the lower flammable limit (LFL). This high termination elevation also reduces the potential for the termination being close to grade-level ignition sources. The design features of nearby buildings that may allow hazardous gases to reenter the building or to collect on the building are to be avoided.

**5303.16.13 Accessway.** Vaults shall be provided with an *approved* personnel accessway with a minimum dimension of 30 inches (762 mm) and with a permanently affixed, nonferrous ladder. Accessways shall be designed to be nonsparking. Travel distance from any point inside a vault to an accessway shall not exceed 20 feet (6096 mm). At each entry point, a warning sign indicating the need for procedures for safe entry into confined spaces shall be posted. Entry points shall be secured against unauthorized entry and vandalism.

❖ Access to the vault must have a minimum dimension of 30 inches (762 mm) for ease of personnel passage. Because there is the possibility of hazardous and potentially flammable gases in the vault, the accessway and ladder are to be constructed of *approved*, nonsparking material. Since gases can replace the air in a vault, for personnel safety, the travel distance is limited and warning signs must be posted to remind personnel of the potential hazards.

**5303.16.14 Classified area.** The interior of a vault containing a flammable gas shall be designated a Class I, Division I location, as defined in NFPA 70.

❖ The interior of a vault storing flammable gas is classified as a Class 1, Division I hazardous electrical location, in accordance with NFPA 70 for determining the type of electrical system to be installed.

### SECTION 5304 STORAGE OF COMPRESSED GASES

**5304.1 Upright storage.** *Compressed gas* containers, cylinders and tanks, except those designed for use in a horizontal position, and all *compressed gas* containers, cylinders and tanks containing nonliquefied gases, shall be stored in an upright position with the valve end up. An upright position shall include conditions where the container, cylinder or tank axis is inclined as much as 45 degrees (0.80 rad) from the vertical.

#### Exceptions:

1. *Compressed gas* containers with a water volume less than 1.3 gallons (5 L) are allowed to be stored in a horizontal position.
  2. Cylinders, containers and tanks containing nonflammable gases, or cylinders, containers and tanks containing nonliquefied flammable gases that have been secured to a pallet for transportation purposes.
- ❖ Containers, cylinders or tanks designed to be used in the horizontal position with the valve end up and accessible are to be stored in an upright position, unless the conditions of one of the two listed exceptions are met. Exception 1 allows gas containers, cylinders and tanks with a water volume of less than 1.3 gallons (5 L) to be stored in the horizontal position. Exception 2 permits gas containers, cylinders and tanks containing nonflammable gases to be in the horizontal position when secured to a pallet for transportation.

**5304.2 Material-specific regulations.** In addition to the requirements of this section, indoor and outdoor storage of *compressed gases* shall comply with the material-specific provisions of Chapters 54, 58 and 60 through 67.

- ❖ In addition to meeting the requirements of this section, storage of compressed gases needs to comply with the material-specific provisions of Chapters 54, 58 and 60 through 67. For example, the storage and use of flammable gases must be in accordance with Chapter 58 in addition to the requirements of this section.

### SECTION 5305 USE AND HANDLING OF COMPRESSED GASES

**5305.1 Compressed gas systems.** *Compressed gas* systems shall be suitable for the use intended and shall be designed by persons competent in such design. *Compressed gas* equipment, machinery and processes shall be *listed* or *approved*.

- ❖ This section contains requirements for gas systems. A system includes stationary or movable gas containers, cylinders and tanks; pressure regulators; safety relief devices; manifolds; interconnecting piping; and controls. It is important that persons designing these systems be competent in this area. All equipment, machinery and processes need to be listed or approved for that particular use.

**5305.2 Controls.** *Compressed gas* system controls shall be designed to prevent materials from entering or leaving process or reaction systems at other than the intended time, rate or path. Automatic controls shall be designed to be fail safe.

- ❖ In designing the system controls, provisions must be made to prevent materials from escaping the system other than at the intended time. Automatic controls must be designed so that they are fail safe to provide safe conditions when personnel are not present.

**5305.3 Piping systems.** Piping, including tubing, valves, fittings and pressure regulators, shall comply with this section and Chapter 50. Piping, tubing, pressure regulators, valves and other apparatus shall be kept gas tight to prevent leakage.

- ❖ All apparatus, connected and part of the system, shall comply with this section and Chapter 50. Proper maintenance of all the components ensures that gas leaks are prevented.

**5305.4 Valves.** Valves utilized on *compressed gas* systems shall be suitable for the use intended and shall be accessible. Valve handles or operators for required shutoff valves shall not be removed or otherwise altered to prevent access.

- ❖ This section is intended to provide adequate safeguards for valves. Valves are to be employed solely for the use for which they were designed. They must be accessible and must not be removed or altered to prevent access.

**5305.5 Venting.** Venting of gases shall be directed to an *approved* location. Venting shall comply with the *International Mechanical Code*.

- ❖ This section indicates that gases must be vented to an approved location. It refers the user to the IMC to ensure compliance with venting requirements.

**5305.6 Upright use.** *Compressed gas* containers, cylinders and tanks, except those designed for use in a horizontal position, and all *compressed gas* containers, cylinders and tanks containing nonliquefied gases, shall be used in an upright position with the valve end up. An upright position shall include conditions where the container, cylinder or tank axis is inclined as much as 45 degrees (0.80 rad) from the vertical. Use of nonflammable liquefied gases in the inverted position where the liquid phase is used shall not be prohibited provided that the container, cylinder or tank is properly secured and the dispensing apparatus is designed for liquefied gas use.

**Exception:** *Compressed gas* containers, cylinders and tanks with a water volume less than 1.3 gallons (5 L) are allowed to be used in a horizontal position.

- ❖ This section has some of the general requirements found in Section 5304.1. Unless the container is designed to be used in the horizontal position, it must be in the upright position with the valve end up and accessible. In a gas system, the container may be in the inverted position when using nonflammable liquefied gases, provided that the container is secured and the dispensing apparatus is designed for liquefied gas use. Exception 1 to Section 5304.1 also applies

here: if the container has a water volume less than 1.3 gallons (5 L), it may be used in the horizontal position.

**5305.7 Transfer.** Transfer of gases between containers, cylinders and tanks shall be performed by qualified personnel using equipment and operating procedures in accordance with CGA P-1.

**Exception:** The fueling of vehicles with CNG or CH<sub>2</sub>, conducted in accordance with Chapter 23.

❖ In order to increase the likelihood that the inherent hazards involved in the transfer of compressed gases between gas containers, cylinders and tanks are mitigated, this section requires that only qualified personnel, using equipment and procedures in accordance with CGA P-1, execute the transfer. The exception to this occurs when fueling vehicles with compressed natural gas (CNG) or compressed hydrogen gas, provided that the fueling is conducted in accordance with the applicable provisions of Chapter 23 of the code.

**5305.8 Use of compressed gas for inflation.** Inflatable equipment, devices or balloons shall only be pressurized or filled with compressed air or inert gases.

❖ This section permits inflatable items, such as balloons, to be pressurized with compressed air or an inert gas only.

**5305.9 Material-specific regulations.** In addition to the requirements of this section, indoor and outdoor use of *compressed gases* shall comply with the material-specific provisions of Chapters 54, 58 and 60 through 67.

❖ In addition to the requirements of this section, storage of compressed gases must comply with the material-specific provisions of Chapters 54, 58 and 60 through 67. For example, the storage and use of a flammable gas system must comply with Chapter 58 in addition to the requirements of this section.

**5305.10 Handling.** The handling of *compressed gas* containers, cylinders and tanks shall comply with Sections 5305.10.1 and 5305.10.2.

❖ The requirements of Sections 5303.10.1 and 5305.10.2 are specific for handling gas containers, cylinders and tanks.

**5305.10.1 Carts and trucks.** Containers, cylinders and tanks shall be moved using an *approved* method. Where containers, cylinders or tanks are moved by hand cart, hand truck or other mobile device, such carts, trucks or devices shall be designed for the secure movement of containers, cylinders or tanks. Carts and trucks utilized for transport of *compressed gas* containers, cylinders and tanks within buildings shall comply with Section 5003.10. Carts and trucks utilized for transport of *compressed gas* containers, cylinders and tanks exterior to buildings shall be designed so that the containers, cylinders and tanks will be secured against dropping or otherwise striking against each other or other surfaces.

❖ This section contains regulations for moving gas containers, cylinders and tanks with carts and trucks.

When carts or trucks are used inside buildings, they must also comply with Section 5003.10. The potential release of gas is greatly increased during the handling process. A leak caused by improper handling, such as dropping a container, striking containers against each other or striking a container on another surface, poses a potential hazard to persons and property. Proper handling of the containers greatly reduces this risk.

**5305.10.2 Lifting devices.** Ropes, chains or slings shall not be used to suspend *compressed gas* containers, cylinders and tanks unless provisions at time of manufacture have been made on the container, cylinder or tank for appropriate lifting attachments, such as lugs.

❖ This section states that, in order to be suspended by ropes, chains or slings, compressed gas containers, cylinders and tanks must be fitted with lifting attachments at the time of manufacture.

## SECTION 5306 MEDICAL GASES

**5306.1 General.** Medical gases at health care-related facilities intended for patient care, inhalation or sedation including, but not limited to, analgesia systems for dentistry, podiatry, veterinary and similar uses shall comply with Sections 5306.2 through 5306.4 in addition to other requirements of this chapter.

❖ Compressed gases used in healthcare-related facilities include oxygen, nitrogen and nitrogen oxides, carbon dioxide and other gases that pose a variety of hazards if not handled and stored properly. Oxygen, for example, represents both a fire and an explosion hazard. Nitrogen oxides are useful for sedation, but in uncontrolled amounts in a confined space can asphyxiate an unknowing occupant. The remainder of these sections are intended to minimize hazards by setting the requirements for storage and supply locations. Note that the use of the phrase “healthcare-related facilities” indicates the intent that these provisions apply to not only hospitals but also to nursing homes and ambulatory care facilities.

**5306.2 Interior supply location.** Medical gases shall be stored in areas dedicated to the storage of such gases without other storage or uses. Where containers of medical gases in quantities greater than the permit amount are located inside buildings, they shall be in a 1-hour exterior room, a 1-hour interior room or a gas cabinet in accordance with Section 5306.2.1, 5306.2.2 or 5306.2.3, respectively. Rooms or areas where medical gases are stored or used in quantities exceeding the *maximum allowable quantity per control area* as set forth in Section 5003.1 shall be in accordance with the *International Building Code* for high-hazard Group H occupancies.

❖ This section states that medical gases must be stored in dedicated areas not used for other storage or any other purpose. Where medical gases are stored

inside buildings in quantities greater than the permit amount indicated in Table 105.6.9, they are required to be in a 1-hour exterior room, in a 1-hour interior room or a gas cabinet in accordance with Section 5306.2.1, 5306.2.2 or 5306.2.3.

The section also makes it clear that where hazardous gases are stored or used in quantities in excess of the maximum allowable quantity per control area (MAQ), the storage room must be constructed as an appropriate Group H area in accordance with the IBC.

**5306.2.1 One-hour exterior rooms.** A 1-hour exterior room shall be a room or enclosure separated from the remainder of the building by *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or horizontal assemblies constructed in accordance with Section 711 of the *International Building Code*, or both, with a *fire-resistance rating* of not less than 1 hour. Openings between the room or enclosure and interior spaces shall be self-closing smoke- and draft-control assemblies having a *fire protection rating* of not less than 1 hour. Rooms shall have not less than one exterior wall that is provided with not less than two nonclosable louvered vents. Each vent shall have a minimum free opening area of 24 square inches (155 cm<sup>2</sup>) for each 1,000 cubic feet (28 m<sup>3</sup>) at normal temperature and pressure (NTP) of gas stored in the room and shall be not less than 72 square inches (465 cm<sup>2</sup>) in aggregate free opening area. One vent shall be within 6 inches (152 mm) of the floor and one shall be within 6 inches (152 mm) of the ceiling. Rooms shall be provided with not less than one automatic sprinkler to provide container cooling in case of fire.

❖ This section contains specific construction, ventilation and suppression requirements for exterior rooms that contain medical gases in quantities greater than the permit amount indicated in Table 105.6.9. All openings between medical gas storage rooms and building interior spaces are required to be protected by self-closing smoke- and fire-rated assemblies to maintain separate airspaces. Even automatic-closing assemblies, which close on detection of fire or smoke, are not allowed since they cause the airspaces to be normally connected. The purpose of keeping airspaces separate is to prevent gas that may escape from a leak in the medical gas room from migrating into other areas of the building. These requirements are consistent with those of NFPA 99 and NFPA 101 used by the federal Centers for Medicare Services (CMS) for healthcare facility licensure.

**5306.2.2 One-hour interior room.** Where an exterior wall cannot be provided for the room, automatic sprinklers shall be installed within the room. The room shall be exhausted through a duct to the exterior. Supply and exhaust ducts shall be enclosed in a 1-hour-rated shaft enclosure from the room to the exterior. *Approved* mechanical ventilation shall comply with the *International Mechanical Code* and be provided at a

minimum rate of 1 cubic foot per minute per square foot [0.00508 m<sup>3</sup>/(s · m<sup>2</sup>)] of the area of the room.

❖ This section contains specific construction, ventilation and suppression requirements for interior rooms that contain medical gases in quantities greater than the permit amount indicated in Table 105.6.9.

**5306.2.3 Gas cabinets.** Gas cabinets shall be constructed in accordance with Section 5003.8.6 and the following:

1. The average velocity of ventilation at the face of access ports or windows shall be not less than 200 feet per minute (1.02 m/s) with not less than 150 feet per minute (0.76 m/s) at any point of the access port or window.
2. They shall be connected to an exhaust system.
3. They shall be internally sprinklered.

❖ This section contains specific requirements for the construction of gas cabinets that contain medical gases in quantities greater than the permit amount indicated in Table 105.6.8. These requirements are in addition to those contained in Section 5003.8.6. The cabinet ventilation system must be designed to operate at a negative pressure and be connected to an exhaust system to maintain a safe atmosphere inside the room in the event of a leak, especially during the normal opening and closing of the cabinet. Additionally, the section requires that gas cabinets be protected with an internal automatic sprinkler system to provide cooling of the gas cylinders housed in the cabinet in the event of a fire that is outside of the cabinet. Other types of extinguishing systems are prohibited.

**5306.3 Exterior supply locations.** Oxidizer medical gas systems located on the exterior of a building with quantities greater than the permit amount shall be located in accordance with Section 6304.2.1.

❖ This section requires compliance with Section 6304.2.1 for oxidizer medical gas systems located on the exterior of the building in amounts greater than permitted in Table 105.6.9 (see commentary, Section 6304.2.1).

**5306.4 Transfilling.** Transfilling areas and operations including, but not limited to, ventilation and separation, shall comply with NFPA 99.

❖ Transfilling is the transfer of oxygen to smaller portable containers from larger storage containers. This can occur in the liquid or gaseous state. The reference to NFPA 99 will provide restrictions on the construction of floors used in transfilling areas, limiting them to concrete or ceramic tile due to their noncombustible nature.

**5306.5 Medical gas systems.** Medical gas systems including, but not limited to, distribution piping, supply manifolds, connections, pressure regulators and relief devices and valves,

shall be installed in accordance with NFPA 99 and the general provisions of this chapter. Existing medical gas systems shall be maintained in accordance with the maintenance, inspection and testing provisions of NFPA 99 for medical gas systems.

- ❖ Compressed medical gas piping systems in hospitals and similar institutions may not be used to distribute flammable gases. Nonflammable compressed gas piping systems installed and used as detailed in NFPA 99 are permitted. Systems are to comply with the general, maintenance, inspection and testing provisions of this chapter and NFPA 99.

### SECTION 5307 CARBON DIOXIDE (CO<sub>2</sub>) SYSTEMS USED IN BEVERAGE DISPENSING APPLICATIONS

**5307.1 General.** Carbon dioxide systems with more than 100 pounds (45.4 kg) of carbon dioxide used in beverage dispensing applications shall comply with Sections 5307.2 through 5307.5.2.

- ❖ Several fatal carbon dioxide (CO<sub>2</sub>) poisoning (asphyxiation) incidents have occurred in restaurants where CO<sub>2</sub> leaked from large storage tanks and displaced oxygen in the area. CO<sub>2</sub> is an odorless and colorless gas with a vapor density of 1.53, making it 50 percent heavier than air. As such, the CO<sub>2</sub> will fill a room from the floor up and displace the oxygen in the room. Just a short exposure to a 10-percent concentration of CO<sub>2</sub> can be fatal. A 2-percent CO<sub>2</sub> concentration in air can increase the breathing rate by 50 percent and a 3-percent concentration can increase it by 100 percent. As the breathing rate increases, so does the amount of CO<sub>2</sub> being drawn into the person's system with the eventual results being headache, nausea, dizziness, disorientation, unconsciousness and death. The displacement of oxygen is more severe in smaller rooms or enclosures.

The intent of Section 5307 is to address locations, typically restaurants or other food service facilities, where liquefied CO<sub>2</sub> is used in conjunction with carbonators to produce carbonated beverages. CO<sub>2</sub> is stored as a compressed gas or a liquefied compressed gas but many larger restaurants are converting from gaseous CO<sub>2</sub> and taking advantage of liquefied CO<sub>2</sub> because the reduced container size and the reduced number of cylinders frees up valuable floor space. Note that CO<sub>2</sub> is not classified as a cryogenic fluid because its boiling point is -109°F.

A minimum trigger of more than 100 pounds was selected for these requirements because it was felt that systems with lesser amounts of CO<sub>2</sub> do not pose as great a risk of asphyxiation as large quantities of the gas.

**5307.2 Permits.** Permits shall be required as set forth in Section 105.6.

- ❖ Operational permits in accordance with Section 105.6.4 are required for CO<sub>2</sub> systems used in the beverage dispensing applications. See the commentary to Section 5301.2.

**5307.3 Equipment.** The storage, use, and handling of liquid carbon dioxide shall be in accordance with Chapter 53 and the applicable requirements of NFPA 55, Chapter 13. Insulated liquid carbon dioxide systems shall have pressure relief devices vented in accordance with NFPA 55.

- ❖ Components in compressed gas systems, including CO<sub>2</sub> systems, are required to comply with Chapter 53, which covers items such as pressure vessel and piping requirements, among others. An additional reference to NFPA 55, Chapter 13 addresses insulated liquid CO<sub>2</sub> systems in indoor and outdoor locations consisting of containers with a capacity of 1,000 pounds or less. The requirements address:

- Pressure relief devices.
- Pressure and level indicators.
- Piping systems including materials of construction.
- Operating instructions.

Some typical equipment are pictured in Commentary Figures 5307.3(1) and (2).



**Figure 5307.3(1)  
EXTERIOR FITTING TO FILL THE  
BULK CO<sub>2</sub> CYLINDER INSIDE THE BUILDING**



**Figure 5307.3(2)**  
**BULK CO<sub>2</sub> CYLINDER IN A**  
**CARBONATED BEVERAGE DISPENSING SYSTEM**

**5307.4 Protection from damage.** Carbon dioxide systems shall be installed so the storage tanks, cylinders, piping and fittings are protected from damage by occupants or equipment during normal facility operations.

❖ A CO<sub>2</sub> release can accumulate and displace oxygen, creating an asphyxiation hazard. To prevent a potential mishap, the CO<sub>2</sub> storage tanks, cylinders, piping, and fittings must be protected from physical damage. This section includes basic requirements intended to protect CO<sub>2</sub> storage tanks, cylinders, piping and fittings from damage by occupants or equipment during normal facility operations. This will decrease the chance of damage that may cause leaks, especially important in facilities where gas detection systems are not provided in accordance with Section 5307.5.2.

**5307.5 Required protection.** Where carbon dioxide storage tanks, cylinders, piping and equipment are located indoors, rooms or areas containing carbon dioxide storage tanks, cylinders, piping and fittings and other areas where a leak of carbon dioxide can collect shall be provided with either

ventilation in accordance with Section 5307.5.1 or an emergency alarm system in accordance with Section 5307.5.2.

❖ This section requires buildings in which the CO<sub>2</sub> systems are installed to be provided with either ventilation that complies with Section 5307.5.1 or an emergency alarm system that complies with Section 5307.5.2. It does not require that both ventilation and gas detection be provided. The hazard associated with these systems is that the heavier-than-air CO<sub>2</sub> may accumulate and displace oxygen, creating an asphyxiation hazard. Leaks are most likely to occur from fittings and connections, but could also be from plastic or other runs of piping.

**5307.5.1 Ventilation.** Mechanical ventilation shall be in accordance with the *International Mechanical Code* and shall comply with all of the following:

1. Mechanical ventilation in the room or area shall be at a rate of not less than 1 cubic foot per minute per square foot [0.00508 m<sup>3</sup>/(s • m<sup>2</sup>)].
2. Exhaust shall be taken from a point within 12 inches (305 mm) of the floor.
3. The ventilation system shall be designed to operate at a negative pressure in relation to the surrounding area.

❖ This section provides the requirements for mechanical ventilation when such is the chosen means of protection for CO<sub>2</sub> storage areas. The minimum ventilation rate of not less than 1 cubic foot per minute per square foot [0.00508 m<sup>3</sup>/(s • m<sup>2</sup>)] is a “standard” rate used for many applications throughout the code and the IMC. Since the room or area must be at a negative pressure to the surrounding areas to prevent any fugitive CO<sub>2</sub> from escaping the room, that “standard” rate may need to be adjusted upward to gain compliance. Though the exhaust system is not specifically required to be constantly in operation, such a precaution would be advisable due to the asphyxiation hazard that could arise in the event of an undetected CO<sub>2</sub> leak. The exhaust ventilation intakes must be located within 12 inches of the floor to allow the airflow to “sweep” the entire lowest part of the room, since CO<sub>2</sub> is heavier than air.

**5307.5.2 Emergency alarm system.** An emergency alarm system shall comply with all of the following:

1. Continuous gas detection shall be provided to monitor areas where carbon dioxide can accumulate.
2. The threshold for activation of an alarm shall not exceed 5,000 parts per million (9,000 mg/m<sup>3</sup>).
3. Activation of the emergency alarm system shall initiate a local alarm within the room or area in which the system is installed.

❖ As the second alternative provided by Section 5307.5, this section contains the requirements for an emergency alarm system consisting of continuous gas detection with CO<sub>2</sub> detectors of adequate number

and spacing to cover the protected area and a local alarm within the room where the CO<sub>2</sub> is stored. The emergency alarm trigger level of 5,000 parts per million (ppm) is the 8-hour time-weighted average (TWA) exposure limit for CO<sub>2</sub> established by the United States Department of Labor, Occupational Safety and Health Administration (OSHA) for CO<sub>2</sub>. This section also provides correlation with CGA-6.5 which, although not referenced in the code, is a national standard on the subject.

### SECTION 5308 COMPRESSED GASES NOT OTHERWISE REGULATED

**5308.1 General.** *Compressed gases* in storage or use not regulated by the material-specific provisions of Chapters 6, 54, 55 and 60 through 67, including asphyxiant, irritant and radioactive gases, shall comply with this section in addition to other requirements of this chapter.

❖ Statistics show that there are more deaths every year from the use of inert and asphyxiant gases than from toxic gases. The indoor storage or use of compressed gases falling into categories such as inert, asphyxiants, irritants and radioactive can be hazardous regardless of the type of gas involved simply due to the hazards related to asphyxiation. Sections 5301 through 5305 have been designed as generic provisions that apply to all compressed gases. Sections 5306 and 5307 are unique in that they establish additional requirements for specific uses. This section is intended to fill a void in the regulations of compressed gases by addressing compressed gases posing material hazards not otherwise regulated while not creating unnecessary additional material-specific chapters in the code. Note that this section requires that the storage and handling of cylinders containing the gases must comply with the remaining requirements of Chapter 53 because their contents are under positive pressure.

The question is often asked as to why the code does not include more comprehensive regulation of these “compressed gases not otherwise regulated.” Historically, the U.S. did not develop comprehensive hazardous materials regulations in the model building and fire codes until the mid-1980s. Prior to that time there were various regulations but they were not correlated, and more importantly, were not tied to a building’s occupancy classification, a material’s hazard classification or how the building was used. As a result, a task group was formed that worked on completely revising the legacy building and fire codes by creating comprehensive hazardous materials regulations.

Part of these early requirements included requirements for radioactive, asphyxiant and irritant gases. In recognition that some of these gases presented minimal risks, the codes reduced the requirements for irritant and asphyxiant gases. Later changes essentially

exempted radioactive gases since they are highly regulated in the U.S. at the state and federal level, and their requirements are driven by the isotope and its respective hazards.

At the time that the hazardous material regulations were being formulated, a number of fire code officials were concerned about a release of simple asphyxiant gases within a room in which they were being stored. Because simple asphyxiant gases are colorless and odorless, some fire code officials were concerned about the potential for a person walking into a room where a simple asphyxiant gas leak had occurred and becoming incapacitated due to an oxygen deficient atmosphere. To minimize this risk, Section 5308 was developed. And more recently, Section 5307 was created in response to several life-loss incidents involving asphyxiation by CO<sub>2</sub> in public assembly occupancies.

**5308.2 Ventilation.** Indoor storage and use areas and storage buildings shall be provided with mechanical exhaust ventilation or natural ventilation in accordance with the requirements of Section 5004.3 or 5005.1.9. Where mechanical ventilation is provided, the systems shall be operational during such time as the building or space is occupied

❖ The provisions of this section are limited to basic ventilation requirements when these materials are stored or used indoors. Section 5004.3 of the code provides the fundamental requirements for ventilation systems. The basic provisions allow natural ventilation to be used as a means to address the concern, and mechanical ventilation is not required when it can be shown that natural ventilation is adequate. By including basic provisions for ventilation for the specified material hazards, a reasonable level of safety for building occupants is maintained.

### Bibliography

The following resource was used in the preparation of the commentary for this chapter of the code:

*Code Changes Resource Collection—2015 International Fire Code.* Washington, DC: International Code Council, 2014.



# Chapter 54: Corrosive Materials

## General Comments

This chapter regulates the storage of corrosive materials, which pose unusual risks to fire fighters, emergency personnel and the general public when they are involved in a spill, fire or explosion.

Section 5401 establishes the scope of Chapter 54 and the quantities requiring a permit. This section also lists the exempt amounts per control area for corrosive materials to aid in establishing the appropriate occupancy group classification for the building.

Section 5402 provides the definition of “Corrosive,” which is derived from DOT 49 CFR, Part 173.

Section 5403 provides the requirements for structures used for the storage of corrosive materials. These requirements are applicable to storage in excess of the exempt amounts per control area.

Section 5404 provides the maintenance provisions for both indoor and outdoor storage conditions, regardless of quantities.

Section 5405 provides the requirements for both the indoor and outdoor use of corrosives, regardless of the quantities.

Corrosive materials may be found in solid, liquid or gaseous states, although the most frequently encountered corrosive materials are liquids and solids. They may be found in all types of occupancies, including research laboratories, hospitals, industrial facilities, warehouses and retail stores.

Corrosive materials may pose multiple hazards, such as radioactivity, toxicity, flammability or detonability. The focus of this chapter is on materials whose primary hazard is corrosivity; that is, the ability to destroy or irreparably damage living tissue on contact.

These regulations are intended to minimize the exposure of the public, fire fighters and other emergency responders to the harmful vapors, liquid matter or splashes resulting from fire or accidental releases. Advance knowledge of the materials in structures through the permit process and the submittal of Material Safety Data Sheets (MSDS) are essential for effective prefire planning by the fire department. NFPA 471 provides useful guidance for managing hazardous material incidents.

## Purpose

Chapter 54 addresses the hazards of corrosive materials that have a destructive effect on living tissues. Though corrosive gases exist, most corrosive materials are solid and classified as either acids or bases (alkalis). These materials may pose a wide range of hazards other than corrosivity, such as combustibility, reactivity or oxidizing hazards. This chapter, however, addresses the hazards associated with the storage of materials based on their corrosivity only. Materials posing multiple hazards must conform to the requirements of the code with respect to all their known hazards.

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## SECTION 5401 GENERAL

**5401.1 Scope.** The storage and use of *corrosive* materials shall be in accordance with this chapter. *Compressed gases* shall also comply with Chapter 53.

### Exceptions:

1. Display and storage in Group M and storage in Group S occupancies complying with Section 5003.11.
2. Stationary storage battery systems in accordance with Section 608.
3. This chapter shall not apply to R-717 (ammonia) where used as a refrigerant in a refrigeration system (see Section 606).

❖ Chapter 54 details specific requirements for the storage and use of corrosive materials. The requirements of this chapter are intended to complement the haz-

ardous materials general storage requirements of Chapter 50.

Exception 1 addresses mercantile displays to which this chapter is not applicable. Section 5003.11 addresses requirements for the storage of hazardous material in mercantile occupancies. Exceptions 2 and 3 state that stationary lead-acid battery systems and R-717 refrigerants are not addressed in this chapter.

**5401.2 Permits.** Permits shall be required as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit, Section 105.6.21 for discussion of specific operational permits for hazardous materials,

## CORROSIVE MATERIALS

Section 105.7 for a general discussion of activities requiring a construction permit and Section 105.7.10 for discussion of specific construction permits for hazardous materials. The permit process also notifies the fire department of the need for prefire planning for hazardous properties.

### SECTION 5402 DEFINITION

**5402.1 Definition.** The following term is defined in Chapter 2:

#### **CORROSIVE.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated term used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> (I-Code<sup>®</sup>) as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4).

### SECTION 5403 GENERAL REQUIREMENTS

**5403.1 Quantities not exceeding the maximum allowable quantity per control area.** The storage and use of *corrosive* materials in amounts not exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Sections 5001, 5003 and 5401.

❖ The stored quantities per control area are addressed in Section 5001 if the quantities do not exceed the amounts in Table 5003.1.1(2) or 5003.1.1(4). The tables address quantities posing a health hazard for control areas located indoors and outdoors.

**5403.2 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of *corrosive* materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with this chapter and Chapter 50.

❖ Tables 5003.1.1(2) and 5003.1.1(4) give the maximum allowable quantity per control area (MAQ). If the amounts exceed the allowable quantities, the occupancy classifications in Chapter 2 and this chapter must be used for requirements. Section 5003.1.4 states that compliance with Chapter 50 is also required.

### SECTION 5404 STORAGE

**5404.1 Indoor storage.** Indoor storage of *corrosive* materials in amounts exceeding the *maximum allowable quantity per*

*control area* indicated in Table 5003.1.1(2), shall be in accordance with Sections 5001, 5003 and 5004 and this chapter.

❖ Table 5003.1.1(2) gives the maximum quantities for an indoor storage control area. Section 5004 addresses the storage requirements of hazardous materials in the amounts that exceed the MAQ.

**5404.1.1 Liquid-tight floor.** In addition to the provisions of Section 5004.12, floors in storage areas for *corrosive* liquids shall be of liquid-tight construction.

❖ Section 5004.12 requires that floors of storage areas must be of noncombustible construction, except for surfacing. This section requires them to be liquid tight, as well.

**5404.2 Outdoor storage.** Outdoor storage of *corrosive* materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(4) shall be in accordance with Sections 5001, 5003 and 5004 and this chapter.

❖ Table 5003.1.1(4) gives the maximum quantities for an outdoor storage control area. Section 5004 addresses storage of hazardous materials in amounts that exceed the MAQ.

**5404.2.1 Above-ground outside storage tanks.** Above-ground outside storage tanks exceeding an aggregate quantity of 1,000 gallons (3785 L) of *corrosive* liquids shall be provided with secondary containment in accordance with Section 5004.2.2.

❖ In order to help confine a leak or spill from an outside above-ground storage tank containing corrosive liquids, secondary containment in accordance with Section 5004.2 must be provided. This section applies to all outside storage areas with an aggregate tank capacity in excess of 1,000 gallons (3785 L).

**5404.2.2 Distance from storage to exposures.** Outdoor storage of *corrosive* materials shall not be within 20 feet (6096 mm) of buildings not associated with the manufacturing or distribution of such materials, *lot lines*, public streets, public alleys, *public ways* or *means of egress*. A 2-hour *fire barrier* without openings or penetrations, and extending not less than 30 inches (762 mm) above and to the sides of the storage area, is allowed in lieu of such distance. The wall shall either be an independent structure, or the *exterior wall* of the building adjacent to the storage area.

❖ The required separation distances for corrosive materials are intended to reduce the hazard of radiant heat transfer from nearby exposures on or off the property. This section also recognizes that a 2-hour fire barrier constructed in accordance with Section 706 of the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>) will provide physical barrier protection as an alternative to the required separation distance. Note that the wall must be positioned to restrict the spread of fire around or over it.

## SECTION 5405 USE

**5405.1 Indoor use.** The indoor use of *corrosive* materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(2) shall be in accordance with Sections 5001, 5003 and 5005 and this chapter.

❖ Table 5003.1.1(2) gives the MAQ for use in either a closed system or an open system. Section 5005 addresses the use, dispensing and handling of hazardous materials in amounts that exceed the MAQ.

**5405.1.1 Liquid transfer.** *Corrosive* liquids shall be transferred in accordance with Section 5005.1.10.

❖ Section 5005.1.10 lists five methods that can be used for the transfer of corrosive liquids. These methods are for liquids having a hazard ranking of 3 or 4 in accordance with NFPA 704.

**5405.1.2 Ventilation.** Where *corrosive* materials are dispensed or used, mechanical exhaust ventilation in accordance with Section 5005.2.1.1 shall be provided.

❖ This section requires mechanical exhaust ventilation for all storage areas containing corrosive liquids with positive vapor pressures, which, if exposed under standard room temperature and atmospheric pressure, give off hazardous fumes and vapors. Adequate mechanical ventilation will reduce the chance for the accumulation of hazardous concentration levels of toxic fumes and vapors. Corrosive liquids without a positive vapor pressure do not readily give off vapors at hazardous concentration levels under normal conditions and, therefore, do not require mechanical exhaust ventilation.

**5405.2 Outdoor use.** The outdoor use of *corrosive* materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(4) shall be in accordance with Sections 5001, 5003 and 5005 and this chapter.

❖ Table 5003.1.1(4) gives the MAQ for an outdoor control area. Section 5005 addresses the use, dispensing and handling of hazardous materials in the amounts that exceed the MAQ.

**5405.2.1 Distance from use to exposures.** Outdoor use of *corrosive* materials shall be located in accordance with Section 5404.2.2.

❖ The required separation distances for corrosive materials are intended to reduce the hazard of radiant heat transfer to nearby structures or public areas. The distances also help protect the property in question from heat exposure from incidents on or off the property. The exception recognizes that a 2-hour fire separation wall will provide physical barrier protection as an alternative to the required separation distance.



# Chapter 55: Cryogenic Fluids

## General Comments

The code regulates the hazards associated with materials that are considered to be cryogenic fluids. These requirements are in addition to the other code requirements that address hazards such as flammability and toxicity. Cryogenics are hazardous because they are held at extremely low temperatures and high pressures. Many cryogenic fluids, however, are actually inert gases and would not be regulated elsewhere in the code.

Cryogenics pose several hazards to humans who come in close contact with them. The first is the potential for severe freeze burns and tissue damage that can result from direct contact with cryogenic liquids, uninsulated cryogenic pipes or uninsulated cryogenic equipment. Also, a jet of cryogen can freeze the skin or the eyes faster than liquid contact. Eyes are especially susceptible to cryogen exposure.

In addition to freeze hazards, cryogens pose an asphyxiation hazard because they rapidly boil and convert from a liquid to a gas. As will be discussed in the definitions, cryogens have extremely low boiling points. When converting from a liquid to a gas, there is a great deal of expansion that displaces breathable air. This hazard is compounded when the gases are also toxic or flammable.

There is also the potential for air surrounding a cryogen containment system to condense. This is especially the case when transferring liquid nitrogen through uninsulated metal pipes. Because nitrogen has a lower boiling point than oxygen, it will evaporate first and leave an

oxygen-enriched atmosphere, which has the potential of improving the conditions for combustion.

Finally, a release of cryogens at extremely low temperatures has the effect of making some materials such as rubber, carbon steel and plastic so brittle that failure of those materials can occur very easily. Materials like stainless steel, copper, brass and most alloys of aluminum must be used when handling cryogenic fluids.

The extreme low temperatures also have the tendency to create thermal stresses in badly designed cryogen containment systems. Uneven temperature distributions can create stress in some piping or related equipment.

The more common cryogens include helium, hydrogen, nitrogen, argon, oxygen and methane. Note that some of these gases are inert but, based on the specific concerns related to cryogens, are still a potential hazard. Cryogens are used for many applications but specifically have had widespread use in the biomedical field and in space programs.

## Purpose

Hazards created by cryogenic materials are sometimes compounded by additional hazard characteristics, such as flammability or toxicity. These other characteristics are dealt with in Chapter 50 and other chapters, such as Chapter 58 dealing with flammable gases. This chapter covers the storage, use and handling of cryogenic fluids through regulation of such things as pressure relief mechanisms and proper container storage.

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## SECTION 5501 GENERAL

**5501.1 Scope.** Storage, use and handling of *cryogenic fluids* shall comply with this chapter and NFPA 55. *Cryogenic fluids* classified as hazardous materials shall also comply with the general requirements of Chapter 50. Partially full containers containing residual *cryogenic fluids* shall be considered as full for the purposes of the controls required.

### Exceptions:

1. Fluids used as refrigerants in refrigeration systems (see Section 606).
2. Liquefied natural gas (LNG), which shall comply with NFPA 59A.

Oxidizing *cryogenic fluids*, including oxygen, shall comply with Chapter 63, as applicable.

Flammable *cryogenic fluids*, including hydrogen, methane and carbon monoxide, shall comply with Chapters 23 and 58, as applicable.

Inert *cryogenic fluids*, including argon, helium and nitrogen, shall comply with ANSI/CGA P-18.

❖ This section states that the chapter focuses on the hazards related to cryogenic fluids. If the materials are also classified as a hazardous material, additional requirements, as found in Chapter 50, must be reviewed as well.

Exception 1 is for cryogens used in refrigeration systems, which are specifically regulated in Section 606 of the code.

Exception 2 is for liquefied natural gas (LNG) since there are more specific and appropriate sections or standards that address those hazards, most notably NFPA 59A.

Following the exceptions are three requirements that reference three additional chapters of the code and an associated standard dealing with inert cryogenic fluids that must be adhered to in addition to complying with Chapter 55.

See also Appendix G for weight and volume equivalents of cryogenic fluids. It is important to note that the appendices are not considered part of the code unless specifically adopted (see Section 1 of the sample adopting ordinance on page xxi of the code book).

**5501.2 Permits.** Permits shall be required as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit, Section 105.6.11 for discussion of specific quantity-based operational permits for the materials regulated in this chapter and Section 105.7.4 for a discussion of activities involving cryogenic fluids requiring a construction permit. The permit process also notifies the fire department of the need for prefire planning for hazardous property.

## SECTION 5502 DEFINITIONS

**5502.1 Definitions.** The following terms are defined in Chapter 2.

**CRYOGENIC CONTAINER.**

**CRYOGENIC FLUID.**

**CRYOGENIC VESSEL.**

**FLAMMABLE CRYOGENIC FLUID.**

**LOW-PRESSURE TANK.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*® as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4).

## SECTION 5503 GENERAL REQUIREMENTS

**5503.1 Containers.** Containers employed for storage or use of *cryogenic fluids* shall comply with Sections 5503.1.1 through 5503.1.3.2 and Chapter 50.

❖ The focus of this section is the proper use of containers when storing, using or handling cryogenic fluids so that they can handle concerns such as pressures, thermal stresses and embrittlement. Chapter 50 would also apply in cases where issues are not specifically dealt with in Chapter 55.

**5503.1.1 Nonstandard containers.** Containers, equipment and devices that are not in compliance with recognized standards for design and construction shall be *approved* upon presentation of satisfactory evidence that they are designed and constructed for safe operation.

❖ Various standards are available for the construction of containers for use with cryogenic materials. In some cases, applications using cryogenics can facilitate the use of a uniquely designed container that does not meet the specifics of the available standards. This section allows such containers with proper technical justification; criteria are listed. Material properties of cryogenic fluids vary based on differences in the boiling point and critical point. For instance, a material with a lower boiling point would require colder temperatures and perhaps higher pressures; therefore, design calculations or test results must show that container designs can meet the specific pressure and temperature criteria for the cryogenic fluid to be stored.

**5503.1.1.1 Data submitted for approval.** The following data shall be submitted to the *fire code official* with reference to the deviation from the recognized standard with the application for approval.

1. Type and use of container, equipment or device.
2. Material to be stored, used or transported.
3. Description showing dimensions and materials used in construction.
4. Design pressure, maximum operating pressure and test pressure.
5. Type, size and setting of pressure relief devices.
6. Other data requested by the *fire code official*.

❖ This section lists approval criteria for nonstandard containers that are to be used with cryogenic fluids. Material properties of cryogenic fluids vary based on differences in the boiling point and critical point. For

instance, a material with a lower boiling point would require colder temperatures and perhaps higher pressures; therefore, design calculations or test results must show that container designs can meet the specific pressure and temperature criteria for the cryogenic fluid to be stored. Approval applications must include specific references to the portions of recognized standards from which they deviate.

**5503.1.2 Concrete containers.** Concrete containers shall be built in accordance with the *International Building Code*. Barrier materials and membranes used in connection with concrete, but not functioning structurally, shall be compatible with the materials contained.

❖ Because concrete containers are often built on site, this section requires that they be built in accordance with the *International Building Code*® (IBC®) and its requirements in Chapter 16 for structural strength and other related issues. Additionally, this section acknowledges the fact that any material in contact with cryogenics must be compatible. This will vary based on what cryogenic fluids are stored and the type of barrier materials chosen.

**5503.1.3 Foundations and supports.** Containers shall be provided with substantial concrete or masonry foundations, or structural steel supports on firm concrete or masonry foundations. Containers shall be supported to prevent the concentration of excessive loads on the supporting portion of the shell. Foundations for horizontal containers shall be constructed to accommodate expansion and contraction of the container. Foundations shall be provided to support the weight of vaporizers or heat exchangers.

❖ Critical to avoiding catastrophic failure of a container is the proper construction of the elements that support the container. The design must anticipate the equipment loads that may be used in conjunction with the container, such as vaporizers or heat exchangers. The foundations and supports need to be strong and firmly set in place by either placing the containers directly on a concrete or masonry foundation or on steel supports that are set into a concrete or masonry foundation.

**5503.1.3.1 Temperature effects.** Where container foundations or supports are subject to exposure to temperatures below -130°F (-90°C), the foundations or supports shall be constructed of materials to withstand the low-temperature effects of *cryogenic fluid* spillage.

❖ As was mentioned in the general comments at the beginning of this chapter, exposure to extremely low temperatures will cause some materials, such as carbon steel, to become brittle and lose structural strength. For this reason, any portion of a foundation or structural support for cryogenic fluid tanks that might be exposed to the fluid in case of a spill must be constructed of materials that will not be affected by the exposure. A cryogenic fluid is defined in Chapter 2 as having a boiling point lower than -130°F. The requirements of this section should apply at that temperature, otherwise the foundations or supports of those cryo-

genic fluid containers within the range not covered are at risk. This section also correlates with the provisions of NFPA 55.

**5503.1.3.2 Corrosion protection.** Portions of containers in contact with foundations or saddles shall be painted to protect against corrosion.

❖ Corrosion can occur for a number of reasons. Because tanks and their supports will probably be constructed of dissimilar materials, this can cause galvanic corrosion. Exposure to moisture can cause oxidation of metals, otherwise known as rust.

If the corrosion occurs in the metal skin of the tank, leakage of the cryogenic fluid could occur. If the corrosion is extensive, tank failure and spillage of pressurized tank contents could occur.

If the corrosion occurs in the saddle or other part of the supporting foundation structure, collapse of the structure could cause the tank to fall and rupture, resulting in spillage of the cryogenic fluid. If the cryogenic fluid is flammable, tank failure could lead to a fire or explosion.

Prevention of corrosion, therefore, is important. The most common way of protecting metal structures from corrosion is to paint them. This painting becomes even more important where dissimilar metals contact each other. This section specifies that the containers must be painted where they are in contact with foundation structures. Good maintenance practice suggests that both tanks and their supporting structures might benefit from painting.

**5503.2 Pressure relief devices.** Pressure relief devices shall be provided in accordance with Sections 5503.2.1 through 5503.2.7 to protect containers and systems containing *cryogenic fluids* from rupture in the event of overpressure. Pressure relief devices shall be designed in accordance with CGA S-1.1, CGA S-1.2 and CGA S-1.3.

❖ Pressure relief devices are essential for cryogenics because of the high pressures and low temperatures at which cryogenics are maintained. Although storage tanks, other containers and transfer piping are normally well insulated, some heating of the contents will occur over time, causing internal pressures to increase. Pressure relief mechanisms provide a method of relieving these overpressures and avoiding a hazardous situation. Three Compressed Gas Association (CGA) standards that cover the full range of container types, from portable to stationary, are referenced at the end of this section.

Sections 5503.2.1 through 5503.2.7 contain requirements related to accessibility for maintenance, general sizing, installation requirements and device integrity.

**5503.2.1 Containers.** Containers shall be provided with pressure relief devices.

❖ This section states very clearly that pressure relief devices are required for cryogenic containers. Section 5503.2.2 addresses associated equipment. Generally, the container is the main area of concern

because it is the primary storage vessel for cryogenics and has the largest potential for overpressurization.

**5503.2.2 Vessels or equipment other than containers.** Heat exchangers, vaporizers, insulation casings surrounding containers, vessels and coaxial piping systems in which liquefied *cryogenic fluids* could be trapped because of leakage from the primary container shall be provided with a pressure relief device.

❖ Just as Section 5503.2.1 requires pressure relief devices on the container itself, this section mentions other areas where overpressures occur if there is a leak in the primary container. This is a smaller hazard potential, but requirements make it more likely that all potential overpressures are addressed.

**5503.2.3 Sizing.** Pressure relief devices shall be sized in accordance with the specifications to which the container was fabricated. The relief device shall have sufficient capacity to prevent the maximum design pressure of the container or system from being exceeded.

❖ This section contains only general language that makes it likely that the pressure relief device is properly designed to fit the needs of the particular container. In most cases, the manufacturer will already have the devices installed on the container. There are cases, however, when a cryogenic system or container may be constructed for a specific purpose and user. In those cases, the relief valves must be sized and installed by the user.

**5503.2.4 Accessibility.** Pressure relief devices shall be located such that they are provided with ready access for inspection and repair.

❖ This section addresses the long-term reliability of pressure relief devices by making maintenance and repair more convenient through accessibility.

**5503.2.5 Arrangement.** Pressure relief devices shall be arranged to discharge unobstructed to the open air in such a manner as to prevent impingement of escaping gas on personnel, containers, equipment and adjacent structures or to enter enclosed spaces.

**Exception:** DOTn-specified containers with an internal volume of 2 cubic feet (0.057 m<sup>3</sup>) or less.

❖ Pressure relief devices must be located to direct vented vapors away from personnel, containers and structures as well as enclosed spaces to prevent personal injury and property damage. The arrangement will vary from one installation to another based on the use and location of the container and the system.

The exception for Department of Transportation (DOT) containers with an internal volume less than or equal to 2 cubic feet (0.057 m<sup>3</sup>) recognizes that the amount of vapor released from these containers is small enough to make this section impractical and unnecessary.

**5503.2.6 Shutoffs between pressure relief devices and containers.** Shutoff valves shall not be installed between pressure relief devices and containers.

**Exceptions:**

1. A shutoff valve is allowed on containers equipped with multiple pressure relief device installations where the arrangement of the valves provides the full required flow through the minimum number of required relief devices at all times.
2. A locking-type shutoff valve is allowed to be used upstream of the pressure relief device for service-related work performed by the supplier when in accordance with the requirements of the ASME *Boiler and Pressure Vessel Code*.

❖ This section prohibits shutoff valves from being installed between the pressure relief device and the container because the closing of a valve in that position would allow pressure in the tank to build without relief. Exception 1 covers containers designed with multiple pressure relief devices that can still handle the pressure relief even when a valve is shut off. Exception 2 is consistent with NFPA 55. The ASME *Boiler and Pressure Vessel Code* (BPVC) allows the use of a locking valve on the upstream side of a pressure relief device in instances where it is impractical to install multiple pressure relief devices and valves, or where having the multiple valves creates more potential safety hazards during maintenance work on the devices. The BPVC has detailed requirements for working on relief devices with the use of upstream valves, including the requirement to lock the valve open when not working on the valve and the requirement to lower pressure in the pressure vessel before maintenance. The BPVC also requires that personnel monitor vessel pressure during maintenance and have access to an alternate valve other than a pressure relief valve to relieve unexpected pressure rises during maintenance activities. Petrochemical plants and industrial gas plant personnel have used the procedures successfully for many years, as evidenced by the continued endorsement of the procedure in the BPVC.

**5503.2.7 Temperature limits.** Pressure relief devices shall not be subjected to *cryogenic fluid* temperatures except when operating.

❖ One concern related to the integrity of the relief valves is deterioration of the valves as a result of extended exposure to extremely low temperatures, which often have the tendency to make materials brittle and more susceptible to failure. This requirement ensures that pressure relief devices are not subject to these extreme temperatures. Instead, the materials can directly interact with the pressure relief valve only when the valve is operating.

**5503.3 Pressure relief vent piping.** Pressure relief vent-piping systems shall be constructed and arranged so as to remain

functional and direct the flow of gas to a safe location in accordance with Sections 5503.3.1 and 5503.3.2.

❖ Because of tank locations, piping must sometimes be used to extend the discharge location of the pressure relief vent. This section generally states that piping can be used along with the pressure relief device when needed for safety. The requirements that follow are similar to those found in the section on pressure relief devices.

**5503.3.1 Sizing.** Pressure relief device vent piping shall have a cross-sectional area not less than that of the pressure relief device vent opening and shall be arranged so as not to restrict the flow of escaping gas.

❖ Though somewhat obvious, this section points out in the most generic way the need for piping to have at least the same diameter as the pressure relief device itself, if not larger. This section also states that piping must be free of any bends or other features that could potentially restrict the flow of gases.

**5503.3.2 Arrangement.** Pressure relief device vent piping and drains in vent lines shall be arranged so that escaping gas will discharge unobstructed to the open air and not impinge on personnel, containers, equipment and adjacent structures or enter enclosed spaces. Pressure relief device vent lines shall be installed in such a manner to exclude or remove moisture and condensation and prevent malfunction of the pressure relief device because of freezing or ice accumulation.

❖ This section is similar to Section 5503.2.5 in that it requires the vent piping to be arranged so that the discharge itself does not cause additional damage simply because of its location. As discussed in Section 5503.2.5, cryogenic liquids can damage materials and pose asphyxiation and burn hazards to people in the surrounding areas.

This section also addresses the fact that moisture accumulated in piping has the potential to freeze and cause an obstruction that could interfere with the proper operation of the pressure relief device.

**5503.4 Marking.** Cryogenic containers and systems shall be marked in accordance with Sections 5503.4.1 through 5503.4.6.

❖ This section is important for the safe and effective use of cryogenics and is also a necessary tool for emergency response teams. The marking requirements apply to a variety of locations, from the area in which these materials are stored, to the marking of the piping and emergency shutoff valves.

**5503.4.1 Identification signs.** Visible hazard identification signs in accordance with NFPA 704 shall be provided at entrances to buildings or areas in which *cryogenic fluids* are stored, handled or used.

❖ This section refers to the placarding requirements in NFPA 704, which are an important tool for emergency response teams when entering a building or

room containing hazardous materials. This section requires all rooms and buildings containing cryogenic fluids, regardless of the amount, to be properly marked.

**5503.4.2 Identification of contents.** Stationary and portable containers shall be marked with the name of the gas contained. Stationary above-ground containers shall be placarded in accordance with Sections 5003.5 and 5003.6. Portable containers shall be identified in accordance with CGA C-7.

❖ Because different cryogens present different hazards, the contents of the container must be specifically identified. This section refers to other sections or standards that contain more detailed identification requirements.

**5503.4.3 Identification of containers.** Stationary containers shall be identified with the manufacturing specification and maximum allowable working pressure with a permanent nameplate. The nameplate shall be installed on the container in an accessible location. The nameplate shall be marked in accordance with the ASME *Boiler and Pressure Vessel Code* or DOTn 49 CFR Parts 100-185.

❖ This section establishes a requirement for the manufacturer of permanently installed tanks to label the tanks with a nameplate meeting the requirements of the ASME *Boiler and Pressure Vessel Code* (BPVC) or DOTn 49 CFR, Parts 100-185. The nameplate must be clearly visible to anyone entering the tank location. The manufacturer's specifications and maximum allowable tank working pressure must be included on the nameplate.

**5503.4.4 Identification of container connections.** Container inlet and outlet connections, liquid-level limit controls, valves and pressure gauges shall be identified in accordance with one of the following:

1. Marked with a permanent tag or label identifying the function.
2. Identified by a schematic drawing that portrays the function and designates whether connected to the vapor or liquid space of the container.

Where a schematic drawing is provided, it shall be attached to the container and maintained in a legible condition.

❖ Cryogens are often used as part of a system or process. Failure of parts of the system or process can be as hazardous as failure of the main container. Also, the better the components of a process or system are understood, the less likely a hazardous situation will be. This section requires that all components, including shutoff valves, gauges, inlet and outlet connections and others, be labeled or that a schematic drawing of the process or system be attached to the container. The labeling and drawings will help personnel responding to an emergency understand both what has gone wrong and how to most effectively handle the situation.

**5503.4.5 Identification of piping systems.** Piping systems shall be identified in accordance with ASME A13.1.

❖ Piping systems are to be labeled using the industry standard requirements found in ASME A13.1. This standard is specific to the identification of piping systems for all types of materials. Use of this standard results in consistency from one type of industrial process to another and again decreases the likelihood of large-scale failures.

**5503.4.6 Identification of emergency shutoff valves.** Emergency shutoff valves shall be identified and the location shall be clearly visible and indicated by means of a sign.

❖ Emergency valves can play the most important role during an emergency. For this reason, they must be clearly visible and identified using signs. This is particularly important because the emergency responders may not be as familiar with the facility as are the daily occupants.

**5503.5 Security.** Cryogenic containers and systems shall be secured against accidental dislodgement and against access by unauthorized personnel in accordance with Sections 5503.5.1 through 5503.5.4.

❖ The security measures stated in the four subsections that follow this general statement are intended to safeguard cryogenic containers and systems from both accidental and intentional damage. Entry of unauthorized personnel into a cryogenic storage or use area can result in personal injury as well as physical damage.

**5503.5.1 Security of areas.** Containers and systems shall be secured against unauthorized entry and safeguarded in an *approved* manner.

❖ This section addresses the restriction of access to the cryogenic containers and associated equipment. The requirements are generic because each facility has unique characteristics. The fire code official is responsible for reviewing and approving security plans.

**5503.5.2 Securing of containers.** Stationary containers shall be secured to foundations in accordance with the *International Building Code*. Portable containers subject to shifting or upset shall be secured. Nesting shall be an acceptable means of securing containers.

❖ This section focuses on the protection of containers from unintentional physical damage by increasing the integrity of the storage arrangement. Stationary containers are addressed through a reference to the IBC or requirements on foundations and similar support systems because they are permanent structures.

Portable containers are addressed only generally because container sizes and locations vary so widely; however, they must be secured to prevent falling due to contact, vibration or seismic activity. See the commentary to the definition of "Nesting" in Section 5502.1 and the commentary to Section 5503.5.3.

Those discussions can be just as useful for guidance in the safeguarding of cryogen containers as they are for compressed gases since the containers and hazards are similar. Fire code official approval is required for proposed security plans.

**5503.5.3 Securing of vaporizers.** Vaporizers, heat exchangers and similar equipment shall be anchored to a suitable foundation and its connecting piping shall be sufficiently flexible to provide for the effects of expansion and contraction due to temperature changes.

❖ The stability of vaporizers and other equipment can be as important as the containers themselves because they regulate the conditions of the fluids. Equipment must be anchored securely and protected from damage. Piping must be able to expand and contract with temperature changes either from the process itself or climatic conditions.

**5503.5.4 Physical protection.** Containers, piping, valves, pressure relief devices, regulating equipment and other appurtenances shall be protected against physical damage and tampering.

❖ The wording of this section is broad and general because the equipment involved can vary so widely. The intent of the section is to ensure that all associated equipment, components and piping are protected from impacts that are fairly likely to occur within a facility and also to reduce the chances for someone to tamper with the components. This could mean restricting access to certain critical areas of the system.

**5503.6 Electrical wiring and equipment.** Electrical wiring and equipment shall comply with NFPA 70 and Sections 5503.6.1 and 5503.6.2.

❖ This section addresses compliance with NFPA 70 requirements.

**5503.6.1 Location.** Containers and systems shall not be located where they could become part of an electrical circuit.

❖ Containers and systems accidentally becoming part of an electrical circuit simply because of where they are placed could overheat, which could lead to expansion of the fluids and overpressure situations.

**5503.6.2 Electrical grounding and bonding.** Containers and systems shall not be used for electrical grounding. Where electrical grounding and bonding is required, the system shall comply with NFPA 70. The grounding system shall be protected against corrosion, including corrosion caused by stray electric currents.

❖ Containers and systems should not be used to ground or bond because this may cause a rise in temperature, which, similar to being part of a circuit, may cause heating (see also Section 5503.6.1).

**5503.7 Service and repair.** Service, repair, modification or removal of valves, pressure relief devices or other container appurtenances shall comply with Sections 5503.7.1 and

5503.7.2 and the ASME *Boiler and Pressure Vessel Code*, Section VIII or DOTn 49 CFR Parts 100-185.

- ❖ To ensure that the initial reliability of the containers and systems is maintained, minimum requirements for the qualifications and procedures for repair are mandated. The general requirements in Sections 5503.7.1 and 5503.7.2 are supplemented by a reference to the ASME BPVC and DOT requirements.

**5503.7.1 Containers.** Containers that have been removed from service shall be handled in an *approved* manner.

- ❖ This section requires that containers out of service must be handled according to procedures previously approved by the authority having jurisdiction. These procedures have to be written to accommodate all types and uses of containers, including stationary and portable containers.

**5503.7.2 Systems.** Service and repair of systems shall be performed by trained personnel.

- ❖ This section gives the jurisdiction having authority the right to enforce training requirements that are consistent with the fluids being handled and the physical plant being operated.

**5503.8 Unauthorized use.** Containers shall not be used for any purpose other than to serve as a vessel for containing the product that it is designed to contain.

- ❖ To ensure that the container can actually handle the pressures and temperatures for which it was designed, containers are limited to the materials they were specifically designed to contain. This can be a material compatibility concern as well. A container designed to be compatible with one cryogenic fluid may not be compatible with other fluids.

**5503.9 Leaks, damage and corrosion.** Leaking, damaged or corroded containers shall be removed from service. Leaking, damaged or corroded systems shall be replaced, repaired or removed in accordance with Section 5503.7.

- ❖ This requirement states that faulty containers must be removed from service before a failure can occur. The section allows repair of the faulty container either before or after it is removed from service as well as the option for replacement.

**5503.10 Lighting.** Where required, lighting, including emergency lighting, shall be provided for fire appliances and operating facilities such as walkways, control valves and gates ancillary to stationary containers.

- ❖ This section gives the fire code official the authority to require lighting around essential features of the facility both for routine use and during emergency operations. This might include paths to such features. This requirement also allows the fire code official to ask for additional lighting that can be used as emergency lighting when it is appropriate. Typically, the phrase “where required” in other places within the code means that another section would enact the requirement. In this case, however, it appears that the intent is to provide authority to the fire code official to ask

for specific lighting to address emergency response in individual situations.

## SECTION 5504 STORAGE

**5504.1 General.** Storage of containers shall comply with this section.

- ❖ As with all the chapters associated with hazardous materials, there is a section specific to storage and one specific to use. This section covers storage aspects, which tend to be less hazardous than use. The requirements are split into indoor and outdoor storage locations. Whether cryogenics are indoors or outdoors will affect the number and type of safeguards required.

**5504.2 Indoor storage.** Indoor storage of containers shall be in accordance with Sections 5504.2.1 through 5504.2.2.3.

- ❖ The indoor storage requirements are divided into stationary and portable containers.

**5504.2.1 Stationary containers.** Stationary containers shall be installed in accordance with the provisions applicable to the type of fluid stored and this section.

- ❖ This section acknowledges that requirements will vary depending on the type of fluid being stored.

**5504.2.1.1 Containers.** Stationary containers shall comply with Section 5503.1.

- ❖ See the commentary to Section 5503.1.

**5504.2.1.2 Construction of indoor areas.** *Cryogenic fluids* in stationary containers stored indoors shall be located in buildings, rooms or areas constructed in accordance with the *International Building Code*.

- ❖ This section requires that indoor storage areas be constructed in accordance with the IBC. This addresses occupancy requirements in terms of maximum allowable quantities (MAQs) and other relevant issues. Again, note that all cryogenics do not necessarily have a characteristic that would classify them as hazardous in the context of MAQs.

**5504.2.1.3 Ventilation.** Storage areas for stationary containers shall be ventilated in accordance with the *International Mechanical Code*.

- ❖ Ventilation is more critical for indoor areas than for outdoor areas because the fluids cannot disperse and be removed as easily. This section refers to the *International Mechanical Code*<sup>®</sup> (IMC<sup>®</sup>) for the ventilation requirements. The IMC ventilation requirements in Section 502 are based on the use of the space. Chapter 50 also addresses ventilation requirements in Sections 5003.8 and 5005.2. These particular requirements apply only when the maximum allowable quantities have been exceeded. Further requirements for ventilation and treatment systems, in some cases, are found in the hazard-specific chapters of the code, such as Chapter 60, which addresses highly toxic and toxic materials.

**5504.2.2 Portable containers.** Indoor storage of portable containers shall comply with the provisions applicable to the type of fluid stored and Sections 5504.2.2.1 through 5504.2.2.3.

❖ This section is a reminder that storage requirements will vary with the fluid being stored.

**5504.2.2.1 Containers.** Portable containers shall comply with Section 5503.1.

❖ See the commentary to Section 5503.1.

**5504.2.2.2 Construction of indoor areas.** *Cryogenic fluids* in portable containers stored indoors shall be stored in buildings, rooms or areas constructed in accordance with the *International Building Code*.

❖ This section is the same as Section 5504.2.1.2 for stationary containers and requires compliance with the IBC for the construction of the building, which means the occupancy classification and related construction requirements must be considered. The use of cryogenics alone may not drive the need for a Group H occupancy. The additional hazard characteristics and amounts of fluids will drive those requirements.

**5504.2.2.3 Ventilation.** Storage areas shall be ventilated in accordance with the *International Mechanical Code*.

❖ These requirements are the same as those for stationary containers (see commentary, Section 5504.2.1.3).

**5504.3 Outdoor storage.** Outdoor storage of containers shall be in accordance with Sections 5504.3.1 through 5504.3.1.2.3.

❖ This section is specific to outdoor areas, which are generally less hazardous because the fluids can more easily disperse if released, thereby reducing the potential for harm to both people in the surrounding area and property. Outdoor storage areas are, however, more susceptible to damage from both weather and people. As with the indoor area section, the requirements are divided into portable and stationary containers.

**5504.3.1 Separation from hazardous conditions.** Cryogenic containers and systems in outdoor storage shall be separated from materials and conditions that pose exposure hazards to or from each other in accordance with Sections 5504.3.1.1 through 5504.3.1.1.5.

❖ This introductory statement emphasizes that cryogenic containers and systems, whether for storage or for use, must be separated from other materials and conditions that could pose a hazard to them or when they could be hazardous to other materials. The two subsections that follow address stationary containers and portable containers.

**5504.3.1.1 Stationary containers.** Stationary containers shall be separated from exposure hazards in accordance with

the provisions applicable to the type of fluid contained and the minimum separation distances indicated in Table 5504.3.1.1.

❖ This section refers to Table 5504.3.1.1 and also notes that there may be other separation requirements associated with the fluids that may increase this distance. For example, Table 5804.2.1 for flammable gases has more restrictive distance requirements in certain cases. This table states that the minimum distance to buildings for 0 to 4,225 cubic feet (0 to 120 m<sup>3</sup>) of flammable gases is 5 feet (1524 mm), whereas Table 5504.3.1.1 requires only a 1-foot (305 mm) separation.

**TABLE 5504.3.1.1  
SEPARATION OF STATIONARY CONTAINERS FROM  
EXPOSURE HAZARDS**

EXPOSURE	MINIMUM DISTANCE (feet)
Buildings, regardless of construction type	1
Building exits	10
Wall openings	1
Air intakes	10
Lot lines	5
Places of public assembly	50
Nonambulatory patient areas	50
Combustible materials such as paper, leaves, weeds, dry grass or debris	15
Other hazardous materials	In accordance with Chapter 50

For SI: 1 foot = 304.8 mm.

❖ This table has several different separation distance criteria for stationary containers. Generally, the distances are larger when exposure to people is involved, such as places of public assembly and areas where nonambulatory patients are housed. These restrictions are related more to the hazards associated with their low temperatures, high pressures and asphyxiation hazards than they are to flammability or toxicity, which are dealt with in other chapters. Depending on these additional characteristics, larger distances to buildings and lot lines are sometimes required. Also, the restrictions in Table 5504.3.1.1 of the code are for any amounts of cryogens where the requirements for other hazards typically vary based on the volume of gas.

**5504.3.1.1.1 Point-of-fill connections.** Remote transfer points and fill connection points shall not be positioned closer to exposures than the minimum distances required for stationary containers.

❖ Because there is a potential for a large release of cryogens from faulty connections, the same separation requirements found in Table 5504.3.1.1 would apply to the point-of-fill connection.

**5504.3.1.1.2 Surfaces beneath containers.** Containers shall be placed on surfaces that are compatible with the fluid in the container.

❖ To ensure that a reaction does not occur with the surface below the container in the event of a cryogen spill, the surface beneath the container and its point of fill must be compatible with the fluid stored. The surface below the container must never be made of materials that may become brittle when exposed to extremely low temperatures or be corroded by the stored fluid. Either embrittlement or corrosion could weaken the supporting structure and affect the stability of the container.

**5504.3.1.1.3 Location.** Containers of *cryogenic fluids* shall not be located within diked areas containing other hazardous materials.

❖ Cryogenic fluids cannot share diked areas with other hazardous materials because of the risk that one type of hazardous material could create an exposure hazard for the other. Cryogenics, if released, will be at very low temperatures and high pressures that could potentially compromise the integrity of the other containers and tanks.

**5504.3.1.1.4 Areas subject to flooding.** Stationary containers located in areas subject to flooding shall be securely anchored or elevated to prevent the containers from separating from foundations or supports.

❖ Because stationary containers are considered permanent, issues such as flooding and the effect that flooding will have on the stability of the container are important. Flooding has the tendency to cause containers to pull away from their foundations because of their potential buoyancy. This section requires that the container either be anchored or elevated; if elevated, containers must be elevated to or above the elevation requirements of the IBC. Flood hazard areas are defined in IBC Section 202.

**5504.3.1.1.5 Drainage.** The area surrounding stationary containers shall be provided with a means to prevent accidental discharge of fluids from endangering personnel, containers, equipment and adjacent structures or to enter enclosed spaces. The stationary container shall not be placed where spilled or discharged fluids will be retained around the container.

**Exception:** These provisions shall not apply where it is determined by the *fire code official* that the container does not constitute a hazard, after consideration of special features such as crushed rock utilized as a heat sink, topographical conditions, nature of occupancy, proximity to structures on the same or adjacent property, and the capacity and construction of containers and character of fluids to be stored.

❖ This section deals with both exposure hazards and the need to avoid a buildup of spilled fluids. People and property must be protected from the exposure hazards of the initial spill. How this is to be done is

not specified because the needs for installation vary considerably.

In terms of the drainage, if the fluids are released, they cannot be held in the immediate vicinity of the container; therefore, diking may be a practical method of containment, but the impounded spill would have to be diverted away from the container once it has been released.

There is an exception for areas where the exposure hazards are very low, such as a container in a very remote location. Several factors need to be addressed before such allowances can be given. In some cases, a smaller container may be able to take advantage of this exception whereas a larger container may not, based on the potential size of the discharge.

**5504.3.1.2 Outdoor storage of portable containers.** Outdoor storage of portable containers shall comply with Section 5503 and Sections 5504.3.1.2.1 through 5504.3.1.2.3.

❖ Portable containers are typically smaller than stationary containers; therefore, the requirements are less detailed and are generally less substantial.

**5504.3.1.2.1 Exposure hazard separation.** Portable containers in outdoor storage shall be separated from exposure hazards in accordance with Table 5504.3.1.2.1.

❖ Concerns with portable containers are similar to those with stationary containers because of low temperatures and high pressures. This section refers to Table 5504.3.1.2.1 for the required separation distances.

**TABLE 5504.3.1.2.1  
SEPARATION OF PORTABLE  
CONTAINERS FROM EXPOSURE HAZARDS**

EXPOSURE	MINIMUM DISTANCE (feet)
Building exits	10
Wall openings	1
Air intakes	10
Lot lines	5
Combustible materials such as paper, leaves, weeds, dry grass or debris	15
Other hazardous materials	In accordance with Chapter 50

For SI: 1 foot = 304.8 mm.

❖ Because portable tanks are generally much smaller than stationary containers and are more easily moved, the separation distances do not address areas of assembly or buildings housing nonambulatory patients. Instead, the focus is on exits and areas where portable tanks are more likely to cause an immediate threat. For those locations that correlate with Table 5504.3.1.1 of the code, the distances are the same. For instance, the distance to wall openings must be at least 1 foot (305 mm) for both stationary and portable containers. Again, these separation

requirements are for all amounts of cryogenics stored in portable containers. Concerns over flammability or toxicity are covered in other chapters.

**5504.3.1.2.2 Surfaces beneath containers.** The surface of the area on which stationary containers are placed, including the surface of the area located below the point where connections are made for the purpose of filling such containers, shall be compatible with the fluid in the container.

❖ This section is identical in intent to Section 5504.3.1.1.2; however, because portable containers are not permanently attached to foundations or similar supports, they can be moved to various locations with different surfaces. Personnel responsible for handling and placing the portable containers must be educated and trained on the interaction of cryogenics with certain materials.

**5504.3.1.2.3 Drainage.** The area surrounding portable containers shall be provided with a means to prevent accidental discharge of fluids from endangering adjacent containers, buildings, equipment or adjoining property.

**Exception:** These provisions shall not apply where it is determined by the *fire code official* that the container does not constitute a hazard.

❖ This section requires placement of the containers where they will not further endanger buildings and other exposures if a spill occurs. If impounding is used to contain a spill, the spilled fluid must be diverted to a location where it would not cause personal injury or property damage. This requirement is in addition to the distances specified in Section 5504.3.1. As in Section 5504.3.1.1.5, there is an exception that allows the fire code official to review container locations and evaluate the potential hazard of a spill. If the arrangement of the container does not create a hazard, compliance with this section is not necessary. A good example is a well-isolated storage area.

## SECTION 5505 USE AND HANDLING

**5505.1 General.** Use and handling of *cryogenic fluid* containers and systems shall comply with Sections 5505.1.1 through 5505.5.2.

❖ These provisions are not quantity-specific but apply generally any time cryogenics are being used or handled. This section addresses system components and the integrity of the components. The container itself is addressed primarily in Section 5504.

**5505.1.1 Cryogenic fluid systems.** *Cryogenic fluid* systems shall be suitable for the use intended and designed by persons competent in such design. Equipment, machinery and processes shall be *listed* or *approved*.

❖ This section contains general requirements for the design of systems, including the requirement for the competency of the designer. Because the use of

cryogenics is varied, a single listed system is not available. There is, however, a requirement that all components of the system either be listed or specifically approved.

The nature of the listing should be understood because it may be unrelated to the performance of the system. Use of listed parts and components alone does not guarantee that a system as a whole operates as intended.

**5505.1.2 Piping systems.** Piping, tubing, valves and joints and fittings conveying *cryogenic fluids* shall be installed in accordance with the material-specific provisions of Section 5501.1 and Sections 5505.1.2.1 through 5505.1.2.6.

❖ See the commentary to Section 5501.1 and for the subsections that follow.

**5505.1.2.1 Design and construction.** Piping systems shall be suitable for the use intended through the full range of pressure and temperature to which they will be subjected. Piping systems shall be designed and constructed to provide adequate allowance for expansion, contraction, vibration, settlement and fire exposure.

❖ This section sets out the basic elements that need to be addressed in an acceptable design, including temperature and pressures and the type of events or climatic exposures that the system must withstand. A competent designer must show that all of these elements have been satisfied.

**5505.1.2.2 Joints.** Joints on container piping and tubing shall be threaded, welded, silver brazed or flanged.

❖ This section lists the acceptable types of joints allowed with cryogenic fluids. Joints represent potential weak points in a system if they are not properly designed and constructed. Friction joints would not be allowed. A high level of reliability is needed from joints to decrease the likelihood of joint failure.

**5505.1.2.3 Valves and accessory equipment.** Valves and accessory equipment shall be suitable for the intended use at the temperatures of the application and shall be designed and constructed to withstand the maximum pressure at the minimum temperature to which they will be subjected.

❖ This section sets the basic criterion for approval, which requires valves and any accessory equipment to be able to withstand the minimum temperature at the highest operating pressure. This will ensure that the valves can withstand the most critical forces to which they may be subject during normal operation.

**5505.1.2.3.1 Shutoff valves on containers.** Shutoff valves shall be provided on all container connections except for pressure relief devices. Shutoff valves shall be provided with access thereto and located as close as practical to the container.

❖ This section requires shutoff valves on all container connections. This allows isolation of the container to prevent a large release. It is critical that shutoff valves not be placed on pressure relief devices.

**5505.1.2.3.2 Shutoff valves on piping.** Shutoff valves shall be installed in piping containing *cryogenic fluids* where needed to limit the volume of liquid discharged in the event of piping or equipment failure. Pressure relief valves shall be installed where liquid is capable of being trapped between shutoff-valves in the piping system (see Section 5503.2).

❖ Further shutoff valves are required at strategic locations within the piping systems where a large release may be possible. The containers themselves must have shutoff valves in accordance with Section 5505.1.2.3.1. This section is quite general. Because piping systems vary so much, there is no single solution based on either use or process layouts. There is an additional requirement for pressure relief devices to be installed where shutoff of the flow could potentially cause a buildup of pressure between the source and the shutoff valve.

**5505.1.2.4 Physical protection and support.** Piping systems shall be supported and protected from physical damage. Piping passing through walls shall be protected from mechanical damage.

❖ This is a general section that requires a level of protection from physical and other damage when piping is either exposed or passes through elements, such as walls and floors, that are subject to movement. These requirements, along with the others, are intended to increase the reliability of the piping and associated processes.

**5505.1.2.5 Corrosion protection.** Above-ground piping that is subject to corrosion because of exposure to corrosive atmospheres, shall be constructed of materials to resist the corrosive environment or otherwise protected against corrosion. Below-ground piping shall be protected against corrosion.

❖ Another possible mode of failure is the weakening of the piping system caused by corrosion. The extent of corrosion protection required will depend on the piping material used, the particular climate or, in the case of the underground installations, the soil condition and content of the soil. In some areas, this may be a significant problem whereas in others it may not. Corrosion-resistant construction materials are the preferred means of compliance with this section.

**5505.1.2.6 Testing.** Piping systems shall be tested and proven free of leaks after installation as required by the standards to which they were designed and constructed. Test pressures shall be not less than 150 percent of the maximum allowable working pressure where hydraulic testing is conducted or 110 percent where testing is conducted pneumatically.

❖ To increase the reliability of the system to work as designed without the occurrence of leaks or other more substantial failures, proof testing of the piping is required. This section sets the testing criteria for either a hydraulic test or a pneumatic test.

**5505.2 Indoor use.** Indoor use of *cryogenic fluids* shall comply with the material-specific provisions of Section 5501.1.

❖ The code does not provide detail on the specifics of indoor use. That is contained in the standards listed in Section 5501.1, principally NFPA 55.

**5505.3 Outdoor use.** Outdoor use of *cryogenic fluids* shall comply with the material specific provisions of Sections 5501.1, 5505.3.1 and 5505.3.2.

❖ This section refers back to the standards, principally NFPA 55, in Section 5501.1 for specific details on the use of cryogenes, and emphasizes the separation requirements and placement of necessary shutoff valves.

**5505.3.1 Separation.** Distances from lot lines, buildings and exposure hazards shall comply with Section 5504.3 and the material-specific provisions of Section 5501.1.

❖ Because use is more hazardous than storage, the basic separation requirements found in Tables 5504.3.1.1 and 5504.3.1.2.1 would apply in addition to any of the restrictions found in the referenced standards in Section 5501.1.

**5505.3.2 Emergency shutoff valves.** Manual or automatic emergency shutoff valves shall be provided to shut off the *cryogenic fluid* supply in case of emergency. An emergency shutoff valve shall be located at the source of supply and at the point where the system enters the building.

❖ This section establishes the requirement for emergency shutoff valves to be provided and be readily available during an emergency to either on-site personnel or the local emergency response personnel. Essentially, the ability must exist to both shut down the supply of cryogenes and also to shut off the supply at the location where it enters the building. Pressure relief devices may be necessary where liquid could be trapped between the source and the emergency shutoff valve at the entrance to the building (see also the commentary to the definitions of “Emergency shutoff valve,” “Emergency shutoff valve, manual” and “Emergency shutoff valve, automatic” in Section 202 and to Section 5505.1.2.3.2 for further information).

**5505.4 Filling and dispensing.** Filling and dispensing of *cryogenic fluids* shall comply with Sections 5505.4.1 through 5505.4.3.

❖ Filling and dispensing is an activity that could result in fluid release because of the connections and disconnections involved with such processes. This section addresses the location and construction of dispensing areas, the approval of loading and unloading activities and controls on the amount of fluids dispensed into stationary tanks. All of these requirements focus on preventing an unwanted fluid release and possible physical damage or personal injury.

**5505.4.1 Dispensing areas.** Dispensing of *cryogenic fluids* with physical or *health hazards* shall be conducted in *approved* locations. Dispensing indoors shall be conducted in areas constructed in accordance with the *International Building Code*.

❖ This section focuses on dispensing of fluids with a physical or health hazard rating, such as flammability or toxicity. This section also refers back to the IBC for construction requirements, primarily for the determination of whether a Group H occupancy would be required. This specifically relates to whether the MAQs of hazardous materials have been exceeded.

**5505.4.1.1 Ventilation.** Indoor areas where *cryogenic fluids* are dispensed shall be ventilated in accordance with the requirements of the *International Mechanical Code* in a manner that captures any vapor at the point of generation.

**Exception:** *Cryogenic fluids* that can be demonstrated not to create harmful vapors.

❖ In addition to the basic ventilation requirements for the indoor storage of cryogens, this section requires that vapors be captured at the source; therefore, special ventilation would be required at the point of fill for the dispensing operation. These ventilation requirements appear to be for normal operation rather than emergency operation.

There is an exception if the amount and type of gas would not be sufficient enough to create a hazardous situation.

**5505.4.1.2 Piping systems.** Piping systems utilized for filling or dispensing of *cryogenic fluids* shall be designed and constructed in accordance with Section 5505.1.2.

❖ This is simply a reference back to Section 5505.1.2 for the general piping requirements to ensure correct design and construction (see commentary, Section 5505.1.2).

**5505.4.2 Vehicle loading and unloading areas.** Loading or unloading areas shall be conducted in an *approved* manner in accordance with the standards referenced in Section 5501.1.

❖ Generally, loading, unloading, dispensing and filling operations have a high potential for creating a hazardous situation if not properly conducted. This section ensures that the areas are constructed and operated as required by approved standards.

**5505.4.3 Limit controls.** Limit controls shall be provided to prevent overfilling of stationary containers during filling operations.

❖ This is a mechanism to prevent a release of fluids caused by an overflow.

**5505.5 Handling.** Handling of cryogenic containers shall comply with Sections 5505.5.1 and 5505.5.2.

❖ This section is focused on portable containers and the prevention of a fluid release.

**5505.5.1 Carts and trucks.** Cryogenic containers shall be moved using an *approved* method. Where cryogenic containers are moved by hand cart, hand truck or other mobile

device, such carts, trucks or devices shall be designed for the secure movement of the container.

Carts and trucks used to transport cryogenic containers shall be designed to provide a stable base for the commodities to be transported and shall have a means of restraining containers to prevent accidental dislodgement.

❖ This section does not specify a particular handling method, but gives the fire code official the authority to determine whether the method chosen by the facility is acceptable. If carts, hand trucks or other similar methods are chosen, they must be able to transport the containers safely and securely. This includes restraining containers while they are being moved.

**5505.5.2 Closed containers.** Pressurized containers shall be transported in a closed condition. Containers designed for use at atmospheric conditions shall be transported with appropriate loose-fitting covers in place to prevent spillage.

❖ This section recognizes that containers designed to hold pressure can be moved safely if they are properly closed. Containers designed for use at normal atmospheric pressure need only have an appropriate cover to ensure that fluid does not escape.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

*Code Changes Resource Collection—2015 International Fire Code.* Washington, DC: International Code Council, 2014.

*Fire Protection Handbook,* 20th ed. Quincy, MA: National Fire Protection Association, 2008.

# Chapter 56: Explosives and Fireworks

## General Comments

The safe handling of explosives in transportation, storage and use requires preventing ignitions and reducing the hazard to exposures. These exposures include people who may be harmed and property that may be damaged by an accidental detonation and other circumstances involving accidental or malicious detonation of the explosive materials. All requirements applicable to explosives are based on these principles. To apply the requirements of this chapter, the fire code official must recognize conditions that are liable to cause ignition or create exposures.

To varying degrees, all explosives, ammunition and blasting agents are susceptible to ignition from heat, sparks and, in certain cases, shock or pressure. Explosives are considered the most susceptible to ignition from these stimuli and may detonate when exposed to any of them, even under controlled conditions. Blasting agents are generally more stable and less susceptible to detonation, but such agents may become sensitized or unstable when exposed to heat or contaminated by certain organic materials. Sources of ignition include: sparks from tools, friction, static electricity, electrical devices, hot surfaces, open flames and open-flame devices, smoking materials, chemical reactions, electric currents, pressure and shock from explosions or impact.

Exposure protection involves protecting people, buildings and public rights-of-way from detonations, and protecting explosives, ammunition and blasting agents from fires or explosions occurring outside the magazine or blasting area. Such protection also includes security—protecting the magazine or blasting area from entry by unauthorized personnel. Two techniques—separation distance requirements and security precautions—are used to reduce exposure hazards.

An excellent discussion of the origin and rationale behind the separation distances specified in Table 5604.5.2(1) is presented in Appendix C of NFPA 495. Required magazine construction features include: weather resistance, bullet resistance, spark resistance, fire resistance, theft resistance and ventilation to prevent excessive heating or dampening of explosives.

Regulation of explosives is a complex enforcement issue. Local fire code officials must understand that many state and federal agencies have concurrent jurisdiction over the manufacture, transportation, storage, sale, handling and use of explosive materials. The U.S. Department of Justice, which oversees the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) division, is the federal agency responsible (see 18 USC, Chapter 40) for regulating the manufacture, sale, distribution and storage of explosives. In addition to enforc-

ing explosives laws and regulations, ATF investigates incidents of theft or misuse of explosives and has extensive resources for investigating bombings and incendiary acts. Recently, ATF's inspection of explosives manufacturing plants has been credited with improving industry safety.

Many states, especially where mining is an important industry, also regulate explosives. States often pick up where federal authority ends, especially in the areas of blasting and siting of explosive material facilities.

Fireworks regulation is one of the most controversial and hotly debated topics in American fire protection. The National Fire Protection Association (NFPA) and U.S. Consumer Product Safety Commission (CPSC) have called for stricter rules to govern the sale and use of common fireworks and trick and novelty items. To understand the tenor of the debate, it is helpful to appreciate the scope of the problem and look back at the origins of this chapter and other standards that were drafted in response to fireworks misuse and injuries.

According to statistics quoted by NFPA and gathered by the CPSC, more than 10,000 citizens are injured each year by the misuse of common and illegally manufactured fireworks. These injuries result in millions of dollars in medical and legal expenses, and untold suffering. The injuries include burns and the loss of fingers, limbs, vision or hearing; most injuries leave permanent scarring. The overwhelming majority of persons injured are younger than 20 years old. Public displays of fireworks have also resulted in several serious accidents. Many of these accidents have involved local fire departments and untrained operators performing public fireworks displays.

Parts of Chapter 56 had their origin in former NFPA 1121L, Model Fireworks Law, which was first published in 1938. According to NFPA, this is the most widely adopted fireworks regulation in the United States. Many states have enacted this model as part of state law and prohibit all fireworks except toy paper or plastic caps and authorized public displays. Other states have adopted modified versions that prohibit all but trick and novelty items, toy paper or plastic caps and permitted public displays. The NFPA Standards Council withdrew NFPA 1121L as an NFPA standard and in 1988 transferred control of the document to the Fire Marshal's Association of North America (FMANA) [now the International Fire Marshals Association (IFMA)], a membership section of NFPA. Copies of the document may be obtained from IFMA or from various internet sources.

This chapter requires the display of fireworks to comply with NFPA 1123. The standard includes criteria for the firing and on-site storage of fireworks, display site location, fallout area and operator qualifications. This

chapter also references NFPA 1124 for the regulation of fireworks manufacture and storage of fireworks at manufacturing plants. Federal regulations also provide useful guidance.

### Purpose

Chapter 56 prescribes minimum requirements for the safe manufacture, storage, handling and use of explosives, ammunition and blasting agents for commercial and industrial occupancies. These provisions are

intended to protect the general public, emergency responders and individuals who handle explosives.

This chapter regulates the manufacturing, retail sale, display and wholesale distribution of fireworks, establishing the requirements for obtaining approval to manufacture, store, sell, discharge or conduct a public display, and references national standards for regulations governing manufacture, storage and public displays.

## SECTION 5601 GENERAL

**5601.1 Scope.** The provisions of this chapter shall govern the possession, manufacture, storage, handling, sale and use of *explosives, explosive materials*, fireworks and small arms ammunition.

### Exceptions:

1. The Armed Forces of the United States, Coast Guard or National Guard.
  2. *Explosives* in forms prescribed by the official United States Pharmacopoeia.
  3. The possession, storage and use of small arms ammunition where packaged in accordance with DOTn packaging requirements.
  4. The possession, storage and use of not more than 1 pound (0.454 kg) of commercially manufactured sporting black powder, 20 pounds (9 kg) of smokeless powder and 10,000 small arms primers for hand loading of small arms ammunition for personal consumption.
  5. The use of *explosive materials* by federal, state and local regulatory, law enforcement and fire agencies acting in their official capacities.
  6. Special industrial *explosive* devices that in the aggregate contain less than 50 pounds (23 kg) of *explosive materials*.
  7. The possession, storage and use of blank industrial-power load cartridges where packaged in accordance with DOTn packaging regulations.
  8. Transportation in accordance with DOTn 49 CFR Parts 100–185.
  9. Items preempted by federal regulations.
- ❖ This chapter contains specific requirements for the manufacture, transportation, handling, storage and use of explosives, ammunition and blasting agents by nonmilitary and nongovernmental agencies and individuals.
- Exceptions in this section detail situations in which compliance with the requirements of this chapter is not required. Generally, these situations are governed by more stringent federal requirements or

another chapter of the code or they may represent a low hazard.

Exception 1 recognizes that the U.S. military promulgates its own regulations governing the manufacture and storage of explosives, ammunition and blasting agents. These regulations are similar to those that apply to civilian explosives with a few exceptions for identifying and marking them in transportation and storage.

An example of Exception 2 is nitroglycerin in tablet and transdermal patch form used for the treatment of angina pectoris and other pharmaceuticals containing explosive materials which are not dangerous in the form dispensed and thus are exempt from these requirements.

Exception 4 exempts small amounts of materials for making small arms ammunition for personal use based on the limited potential hazard due to the quantity.

Exception 5 is a limited exception that exempts certain federal, state and local agencies from the application of Article 56 when using explosive materials while acting in the course of their official capacities. All other applicable provisions contained in the chapter would apply, i.e., possession, storage and handling regulations.

Exception 6 exempts from the provisions of this chapter special industrial explosive devices in an aggregate quantity of 50 pounds of explosive materials. See the commentary to Chapter 2 definitions of “Special industrial explosive device” and “Explosive material.”

Exception 7 exempts from the provisions of this chapter the possession, storage, and use of blank industrial power load cartridges. Sometimes called propellant-actuated power devices, these articles include devices such as rivets, nail guns, bolt or stud drivers, punches and cutting tools which use explosive cartridges to perform their function. Devices employing explosive mixtures to produce a flame or jet for cutting, propelling or directing work would not be included.

Exceptions 8 and 9 recognize that adequate regulations may already exist at the federal level for certain materials.

**5601.1.1 Explosive material standard.** In addition to the requirements of this chapter, NFPA 495 shall govern the manufacture, transportation, storage, sale, handling and use of *explosive* materials.

❖ The requirements in NFPA 495 apply to situations not specifically addressed by this chapter.

**5601.1.2 Explosive material terminals.** In addition to the requirements of this chapter, the operation of *explosive material* terminals shall conform to the provisions of NFPA 498.

❖ The requirements of NFPA 498 apply to situations not specifically addressed by this chapter.

**5601.1.3 Fireworks.** The possession, manufacture, storage, sale, handling and use of fireworks are prohibited.

**Exceptions:**

1. Storage and handling of fireworks as allowed in Section 5604.
2. Manufacture, assembly and testing of fireworks as allowed in Section 5605.
3. The use of fireworks for fireworks displays as allowed in Section 5608.
4. The possession, storage, sale, handling and use of specific types of Division 1.4G fireworks where allowed by applicable laws, ordinances and regulations, provided such fireworks and facilities comply with NFPA 1124, CPSC 16 CFR Parts 1500 and 1507, and DOTn 49 CFR Parts 100–185, for consumer fireworks.

❖ The possession, manufacture, storage, sale and unauthorized use of fireworks are prohibited by this section. The prohibition of retail sales allows communities to have direct control over the hazards associated with small amounts of storage typical of retail sales. Exception 1 allows storage and handling of fireworks within the limitations of Section 5604. Exception 2 allows the manufacture, assembly and testing of fireworks within the limitations of Section 5605. Exception 3 allows those displays to be specifically approved by the fire code official in accordance with Section 5608.

Exception 4 recognizes that, in some instances, the possession, storage, sale, handling and use of certain types of fireworks may be allowed by provisions of the preemptive laws of superior jurisdictions, most typically the state. Even if such laws preempt the local jurisdiction, the exception stipulates that the fireworks and the facilities allowed by such laws must still meet the minimum requirements of the referenced standards. The scope of NFPA 1124 includes important criteria related to construction, allowable area, egress and protection which is not identified in CPSC 16 CFR, Parts 1500 and 1507, or DOTn 49 CFR, Parts 100–185 for facilities for the storage, handling and sale of consumer fireworks. See also Section 5609.1.

**5601.1.4 Rocketry.** The storage, handling and use of model and high-power rockets shall comply with the requirements of NFPA 1122, NFPA 1125 and NFPA 1127.

❖ NFPA 1122 contains instructional guidelines and specific standards for the design, construction, limitation of charge and power, and reliability of rocket motors manufactured for sale to the general public; for the design and construction of rockets propelled by these motors; and for tests, launchings and other operations involving such rockets in order to minimize hazards. NFPA 1125 applies to the manufacture of model rocket motors designed, sold and used for the purpose of propelling recoverable aero models. NFPA 1127 contains instructional guidelines and specific standards for the design, construction, limitation of charge and power and reliability of high-power rocket motors manufactured for sale to users; for the qualification and certification of users; for the design and construction of high-power rockets propelled by these motors; and for tests, launchings and other operations involving rockets so that hazards are minimized.

**5601.1.5 Ammonium nitrate.** The storage and handling of ammonium nitrate shall comply with the requirements of NFPA 400 and Chapter 63.

**Exception:** Storage of ammonium nitrate in magazines with blasting agents shall comply with the requirements of NFPA 495.

❖ NFPA 400 addresses storage and Chapter 63 addresses oxidizers and separation distances for ammonium nitrate. Ammonium nitrate can be sensitized by both heat and contaminants, causing it to become a greater explosive danger (commercial blasting agents are made from a mixture of diesel oil and ammonium nitrate).

It cannot be determined when or if contamination will occur. No matter how many times it has failed to explode in fires, the important point is that ammonium nitrate might explode and has the potential to explode in any fire.

**5601.2 Permit required.** Permits shall be required as set forth in Section 105.6 and regulated in accordance with this section.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit and Section 105.6.14 for a discussion of specific quantity-based operational permits for the materials regulated in this chapter. The permit process also notifies the fire department of the need for prefire planning for the hazardous property.

**5601.2.1 Residential uses.** Persons shall not keep or store, nor shall any permit be issued to keep or store, any *explosives* at any place of habitation, or within 100 feet (30 480 mm) thereof.

**Exception:** Storage of smokeless propellant, black powder and small arms primers for personal use and not for resale in accordance with Section 5606.

❖ Small amounts of materials for making small arms ammunition for personal use are exempt based on the limited potential hazard of the small quantities.

**5601.2.2 Sale and retail display.** Persons shall not construct a retail display nor offer for sale *explosives*, *explosive materials* or fireworks upon highways, sidewalks, public property or in Group A or E occupancies.

❖ Where retail sales are allowed by Section 5601.1.3, Exception 4, the intent of this section is to prohibit the retail display and sale of explosives, including fireworks 1.3G and 1.4G, in public rights-of-way, on public property and in assembly (Group A) and educational (Group E) buildings. This reduces the likelihood of theft and personal injury if a fire or explosion occurs. See also the commentary to Section 5601.1.3 for further discussion of retail sales of fireworks.

**5601.2.3 Permit restrictions.** The *fire code official* is authorized to limit the quantity of *explosives*, *explosive materials* or fireworks permitted at a given location. Persons possessing a permit for storage of *explosives* at any place, shall not keep or store an amount greater than authorized in such permit. Only the kind of *explosive* specified in such a permit shall be kept or stored.

❖ The fire code official may set limits on the quantity of explosive materials or blasting agents stored at any site as a means of maintaining control over the degree of hazard posed by explosive storage. Limits should be based on the severity of the exposure if an explosion or fire occurs in the magazine. This section is not intended to give the fire code official authority to prohibit the storage of explosives or blasting agents on any site.

**5601.2.4 Financial responsibility.** Before a permit is issued, as required by Section 5601.2, the applicant shall file with the jurisdiction a corporate surety bond in the principal sum of \$100,000 or a public liability insurance policy for the same amount, for the purpose of the payment of all damages to persons or property that arise from, or are caused by, the conduct of any act authorized by the permit upon which any judicial judgment results. The *fire code official* is authorized to specify a greater or lesser amount when, in his or her opinion, conditions at the location of use indicate a greater or lesser amount is required. Government entities shall be exempt from this bond requirement.

❖ The fire code official should understand that some insurance coverages are invalidated by violations of federal, state and local regulations. Insurance coverages obtained by an owner or operator provide no protection from liability for the fire code official who is

responsible for issuing approvals or conducting inspections. Moreover, third-party insurance may conflict with other coverages obtained by the jurisdiction, as well as governmental immunity or tort claims protections under state or local statutes.

**5601.2.4.1 Blasting.** Before approval to do blasting is issued, the applicant for approval shall file a bond or submit a certificate of insurance in such form, amount and coverage as determined by the legal department of the jurisdiction to be adequate in each case to indemnify the jurisdiction against any and all damages arising from permitted blasting.

❖ Insurance coverage is required in an amount specified by a jurisdiction's legal department. This coverage is intended to indemnify the operator or responsible individual from damages arising from accidents involving blasting operations.

**5601.2.4.2 Fireworks display.** The permit holder shall furnish a bond or certificate of insurance in an amount deemed adequate by the *fire code official* for the payment of all potential damages to a person or persons or to property by reason of the permitted display, and arising from any acts of the permit holder, the agent, employees or subcontractors.

❖ The bonding requirement is intended to indemnify the display operator and, if required by the fire code official, the jurisdiction in the event of an accident. Jurisdictions desiring coverage under the display operator's policy should require that the jurisdiction be named on the policy as an additional insured or a named insured. (Before making this requirement, check with legal counsel to determine the fire code official's and the jurisdiction's liability. Many tort claims acts exempt the government from certain claims, while others limit the amount of liability. The standard of care that must be exercised by the fire code official when reviewing conditions for a permit varies widely.)

The fire code official must exercise great care when establishing bonding requirements. Insurance companies underwriting fireworks displays often issue a large number of policies at the same time of year. Often the face value of these policies far exceeds the total of the companies' assets and reserves. Insurance evaluation services should be consulted to evaluate the companies' ratings. (Like credit bureaus, these evaluation services rate the companies' financial health on a letter scale—AAA being the highest rating, B and C the lowest.) Most policies include some coverage restrictions. Losses within 150 feet (45 720 mm) of the discharge site are often excluded from coverage, and claims within 600 feet (182 m) of the discharge site are frequently severely limited. When included in the policy, these separation distances usually conform to the separation requirements of NFPA 1123. This is done purposely to encourage display operators to follow nationally recognized standards.

The fire code official may require the approval holder to submit an original copy of the certificate of insurance verifying indemnification of the display.

When an original copy cannot be obtained, a facsimile of the original from the issuing broker is a good alternative. Most insurance companies authorize only highly trusted, specially trained, bonded employees to issue these certificates. The fire code official should examine the certificate carefully and never accept a photocopy of this document unless it can be thoroughly authenticated. Unscrupulous operators have been known to alter old certificates or produce and submit counterfeit certificates. The fire code official may contact the broker, underwriter or other insurance company representative to verify coverage, although these agents may be reluctant to confirm coverage if the jurisdiction is not named as an additional insured on the policy.

**5601.3 Prohibited explosives.** Permits shall not be issued or renewed for possession, manufacture, storage, handling, sale or use of the following materials and such materials currently in storage or use shall be disposed of in an *approved* manner.

1. Liquid nitroglycerin.
2. Dynamite containing more than 60-percent liquid *explosive* ingredient.
3. Dynamite having an unsatisfactory absorbent or one that permits leakage of a liquid *explosive* ingredient under any conditions liable to exist during storage.
4. Nitrocellulose in a dry and uncompressed condition in a quantity greater than 10 pounds (4.54 kg) of net weight in one package.
5. Fulminate of mercury in a dry condition and fulminate of all other metals in any condition except as a component of manufactured articles not hereinafter forbidden.
6. *Explosive* compositions that ignite spontaneously or undergo marked decomposition, rendering the products of their use more hazardous, when subjected for 48 consecutive hours or less to a temperature of 167°F (75°C).
7. New *explosive materials* until *approved* by DOTn, except that permits are allowed to be issued to educational, governmental or industrial laboratories for instructional or research purposes.
8. *Explosive materials* forbidden for transport by DOTn.
9. *Explosive materials* containing an ammonium salt and a chlorate.
10. *Explosives* not packed or marked as required by DOTn 49 CFR Parts 100–185.

**Exception:** Gelatin dynamite.

- ❖ The fire code official is not authorized to issue approval for manufacture, transportation, storage, sale or use because of extreme or unusual hazards presented by the listed materials.

**5601.4 Qualifications.** Persons in charge of magazines, blasting, fireworks display or pyrotechnic special effect operations shall not be under the influence of alcohol or drugs that impair sensory or motor skills, shall be not less than 21 years

of age and shall demonstrate knowledge of all safety precautions related to the storage, handling or use of *explosives*, *explosive materials* or fireworks.

- ❖ The only discharge of fireworks permissible under the code is a public display conducted by competent pyrotechnicians in accordance with the requirements of NFPA 1123 and authorized by the fire code official.

The competence of the display operator is first among the important safeguards that must be observed for a safe and enjoyable public display. Chapter 6 of NFPA 1123 details the qualifications of competent fireworks display operators. Many jurisdictions also require display operators to possess a license or certificate of fitness. To obtain such a certificate, the operator must be bonded or indemnified, pass a written examination and serve an apprenticeship under another licensed or certified pyrotechnician.

The best sites are free of overhead obstructions and are well isolated, with clear viewing paths and landing areas. Fallout areas should be large, open areas, clear of spectators, vehicles and combustible materials. Generally, the discharge site must have a minimum radius of 70 feet (21 336 mm) for each inch of aerial shell diameter. Table 31.3 of NFPA 1123 specifies the separation distances.

Fireworks discharge sites must be separated from institutional and high-hazard occupancies by at least twice the distance specified in the table [140 feet (42 672 mm) per inch of shell diameter]. When mortars are positioned vertically (zero degrees), they must be located at the center of the display area. When mortars or shells stored at the discharge site are angled, they must be aimed away from principal spectator viewing and shell storage areas. When angled, mortars may be placed up to one-third the distance from the center of the display area to the principal spectator viewing area. Aerial shell trajectories must not come within 25 feet (7620 mm) of overhead obstructions, such as power lines and trees. Tents and canvas structures must be at least 100 feet (30 480 mm) from the discharge site.

High winds, precipitation or extremely hot, dry conditions should be avoided. Moisture-damaged shells must not be fired. If, in the opinion of the fire code official or the display operator, weather conditions present a danger, the display must be postponed or canceled.

**5601.5 Supervision.** The *fire code official* is authorized to require operations permitted under the provisions of Section 5601.2 to be supervised at any time by the *fire code official* in order to determine compliance with all safety and fire regulations.

- ❖ Only supervised public displays of fireworks, approved in advance by the fire code official, and wholesale sales in accordance with Section 5601.1.3, Exception 4, are permitted under the requirements of this chapter. Written application for approval of public displays must be made at least 15 days prior to the

display. Before approval can be issued, the fire code official must review the qualifications and determine the competence of the display operator, verify the operator's proof of insurance or indemnification, inspect the proposed discharge site and viewing area and review the operator's fire protection and crowd control plans.

**5601.6 Notification.** Whenever a new *explosive material* storage or manufacturing site is established, including a temporary job site, the local law enforcement agency, fire department and local emergency planning committee shall be notified 48 hours in advance, not including Saturdays, Sundays and holidays, of the type, quantity and location of *explosive materials* at the site.

❖ Local law enforcement, fire department and emergency planning officials must be notified of all new explosive materials storage and handling sites at least 48 hours, excluding weekends and holidays, prior to operations beginning. This period is intended to give officials time to prepare response plans for the new site, communicate the operation's potential hazards to first responders and train site personnel and emergency responders on the management of emergencies at the new site.

In practice, this notice should be submitted well in advance of the required 48 hours. Approval should not be granted or should be suspended if local law enforcement, fire department or emergency planning officials believe that adequate and proper preparations cannot be made to safeguard the public and emergency responders prior to the planned start of such operations.

**5601.7 Seizure.** The *fire code official* is authorized to remove or cause to be removed or disposed of in an *approved* manner, at the expense of the *owner, explosives, explosive materials* or fireworks offered or exposed for sale, stored, possessed or used in violation of this chapter.

❖ The seizure and disposal of controlled articles, in this case fireworks, at the owner's expense is usually considered a lawful taking of private property under the U.S. Constitution. However, before taking such measures, fire code officials should consult with legal counsel regarding due process requirements.

Seizure requires probable cause that the article or device being seized is unlawful itself, is being used in an unlawful manner, has been used in conjunction with an unlawful activity or poses an imminent danger to life and property. Recovery of expenses may require the filing of civil or criminal charges against the owner or his or her agents.

Before taking possession of fireworks, it is also prudent for the jurisdiction to verify that it has adequate facilities for safely handling, transporting, storing and disposing of the articles. The jurisdiction may require assistance to dispose of large quantities of special fireworks. Transportation of special fireworks is governed by DOTn 49 CFR. A commercial driver's

license with a hazardous materials endorsement is required, as well as a vehicle with special equipment and inspections.

**5601.8 Establishment of quantity of explosives and distances.** The quantity of *explosives* and distances shall be in accordance with Sections 5601.8.1 and 5601.8.1.1.

❖ This section provides a methodology for establishing the explosive quantities and distances based on the class of explosives.

**5601.8.1 Quantity of explosives.** The quantity-distance (Q-D) tables in Sections 5604.5 and 5605.3 shall be used to provide the minimum separation distances from potential explosion sites as set forth in Tables 5601.8.1(1) through 5601.8.1(3). The classification and the weight of the *explosives* are primary characteristics governing the use of these tables. The net *explosive* weight shall be determined in accordance with Sections 5601.8.1.1 through 5601.8.1.4.

❖ The hazards presented by explosive materials range across a spectrum identified by hazard Divisions 1.1 through 1.6. When all of the explosive materials are in a single hazard division, the quantity is easily determined; however, when the materials are mixed among multiple hazard divisions, a method is needed to determine the level of hazard in order to apply the quantity-distance (Q-D) tables contained in Sections 5604 and 5605. The concepts in this and the following sections have been drawn from applicable federal regulations governing the use of these materials [i.e., the Department of Defense (DOD) *Contractor's Safety Manual for Ammunition and Explosives*].

This section requires the quantity of explosives and the distances used to be in accordance with the limits expressed in the Q-D Tables 5604.5.2(2), 5604.5.2(3) and 5605.3, as appropriate, based on application of Tables 5601.8.1(1) through 5601.8.1(3).

The intent of the tables is not unlike the intent behind Table 5604.5.2(1). They serve as guides to assist the user in answering the question as to what is the appropriate table to use when Q-D is to be determined. The relationship between intraplant distance (IPD), intraline distance (ILD), intermagazine distance (IMD), public traffic route (PTR), etc., is cross referenced in each of the tables.

Guidance is provided as to the interpolation of distances when using the tables. In general, linear interpolation is not appropriate for high explosives as the effects of an explosion vary with the cube root of the distance [Table 5601.8.1(1)]. Nonlinear interpolation may be performed with the provision that the interpolation be documented in an approved technical opinion and report as required by Section 104.7.2. For materials with mass fire hazards shown in Table 5601.8.1(2), linear interpolation is allowed as noted in Note b to the table.

**5601.8.1.1 Mass-detonating explosives (Division 1.1, 1.2 or 1.5).** The total net *explosive* weight of mass-detonating explo-

sives (Division 1.1, 1.2 or 1.5) shall be used. See Table 5604.5.2(1) or Table 5605.3 as appropriate.

**Exception:** Where the TNT equivalence of the *explosive material* has been determined, the equivalence is allowed to be used to establish the net *explosive* weight.

❖ Mass-detonating explosives are typically classified as Group H-1 by the *International Building Code*® (IBC®), and present a detonation hazard and a greater threat to adjacent objects and structures. The code, therefore, contains provisions in Table 5605.3 to deal with the separation distances for mass explosion hazards. This section establishes the weights to be used when applying that table as the total net weight of all mass-detonating explosive hazard divisions.

**TABLE 5601.8.1(1).** See below.

❖ See the commentary to Section 5601.8.1.

**TABLE 5601.8.1(2).** See below.

❖ See the commentary to Section 5601.8.1.

**TABLE 5601.8.1(3).** See page 56-8.

❖ See the commentary to Section 5601.8.1.

**5601.8.1.2 Nonmass-detonating explosives (excluding Division 1.4).** Nonmass-detonating *explosives* (excluding Division 1.4) shall be as follows:

1. Division 1.3 propellants. The total weight of the propellants alone shall be the net *explosive* weight. The net weight of propellant shall be used. See Table 5604.5.2(2).
2. Combinations of bulk metal powder and pyrotechnic compositions. The sum of the net weights of metal powders and pyrotechnic compositions in the containers shall be the net *explosive* weight. See Table 5604.5.2(2).

❖ This section establishes the explosive material weight for entering in Table 5604.5.2(3) for explosives classified as nonmass detonating.

**5601.8.1.3 Combinations of mass-detonating and non-mass-detonating explosives (excluding Division 1.4).** Combination of mass-detonating and nonmass-detonating *explosives* (excluding Division 1.4) shall be as follows:

1. Where Division 1.1 and 1.2 *explosives* are located in the same site, determine the distance for the total quan-

**TABLE 5601.8.1(1)**  
**APPLICATION OF SEPARATION DISTANCE (Q-D) TABLES—DIVISION 1.1, 1.2 AND 1.5 EXPLOSIVES<sup>a, b, c</sup>**

ITEM	MAGAZINE	Q-D	OPERATING BUILDING	Q-D	INHABITED BUILDING	Q-D	PUBLIC TRAFFIC ROUTE	Q-D
Magazine	Table 5604.5.2(1)	IMD	Table 5605.3	ILD or IPD	Table 5604.5.2(1)	IBD	Table 5604.5.2(1)	PTR
Operating building	Table 5604.5.2(1)	ILD or IPD	Table 5605.3	ILD or IPD	Table 5604.5.2(1)	IBD	Table 5604.5.2(1)	PTR
Inhabited building	Table 5604.5.2(1)	IBD	Table 5604.5.2(1)	IBD	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Public traffic route	Table 5604.5.2(1)	PTR	Table 5604.5.2(1)	PTR	Not Applicable	Not Applicable	Not Applicable	Not Applicable

For SI: 1 foot = 304.8 mm.

- a. The minimum separation distance (D<sub>s</sub>) shall be 60 feet. Where a building or magazine containing explosives is barricaded, the minimum distance shall be 30 feet.
- b. Linear interpolation between tabular values in the referenced Q-D tables shall not be allowed. Nonlinear interpolation of the values shall be allowed subject to an approved technical opinion and report prepared in accordance with Section 104.7.2.
- c. For definitions of Quantity-Distance abbreviations IBD, ILD, IMD, IPD and PTR, see Chapter 2.

**TABLE 5601.8.1(2)**  
**APPLICATION OF SEPARATION DISTANCE (Q-D) TABLES—DIVISION 1.3 EXPLOSIVES<sup>a, b, c</sup>**

ITEM	MAGAZINE	Q-D	OPERATING BUILDING	Q-D	INHABITED BUILDING	Q-D	PUBLIC TRAFFIC ROUTE	Q-D
Magazine	Table 5604.5.2(2)	IMD	Table 5604.5.2(2)	ILD or IPD	Table 5604.5.2(2)	IBD	Table 5604.5.2(2)	PTR
Operating building	Table 5604.5.2(2)	ILD or IPD	Table 5604.5.2(2)	ILD or IPD	Table 5604.5.2(2)	IBD	Table 5604.5.2(2)	PTR
Inhabited building	Table 5604.5.2(2)	IBD	Table 5604.5.2(2)	IBD	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Public traffic route	Table 5604.5.2(2)	PTR	Table 5604.5.2(2)	PTR	Not Applicable	Not Applicable	Not Applicable	Not Applicable

For SI: 1 foot = 304.8 mm.

- a. The minimum separation distance (D<sub>s</sub>) shall be not less than 50 feet.
- b. Linear interpolation between tabular values in the referenced Q-D table shall be allowed.
- c. For definitions of Quantity-Distance abbreviations IBD, ILD, IMD, IPD and PTR, see Chapter 2.

tity considered first as 1.1 and then as 1.2. The required distance is the greater of the two. Where the Division 1.1 requirements are controlling and the TNT equivalence of the 1.2 is known, the TNT equivalent weight of the 1.2 items shall be allowed to be added to the total *explosive* weight of Division 1.1 items to determine the net *explosive* weight for Division 1.1 distance determination. See Table 5604.5.2(2) or Table 5605.3 as appropriate.

2. Where Division 1.1 and 1.3 *explosives* are located in the same site, determine the distances for the total quantity considered first as 1.1 and then as 1.3. The required distance is the greater of the two. Where the Division 1.1 requirements are controlling and the TNT equivalence of the 1.3 is known, the TNT equivalent weight of the 1.3 items shall be allowed to be added to the total *explosive* weight of Division 1.1 items to determine the net *explosive* weight for Division 1.1 distance determination. See Table 5604.5.2(1), 5604.5.2(2) or 5605.3, as appropriate.
3. Where Division 1.1, 1.2 and 1.3 *explosives* are located in the same site, determine the distances for the total quantity considered first as 1.1, next as 1.2 and finally as 1.3. The required distance is the greatest of the three. As allowed by paragraphs 1 and 2 above, TNT equivalent weights for 1.2 and 1.3 items are allowed to be used to determine the net weight of *explosives* for Division 1.1 distance determination. Table 5604.5.2(1) or 5605.3 shall be used where TNT equivalency is used to establish the net *explosive* weight.
4. For composite pyrotechnic items Division 1.1 and Division 1.3, the sum of the net weights of the pyrotechnic composition and the *explosives* involved shall be used. See Tables 5604.5.2(1) and 5604.5.2(2).

❖ This section establishes the explosive material weights to be used when applying the various distance tables in Sections 5604 and 5605 for mixed storage combinations of explosives classified as both mass detonating and nonmass detonating. The most hazardous explosives will likely drive the distance requirements.

**5601.8.1.4 Moderate fire—no blast hazards (Division 1.4).** For Division 1.4 explosives, the total weight of the explosive material alone is the net weight. The net weight of the explosive material shall be used.

❖ This section establishes the explosive material weight to be used when applying Table 5604.5.2(3) for explosives classified as a moderate fire hazard without a blast hazard.

**SECTION 5602  
DEFINITIONS**

**5602.1 Definitions.** The following terms are defined in Chapter 2:

**AMMONIUM NITRATE.**

**BARRICADE.**

Artificial barricade.

Natural barricade.

**BARRICADED.**

**BLAST AREA.**

**BLAST SITE.**

**BLASTER.**

**BLASTING AGENT.**

**BULLET RESISTANT.**

**DETONATING CORD.**

**DETONATION.**

**DETONATOR.**

**DISCHARGE SITE.**

**DISPLAY SITE.**

**EXPLOSIVE.**

High explosive.

Low explosive.

Mass-detonating explosives.

UN/DOTn Class 1 explosives.

Division 1.1.

Division 1.2.

**TABLE 5601.8.1(3)  
APPLICATION OF SEPARATION DISTANCE (Q-D) TABLES—DIVISION 1.4 EXPLOSIVES<sup>a, b, c, d</sup>**

ITEM	MAGAZINE	Q-D	OPERATING BUILDING	Q-D	INHABITED BUILDING	Q-D	PUBLIC TRAFFIC ROUTE	Q-D
Magazine	Table 5604.5.2(3)	IMD	Table 5604.5.2(3)	ILD or IPD	Table 5604.5.2(3)	IBD	Table 5604.5.2(3)	PTR
Operating building	Table 5604.5.2(3)	ILD or IPD	Table 5604.5.2(3)	ILD or IPD	Table 5604.5.2(3)	IBD	Table 5604.5.2(3)	PTR
Inhabited building	Table 5604.5.2(3)	IBD	Table 5604.5.2(3)	IBD	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Public traffic route	Table 5604.5.2(3)	PTR	Table 5604.5.2(3)	PTR	Not Applicable	Not Applicable	Not Applicable	Not Applicable

For SI: 1 foot = 304.8 mm.

- a. The minimum separation distance (D<sub>s</sub>) shall be not less than 50 feet.
- b. Linear interpolation between tabular values in the referenced Q-D table shall not be allowed.
- c. For definitions of Quantity-Distance abbreviations IBD, ILD, IMD, IPD and PTR, see Chapter 2.
- d. This table shall not apply to consumer fireworks, 1.4G.

Division 1.3.  
 Division 1.4.  
 Division 1.5.  
 Division 1.6.

EXPLOSIVE MATERIAL.

FALLOUT AREA.

FIREWORKS.

Fireworks, 1.4G.  
 Fireworks, 1.3G.

FIREWORKS DISPLAY.

HIGHWAY.

INHABITED BUILDING.

MAGAZINE.

Indoor.  
 Type 1.  
 Type 2.  
 Type 3.  
 Type 4.  
 Type 5.

MORTAR.

NET EXPLOSIVE WEIGHT (net weight).

OPERATING BUILDING.

OPERATING LINE.

PLOSOPHORIC MATERIAL.

PROXIMATE AUDIENCE.

PUBLIC TRAFFIC ROUTE (PTR).

PYROTECHNIC ARTICLE.

PYROTECHNIC COMPOSITION.

PYROTECHNIC SPECIAL EFFECT.

PYROTECHNIC SPECIAL-EFFECT MATERIAL.

PYROTECHNICS.

QUANTITY-DISTANCE (Q-D).

Inhabited building distance (IBD).  
 Intermagazine distance (IMD).  
 Intraline distance (ILD) or Intraplant distance (IPD).  
 Minimum separation distance ( $D_0$ ).

RAILWAY.

READY BOX.

SMALL ARMS AMMUNITION.

SMALL ARMS PRIMERS.

SMOKELESS PROPELLANTS.

SPECIAL INDUSTRIAL EXPLOSIVE DEVICE.

THEFT RESISTANT.

- ❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> as indicated in Section 201.3, or

the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4).

## SECTION 5603

### RECORD KEEPING AND REPORTING

**5603.1 General.** Records of the receipt, handling, use or disposal of *explosive materials*, and reports of any accidents, thefts or unauthorized activities involving *explosive materials* shall conform to the requirements of this section.

- ❖ An accumulation of invoices, sales slips, delivery tickets, receipts or similar records representing individual transactions will satisfy the requirements for record keeping if they include the signature of the receiver of the explosive materials.

**5603.2 Transaction record.** The permittee shall maintain a record of all transactions involving receipt, removal, use or disposal of *explosive materials*. Such records shall be maintained for a period of 5 years.

**Exception:** Where only Division 1.4G (consumer fireworks) are handled, records need only be maintained for a period of 3 years.

- ❖ A permit holder must keep a record of all transactions or operations involving explosive materials for 5 years and that record should be made available to the issuing authority upon request.

**5603.3 Loss, theft or unauthorized removal.** The loss, theft or unauthorized removal of *explosive materials* from a magazine or permitted facility shall be reported to the *fire code official*, local law enforcement authorities and the U.S. Department of Treasury, Bureau of Alcohol, Tobacco, Firearms and Explosives within 24 hours.

**Exception:** Loss of Division 1.4G (consumer fireworks) need not be reported to the Bureau of Alcohol, Tobacco, Firearms and Explosives.

- ❖ The loss, theft or unlawful removal of explosive materials must be reported within 24 hours to the ATF, to the permit-issuing authority and to the local law enforcement agency.

**5603.4 Accidents.** Accidents involving the use of *explosives*, *explosive materials* and fireworks that result in injuries or property damage shall be reported to the *fire code official* immediately.

- ❖ Accidents involving explosive material that cause a lost-time injury or property damage must be reported immediately to the authority having jurisdiction for its records.

**5603.5 Misfires.** The pyrotechnic display operator or blaster in charge shall keep a record of all aerial shells that fail to fire or charges that fail to detonate.

- ❖ A record of all misfires must be kept, eliminating the possibility of using the misfires in other displays and shows.

**5603.6 Hazard communication.** Manufacturers of *explosive materials* and fireworks shall maintain records of chemicals,

## EXPLOSIVES AND FIREWORKS

chemical compounds and mixtures required by DOL 29 CFR Part 1910.1200, and Section 407.

- ❖ Manufacturers of explosive materials and fireworks are required to assess the hazards of chemicals that they produce or import. Employers must inform their employees of the hazardous chemicals to which they are exposed, using a hazard communication program, labels and other forms of warning, Material Safety Data Sheets (MSDS) and information and training. In addition, this section requires distributors to transmit the required information to employers.

**5603.7 Safety rules.** Current safety rules covering the operation of magazines, as described in Section 5604.7, shall be posted on the interior of the magazine in a visible location.

- ❖ Magazine safety rules must be posted conspicuously on the interior of the magazine as a reminder to employees of the requirements for the safe operation of the magazine. These safety rules must cover security; open flames and lights; area around the magazine; separation distance of combustibles; instructions for packing and unpacking; acceptable tools and equipment.

### SECTION 5604 EXPLOSIVE MATERIALS STORAGE AND HANDLING

**5604.1 General.** Storage of *explosives* and *explosive materials*, small arms ammunition, small arms primers, propellant-actuated cartridges and smokeless propellants in magazines shall comply with the provisions of this section.

- ❖ This section establishes requirements for various magazines associated with explosive materials storage.

**5604.2 Magazine required.** *Explosives* and *explosive materials*, and Division 1.3G fireworks shall be stored in magazines constructed, located, operated and maintained in accordance with the provisions of Section 5604 and NFPA 495 or NFPA 1124.

#### Exceptions:

1. Storage of fireworks at display sites in accordance with Section 5608.5 and NFPA 1123 or NFPA 1126.
2. Portable or mobile magazines not exceeding 120 square feet (11 m<sup>2</sup>) in area shall not be required to comply with the requirements of the *International Building Code*.

- ❖ Explosives and blasting agents must be kept in magazines when not in use to reduce the exposure hazard.

**5604.3 Magazines.** The storage of *explosives* and *explosive materials* in magazines shall comply with Table 5604.3.

- ❖ This section gives the requirements for magazine storage of explosives and explosive materials. The section covers high explosives, low explosives and detonating cord.

**TABLE 5604.3.** See below.

- ❖ This table gives both the new and the old classification of explosives. It also states whether the explosive is a low or high type of explosive. The table specifies the maximum amounts allowed in the control areas, whether indoors or outdoors. The last columns specify the type of magazine required for storage of various explosives. Then Table 5604.5.2(1) refers to the proper table for separation distances.

**5604.3.1 High explosives.** *Explosive materials* classified as Division 1.1 or 1.2 or formerly classified as Class A by the

**TABLE 5604.3**  
**STORAGE AMOUNTS AND MAGAZINE REQUIREMENTS FOR EXPLOSIVES, EXPLOSIVE MATERIALS AND**  
**FIREWORKS, 1.3G MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA**

NEW UN/ DOTn DIVISION	OLD DOTn CLASS	ATF/OSHA CLASS	INDOOR <sup>a</sup> (pounds)				OUTDOOR (pounds)	MAGAZINE TYPE REQUIRED				
			Unprotected	Cabinet	Sprinklers	Sprinklers & cabinet		1	2	3	4	5
1.1 <sup>b</sup>	A	High	0	0	1	2	1	X	X	X	—	—
1.2	A	High	0	0	1	2	1	X	X	X	—	—
1.2	B	Low	0	0	1	1	1	X	X	X	X	—
1.3	B	Low	0	0	5	10	1	X	X	X	X	—
1.4 <sup>c</sup>	B	Low	0	0	50	100	1	X	X	X	X	—
1.5	C	Low	0	0	1	2	1	X	X	X	X	—
1.5	Blasting Agent	Blasting Agent	0	0	1	2	1	X	X	X	X	X
1.6	Not Applicable	Not Applicable	0	0	1	2	1	X	X	X	X	X

For SI: 1 pound = 0.454 kg, 1 pound per gallon = 0.12 kg per liter, 1 ounce = 28.35 g.

a. A factor of 10 pounds per gallon shall be used for converting pounds (solid) to gallons (liquid) in accordance with Section 5003.1.2.

b. Black powder shall be stored in a Type 1, 2, 3 or 4 magazine as provided for in Section 5604.3.1.

c. This table shall not apply to consumer fireworks, 1.4G.

U.S. Department of Transportation shall be stored in Type 1, 2 or 3 magazines.

**Exceptions:**

1. Black powder shall be stored in a Type 1, 2, 3 or 4 magazine.
2. Cap-sensitive *explosive material* that is demonstrated not to be bullet sensitive shall be stored in a Type 1, 2, 3, 4 or 5 magazine.

❖ Type 1, 2 and 3 magazines are constructed with stricter requirements for the prevention of possible fire, water damage or bullet hazards.

**5604.3.2 Low explosives.** *Explosive materials* that are not cap sensitive shall be stored in a Type 1, 2, 3, 4 or 5 magazine.

❖ There are fewer restrictions on the storage of low explosives that are not cap sensitive. Protection against theft is a primary concern.

**5604.3.3 Detonating cord.** For quantity and distance purposes, detonating cord of 50 grains per foot shall be calculated as equivalent to 8 pounds (4 kg) of high *explosives* per 1,000 feet (305 m). Heavier or lighter core loads shall be rated proportionally.

❖ Standard detonating cord averaging about 50 grains per foot, which is considered the equivalent of 8 pounds (4 kg) of high explosives per 1,000 feet (305 m), is a benchmark for detonating cord. Heavier cord would be 60 grains per foot equaling 9 pounds (4 kg) of high explosive per 1,000 feet (305 m).

**5604.4 Prohibited storage.** Detonators shall be stored in a separate magazine for blasting supplies and shall not be stored in a magazine with other *explosive materials*.

❖ Storage of detonators with explosives may result in an accidental mass detonation. Detonators may be stored with other explosives only if that storage is approved by the fire code official and is under the following conditions [see DOTy 27 CFR, Part 55.213(b)]:

1. Nonmass-detonating detonators may be stored with electric squibs, safety fuses, ignitors and ignitor cord in a Type 4 magazine.
2. Detonators may be stored with delay devices, electric squibs, safety fuses, ignitors and ignitor cord in Type 1 and 2 magazines.

**5604.5 Location.** The use of magazines for storage of *explosives* and *explosive materials* shall comply with Sections 5604.5.1 through 5604.5.3.3.

❖ Explosives and blasting agents must be kept in magazines when not in use to reduce the exposure hazard.

**5604.5.1 Indoor magazines.** The use of indoor magazines for storage of *explosives* and *explosive materials* shall com-

ply with the requirements of Sections 5604.5.1.1 through 5604.5.1.7.

❖ The following sections address the requirements for indoor magazines. These sections cover the use, construction, quantity limit, prohibited use, number and separation distance of indoor magazines.

**5604.5.1.1 Use.** The use of indoor magazines for storage of *explosives* and *explosive materials* shall be limited to occupancies of Group F, H, M or S, and research and development laboratories.

❖ Section 5604.2 requires all explosives in storage to be located in magazines. This section, however, recognizes that certain operations engaged in manufacturing or research processes require the use of magazines (commonly referred to as “day boxes”) inside the building for the purposes of storing small quantities of material awaiting use.

**5604.5.1.2 Construction.** Indoor magazines shall comply with the following construction requirements:

1. Construction shall be fire resistant and theft resistant.
2. Exterior shall be painted red.
3. Base shall be fitted with wheels, casters or rollers to facilitate removal from the building in an emergency.
4. Lid or door shall be marked with conspicuous white lettering not less than 3 inches (76 mm) high and minimum  $\frac{1}{2}$  inch (12.7 mm) stroke, reading EXPLOSIVES—KEEP FIRE AWAY.
5. The least horizontal dimension shall not exceed the clear width of the entrance door.

❖ Indoor magazines need not be bullet resistant if the building in which they are located gives protection from bullet penetration. Not more than 50 pounds (23 kg) of high explosives may be stored in an indoor magazine, and not more than one indoor magazine may be stored inside a single building if the 50-pound (23 kg) limit has not been exceeded. The following comments clarify the intent of special requirements applying to magazines used indoors:

1. Construction specifications in this section state the minimum acceptable degree of protection from physical hazards and an exterior fire exposure when wood is used as a construction material for the magazine. Interior nails and screws must be countersunk to prevent damage to explosives and friction or sparks when the magazine is in transit or explosives are moved within the magazine.
2. The required color serves as a reminder of flammable, explosive and detonation hazards.
3. If a fire or an emergency occurs in the building, wheels or casters will permit the magazine to

be removed from the building or relocated to a safer area.

4. The required sign serves as a reminder to keep open flames and ignition sources away from the magazine.
5. In case of emergency, the magazine should clear the opening of the door for transfer of the magazine to the outdoors.

**5604.5.1.3 Quantity limit.** Not more than 50 pounds (23 kg) of *explosives* or *explosive materials* shall be stored within an indoor magazine.

**Exception:** Day boxes used for the storage of in-process material in accordance with Section 5605.6.4.1.

❖ Section 5605.6.4.1 establishes the requirements for magazines used for in-process materials that are consumed over the course of the workday. Magazines used in daily operations are generally referred to as “day boxes” by the industry. The ATF uses the term “day box” in its description of a Type 3 magazine. Magazines may either be used as storage magazines or as designated holding containers or structures within an operating building. The primary differences between a storage magazine and the magazines that are used as day boxes are limited to operational controls and the duration that the materials are allowed to be present in the work area.

A storage magazine is regulated by ATF, which requires materials present in the magazine to be identified on written logs and the inventory closely maintained during the time when it is present in the magazine. On the other hand, ATF does not regulate in-process materials that may be located in holding containers or structures, including day boxes located within an operating building.

Magazines (day boxes) that are used for the interim storage or staging of in-process materials are required to be emptied at the end of the work day. As containers for in-process material, they are not “storage” magazines, and as such are not further regulated by ATF. They are, however, regulated by Sections 5605.6.4 and 5605.6.4.1. The magazines (day boxes) used for in-process materials are protective enclosures that serve to isolate the materials from the work area and to minimize the exposure risk to personnel when materials are located outside of areas that may otherwise be provided with workstation protection. They serve to protect the material contained from potential fire exposure as well as to serve as a means to separate various in-process materials in order to avoid propagation hazards.

On the other hand, explosives stored in manufacturing buildings where the materials are not staged for in-process use are limited to quantities not exceeding 50 pounds (23 kg) net explosive weight. This storage can remain in the building without regard to a time limit, and all such storage may be further regulated by the operational controls required by ATF.

Day boxes or magazines used for process operations are used as a means to isolate in-process material from a workstation and to minimize the potential for involvement should an event occur within the immediate area of the workstation. This same material could be located in the same work space without the benefit of a day box.

Quantity control for these in-process magazines is limited to aggregating the quantity contained within the Q-D relationships of the building as specified by Section 5605.4. The 50-pound (23 kg) limit specified by this section applies to the storage of material where the storage can remain in an unattended mode and left in place during times when the building is unoccupied.

**5604.5.1.4 Prohibited use.** Indoor magazines shall not be used within buildings containing Group R occupancies.

❖ Indoor magazines are not permitted inside residences or dwellings because of the life hazard present and the difficulty of maintaining control over their use through routine inspections.

**5604.5.1.5 Location.** Indoor magazines shall be located within 10 feet (3048 mm) of an entrance and only on floors at or having ramp access to the exterior grade level.

❖ The location of these magazines must be chosen to minimize exposure of means of egress but maintain ready access from the exterior to facilitate fire fighting.

**5604.5.1.6 Number.** Not more than two indoor magazines shall be located in the same building. Where two such magazines are located in the same building, one magazine shall be used solely for the storage of not more than 5,000 detonators.

❖ The location of magazines in wholesale and retail establishments should be coordinated with and approved by the fire department’s prefire plans. Any changes in magazine locations require prior approval of the fire code official and should be noted on the permit.

**5604.5.1.7 Separation distance.** Where two magazines are located in the same building, they shall be separated by a distance of not less than 10 feet (3048 mm).

❖ Explosives and blasting agents that are offered for sale must be stored in separate magazines to prevent an explosion in one magazine from triggering an explosion in another magazine or mass detonation.

**5604.5.2 Outdoor magazines.** Outdoor magazines other than Type 3 shall be located so as to comply with Table 5604.5.2(2) or 5604.5.2(3) as set forth in Tables 5601.8.1(1) through 5601.8.1(3). Where a magazine or group of magazines, as described in Section 5604.5.2.2, contains different classes of *explosive materials*, and Division 1.1 materials are present, the required separations for the magazine or magazine group as a whole shall comply with Table 5604.5.2(2).

❖ Specified separation distances in the tables are intended to minimize the potential damage to life and property that may result from a blast inside a maga-

zine. Additionally, the separation distances help control the hazard to a given magazine from exposure fires involving ground cover or a fire occurring in another magazine and thus provide clear access for emergency response personnel. Separation and the rules governing blasting for those magazines are addressed by Section 5607.

Tables 5601.8.1(1) through (3) enhance the code and provide guidance in application for operating buildings as well as magazines.

Sections 5604.5.2.1 and 5604.5.2.2 recognize the circumstance surrounding the use of multiple magazines and magazines that are arranged in groups where the separation between magazines is less than the tabular distance established by the intermagazine (inter = between or among) distances. The basis for these provisions is Note d to the American Table of Distances [Table 5604.5.2(1)], except that the permissive language has been removed and the note divided into two distinct provisions. The provisions of Sections 5604.5.2.1 and 5604.5.2.2 are consistent with the footnote, and applicable to Division 1.3 and 1.4 materials as well as to the materials addressed by Table 5604.5.2(1). It is common to group a number of magazines, each containing different materials, on manufacturing sites for the purposes of operational control and dedication to specific manufacturing lines.

**5604.5.2.1 Separation.** Where two or more storage magazines are located on the same property, each magazine shall comply with the minimum distances specified from inhabited buildings, public transportation routes and operating buildings. Magazines shall be separated from each other by not less than the intermagazine distances (IMD) shown for the separation of magazines.

❖ See the commentary to Section 5604.5.2.

**TABLE 5604.5.2(1).** See page 56-14.

❖ Table 5604.5.2(1) establishes minimum separation distances for the permanent storage of explosives from selected property classes. The intent of the table is to place explosive storage far enough away from occupied buildings, highways, railways and other magazines to reduce exposure of those properties to damage if a detonation of a magazine occurs. Storage exceeding tabular amounts in a single magazine is rare and thus requires special approval by the fire code official.

**5604.5.2.2 Grouped magazines.** Where two or more magazines are separated from each other by less than the intermagazine distances (IMD), such magazines as a group shall be considered as one magazine and the total quantity of *explosive materials* stored in the group shall be treated as if stored in a single magazine. The location of the group of magazines shall comply with the intermagazine distances (IMD) speci-

fied from other magazines or magazine groups, inhabited buildings (IBD), public transportation routes (PTR) and operating buildings (ILD or IPD) as required.

❖ See the commentary to Section 5604.5.2.

**TABLE 5604.5.2(2).** See page 56-16.

❖ Magazines containing special fireworks, other than special salutes, and black powder or other low explosives must be separated from each other and from inhabited buildings, public highways and passenger railways. Amounts of low explosives are located in the left two columns. The separation distances are located on the row of the amount of low explosives in reference to inhabited buildings, railways or other magazines.

**TABLE 5604.5.2(3).** See page 56-16.

❖ Items in Division 1.4 present a fire hazard with no blast hazard and virtually no fragmentation hazard beyond the fire-hazard clearance ordinarily specified for high-risk materials. Separate facilities for storage and handling of this division should not be less than 100 feet (30 480 mm) from other facilities, except those of noncombustible construction, which can be 50 feet (15 240 mm) from each other, provided both are noncombustible.

Division 1.4 materials are finished goods or devices that contain energetic materials. A fire or explosive event with Division 1.4 materials is limited to the individual devices involved and, unlike the materials in the other divisions, there is no mass reaction. The table of distances has been based on federal regulations as published by the DOD.

**5604.5.3 Special requirements for Type 3 magazines.** Type 3 magazines shall comply with Sections 5604.5.3.1 through 5604.5.3.3.

❖ These requirements are intended to provide a reasonable degree of safety for Type 3 magazines at blasting sites.

**5604.5.3.1 Location.** Wherever practicable, Type 3 magazines shall be located away from neighboring inhabited buildings, railways, highways and other magazines in accordance with Table 5604.5.2(2) or 5604.5.2(3) as applicable.

❖ Type 3 magazines must be located as remotely as practical from public rights-of-way, buildings and other magazines to reduce exposures between them.

**5604.5.3.2 Supervision.** Type 3 magazines shall be attended when *explosive materials* are stored within. *Explosive materials* shall be removed to appropriate storage magazines for unattended storage at the end of the work day.

❖ The magazine must be constantly supervised by a trained attendant when explosives are being stored to prevent unauthorized removal of the contents and to enforce safety rules.

**EXPLOSIVES AND FIREWORKS**

**TABLE 5604.5.2(1)  
AMERICAN TABLE OF DISTANCES FOR STORAGE OF EXPLOSIVES AS  
APPROVED BY THE INSTITUTE OF MAKERS OF EXPLOSIVES AND REVISED JUNE 1991<sup>a</sup>**

QUANTITY OF EXPLOSIVE MATERIALS <sup>c</sup>		DISTANCES IN FEET							
		Inhabited buildings		Public highways with traffic volume less than 3,000 vehicles per day		Public highways with traffic volume greater than 3,000 vehicles per day and passenger railways		Separation of magazines <sup>d</sup>	
Pounds over	Pounds not over	Barricaded	Unbarricaded	Barricaded	Unbarricaded	Barricaded	Unbarricaded	Barricaded	Unbarricaded
0	5	70	140	30	60	51	102	6	12
5	10	90	180	35	70	64	128	8	16
10	20	110	220	45	90	81	162	10	20
20	30	125	250	50	100	93	186	11	22
30	40	140	280	55	110	103	206	12	24
40	50	150	300	60	120	110	220	14	28
50	75	170	340	70	140	127	254	15	30
75	100	190	380	75	150	139	278	16	32
100	125	200	400	80	160	150	300	18	36
125	150	215	430	85	170	159	318	19	38
150	200	235	470	95	190	175	350	21	42
200	250	255	510	105	210	189	378	23	46
250	300	270	540	110	220	201	402	24	48
300	400	295	590	120	240	221	442	27	54
400	500	320	640	130	260	238	476	29	58
500	600	340	680	135	270	253	506	31	62
600	700	355	710	145	290	266	532	32	64
700	800	375	750	150	300	278	556	33	66
800	900	390	780	155	310	289	578	35	70
900	1,000	400	800	160	320	300	600	36	72
1,000	1,200	425	850	165	330	318	636	39	78
1,200	1,400	450	900	170	340	336	672	41	82
1,400	1,600	470	940	175	350	351	702	43	86
1,600	1,800	490	980	180	360	366	732	44	88
1,800	2,000	505	1,010	185	370	378	756	45	90
2,000	2,500	545	1,090	190	380	408	816	49	98
2,500	3,000	580	1,160	195	390	432	864	52	104
3,000	4,000	635	1,270	210	420	474	948	58	116
4,000	5,000	685	1,370	225	450	513	1,026	61	122
5,000	6,000	730	1,460	235	470	546	1,092	65	130
6,000	7,000	770	1,540	245	490	573	1,146	68	136
7,000	8,000	800	1,600	250	500	600	1,200	72	144
8,000	9,000	835	1,670	255	510	624	1,248	75	150
9,000	10,000	865	1,730	260	520	645	1,290	78	156
10,000	12,000	875	1,750	270	540	687	1,374	82	164
12,000	14,000	885	1,770	275	550	723	1,446	87	174
14,000	16,000	900	1,800	280	560	756	1,512	90	180
16,000	18,000	940	1,880	285	570	786	1,572	94	188
18,000	20,000	975	1,950	290	580	813	1,626	98	196
20,000	25,000	1,055	2,000	315	630	876	1,752	105	210

*(continued)*

**TABLE 5604.5.2(1)-continued**  
**AMERICAN TABLE OF DISTANCES FOR STORAGE OF EXPLOSIVES AS**  
**APPROVED BY THE INSTITUTE OF MAKERS OF EXPLOSIVES AND REVISED JUNE 1991<sup>a</sup>**

QUANTITY OF EXPLOSIVE MATERIALS <sup>c</sup>		DISTANCES IN FEET							
		Inhabited buildings		Public highways with traffic volume less than 3,000 vehicles per day		Public highways with traffic volume greater than 3,000 vehicles per day and passenger railways		Separation of magazines <sup>d</sup>	
Pounds over	Pounds not over	Barricaded	Unbarricaded	Barricaded	Unbarricaded	Barricaded	Unbarricaded	Barricaded	Unbarricaded
25,000	30,000	1,130	2,000	340	680	933	1,866	112	224
30,000	35,000	1,205	2,000	360	720	981	1,962	119	238
35,000	40,000	1,275	2,000	380	760	1,026	2,000	124	248
40,000	45,000	1,340	2,000	400	800	1,068	2,000	129	258
45,000	50,000	1,400	2,000	420	840	1,104	2,000	135	270
50,000	55,000	1,460	2,000	440	880	1,140	2,000	140	280
55,000	60,000	1,515	2,000	455	910	1,173	2,000	145	290
60,000	65,000	1,565	2,000	470	940	1,206	2,000	150	300
65,000	70,000	1,610	2,000	485	970	1,236	2,000	155	310
70,000	75,000	1,655	2,000	500	1,000	1,263	2,000	160	320
75,000	80,000	1,695	2,000	510	1,020	1,293	2,000	165	330
80,000	85,000	1,730	2,000	520	1,040	1,317	2,000	170	340
85,000	90,000	1,760	2,000	530	1,060	1,344	2,000	175	350
90,000	95,000	1,790	2,000	540	1,080	1,368	2,000	180	360
95,000	100,000	1,815	2,000	545	1,090	1,392	2,000	185	370
100,000	110,000	1,835	2,000	550	1,100	1,437	2,000	195	390
110,000	120,000	1,855	2,000	555	1,110	1,479	2,000	205	410
120,000	130,000	1,875	2,000	560	1,120	1,521	2,000	215	430
130,000	140,000	1,890	2,000	565	1,130	1,557	2,000	225	450
140,000	150,000	1,900	2,000	570	1,140	1,593	2,000	235	470
150,000	160,000	1,935	2,000	580	1,160	1,629	2,000	245	490
160,000	170,000	1,965	2,000	590	1,180	1,662	2,000	255	510
170,000	180,000	1,990	2,000	600	1,200	1,695	2,000	265	530
180,000	190,000	2,010	2,010	605	1,210	1,725	2,000	275	550
190,000	200,000	2,030	2,030	610	1,220	1,755	2,000	285	570
200,000	210,000	2,055	2,055	620	1,240	1,782	2,000	295	590
210,000	230,000	2,100	2,100	635	1,270	1,836	2,000	315	630
230,000	250,000	2,155	2,155	650	1,300	1,890	2,000	335	670
250,000	275,000	2,215	2,215	670	1,340	1,950	2,000	360	720
275,000	300,000 <sup>b</sup>	2,275	2,275	690	1,380	2,000	2,000	385	770

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg.

- This table applies only to the manufacture and permanent storage of commercial explosive materials. It is not applicable to transportation of explosives or any handling or temporary storage necessary or incident thereto. It is not intended to apply to bombs, projectiles or other heavily encased explosives.
- Storage in excess of 300,000 pounds of explosive materials in one magazine is not allowed.
- Where a manufacturing building on an explosive materials plant site is designed to contain explosive materials, such building shall be located with respect to its proximity to inhabited buildings, public highways and passenger railways based on the maximum quantity of explosive materials permitted to be in the building at one time.
- Where two or more storage magazines are located on the same property, each magazine shall comply with the minimum distances specified from inhabited buildings, railways and highways, and, in addition, they should be separated from each other by not less than the distances shown for separation of magazines, except that the quantity of explosives in detonator magazines shall govern in regard to the spacing of said detonator magazines from magazines containing other explosive materials. Where any two or more magazines are separated from each other by less than the specified separation of magazines distances, then two or more such magazines, as a group, shall be considered as one magazine, and the total quantity of explosive materials stored in such group shall be treated as if stored in a single magazine located on the site of any magazine in the group and shall comply with the minimum distances specified from other magazines, inhabited buildings, railways and highways.

**EXPLOSIVES AND FIREWORKS**

**TABLE 5604.5.2(2)**

**TABLE OF DISTANCES (Q-D) FOR BUILDINGS AND MAGAZINES CONTAINING EXPLOSIVES—DIVISION 1.3 MASS-FIRE HAZARD<sup>a, b, c</sup>**

QUANTITY OF DIVISION 1.3 EXPLOSIVES (NET EXPLOSIVES WEIGHT)		DISTANCES IN FEET			
Pounds over	Pounds not over	Inhabited Building Distance (IBD)	Distance to Public Traffic Route (PTR)	Intermagazine Distance (IMD)	Intraline Distance (ILD) or Intraplant Distance (IPD)
0	1,000	75	75	50	50
1,000	5,000	115	115	75	75
5,000	10,000	150	150	100	100
10,000	20,000	190	190	125	125
20,000	30,000	215	215	145	145
30,000	40,000	235	235	155	155
40,000	50,000	250	250	165	165
50,000	60,000	260	260	175	175
60,000	70,000	270	270	185	185
70,000	80,000	280	280	190	190
80,000	90,000	295	295	195	195
90,000	100,000	300	300	200	200
100,000	200,000	375	375	250	250
200,000	300,000	450	450	300	300

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg

- a. Black powder, when stored in magazines, is defined as low explosive by the Bureau of Alcohol, Tobacco, Firearms and Explosives (BATF).
- b. For quantities less than 1,000 pounds, the required distances are those specified for 1,000 pounds. The use of lesser distances is allowed where supported by approved test data and/or analysis.
- c. Linear interpolation of explosive quantities between table entries is allowed.

**TABLE 5604.5.2(3)**

**TABLE OF DISTANCES (Q-D) FOR BUILDINGS AND MAGAZINES CONTAINING EXPLOSIVES—DIVISION 1.4<sup>c</sup>**

QUANTITY OF DIVISION 1.4 EXPLOSIVES (NET EXPLOSIVES WEIGHT)		DISTANCES IN FEET			
Pounds over	Pounds not over	Inhabited Building Distance (IBD)	Distance to Public Traffic Route (PTR)	Intermagazine Distance <sup>a, b</sup> (IMD)	Intraline Distance (ILD) or Intraplant Distance <sup>a</sup> (IPD)
50	Not Limited	100	100	50	50

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg.

- a. A separation distance of 100 feet is required for buildings of other than Type I or Type II construction as defined in the *International Building Code*.
- b. For earth-covered magazines, specific separation is not required.
  - 1. Earth cover material used for magazines shall be relatively cohesive. Solid or wet clay and similar types of soil are too cohesive and shall not be used. Soil shall be free from unsanitary organic matter, trash, debris and stones heavier than 10 pounds or larger than 6 inches in diameter. Compaction and surface preparation shall be provided, as necessary, to maintain structural integrity and avoid erosion. Where cohesive material cannot be used, as in sandy soil, the earth cover over magazines shall be finished with a suitable material to ensure structural integrity.
  - 2. The earth fill or earth cover between earth-covered magazines shall be either solid or sloped, in accordance with the requirements of other construction features, but not less than 2 feet of earth cover shall be maintained over the top of each magazines. To reduce erosion and facilitate maintenance operations, the cover shall have a slope of 2 horizontal to 1 vertical.
- c. Restricted to articles, including articles packaged for shipment, that are not regulated as an explosive under Bureau of Alcohol, Tobacco, Firearms and Explosives regulations, or unpacked articles used in process operations that do not propagate a detonation or deflagration between articles. This table shall not apply to consumer fireworks, 1.4G.

**5604.5.3.3 Use.** Not more than two Type 3 magazines shall be located at the same blasting site. Where two Type 3 magazines are located at the same blasting site, one magazine shall be used solely for the storage of detonators.

❖ Detonators must be stored in separate magazines from explosives to prevent an accidental mass detonation.

**5604.6 Construction.** Magazines shall be constructed in accordance with Sections 5604.6.1 through 5604.6.5.2.

❖ Magazine construction requirements are based on requirements in DOTy 27 CFR, Part 55 and NFPA 495. Magazines are identified by designation as one of five types: Types 1 through 5.

**5604.6.1 Drainage.** The ground around a magazine shall be graded so that water drains away from the magazine.

❖ Grading land away from the magazine allows storm water to run off and not accumulate in, under or around a magazine. Water may damage explosives. Contaminated water may conduct an electric current, possibly resulting in the detonation of explosives.

**5604.6.2 Heating.** Magazines requiring heat shall be heated as prescribed in NFPA 495 by either hot water radiant heating within the magazine or by indirect warm air heating.

❖ Indirect heating systems can prevent freezing and avoid excessive heating of magazine contents. These systems also do not constitute an ignition hazard.

**5604.6.3 Lighting.** Where lighting is necessary within a magazine, electric safety flashlights or electric safety lanterns shall be used, except as provided in NFPA 495.

❖ Safety flashlights and safety lanterns used inside magazines must be designed for use in hazardous locations. Fixed electric lighting installed as specified in Section 65.5.1 of NFPA 495 is acceptable. All electrical work must conform to NFPA 70 requirements. DOTy 27 CFR, Part 55.217(c), requires that copies of documents indicating that the electrical installation conforms to NFPA 70 to be maintained on site and always available for inspections. Requirements of NFPA 70 and NFPA 495 are intended to minimize the possibility that sparks generated by electrical arcing during normal operations or through equipment failures will ignite explosives within the magazine.

**5604.6.4 Nonsparking materials.** In other than Type 5 magazines, there shall not be exposed ferrous metal on the interior of a magazine containing packages of *explosives*.

❖ Ferrous metal must not be exposed in the interior of a Type 1, 2, 3 or 4 magazine where the metal could come in contact with packages of explosives.

**5604.6.5 Signs and placards.** Property upon which Type 1 magazines and outdoor magazines of Types 2, 4 and 5 are located shall be posted with signs stating: EXPLOSIVES—KEEP OFF. These signs shall be of contrasting colors with a minimum letter height of 3 inches (76 mm) with a minimum brush stroke of 1/2 inch (12.7 mm). The signs shall be located

to minimize the possibility of a bullet shot at the sign hitting the magazine.

❖ Signs are intended to identify the public hazard and provide warning to fire fighters. Signs should also be prominently displayed at the entrance to the property and at regular intervals around the perimeter of the property. Contrasting letters and backgrounds on the signs (red on white preferred) should be used with letters that are legible from a distance. A minimum 3-inch (76 mm) height is recommended for the letters. The Institute of Makers of Explosives (IME) recommends the following wording in addition to that required by this section:

**DANGER!**  
**NEVER FIGHT EXPLOSIVE FIRES.**  
**EXPLOSIVES ARE STORED AT THIS SITE.**  
CALL: \_\_\_\_\_.

Military and DOT explosives warning signs use black letters, numerals and symbols on orange backgrounds. Nonreflective sign materials make these types of signs difficult to identify and read. Signs must always be conspicuously posted and maintained in a clear, clean and legible condition.

Signs are attractive targets for irresponsible fire-arms bearers. Therefore, signs must be located, in anticipation of an individual shooting a rifle or handgun at the sign, so the bullet will not hit the magazine.

The absence of clear warning signs was cited as a contributing factor in the November 1988 deaths of six Kansas City, Missouri, fire fighters who were approaching a Type 4 magazine at a remote highway construction site when it exploded. A similar incident in March 1989 in Peterborough, England, killed one fire fighter and injured 76 other persons, including six fire fighters. The Peterborough, England, incident occurred while fire fighters were trying to control a fire in a motor carrier hauling explosives.

**5604.6.5.1 Access road signs.** At the entrance to *explosive* material manufacturing and storage sites, all access roads shall be posted with the following warning sign or other *approved* sign:

**DANGER!**  
**NEVER FIGHT EXPLOSIVE FIRES.**  
**EXPLOSIVES ARE STORED ON THIS SITE**  
CALL \_\_\_\_\_.

The sign shall be weather-resistant with a reflective surface and have lettering not less than 2 inches (51 mm) high.

❖ Signs are intended to identify the public hazard and warn fire fighters. Signs should also be prominently displayed at the entrance to the property and at regular intervals around the perimeter of the property. Contrasting letters and backgrounds on the signs (red on white preferred) should be used with letters that are legible from a distance. A minimum 2-inch (51 mm) height is recommended for the letters.

**5604.6.5.2 Placards.** Type 5 magazines containing Division 1.5 blasting agents shall be prominently placarded as required during transportation by DOTn 49 CFR Part 172 and DOTy 27 CFR Part 55.

- ❖ Requirements for placarding explosives shipments are found in DOTn 49 CFR; Part 172, Subpart F. Commentary Figure 5604.6.5.2 depicts the format of a typical explosives placard (black graphics on an orange background). Placards allow emergency response personnel to readily identify the explosive materials being transported if a fire or accident involving the transport vehicle occurs.



**5604.7 Operation.** Magazines shall be operated in accordance with Sections 5604.7.1 through 5604.7.9.

- ❖ The following sections address the operations of magazines. Items covered include security; open flames; brush; combustible storage; unpacking and packing; tools and equipment.

**5604.7.1 Security.** Magazines shall be kept locked in the manner prescribed in NFPA 495 at all times except during placement or removal of *explosives* or inspection.

- ❖ Security precautions must be taken to minimize the possibility of theft, tampering or misuse of explosives.

**5604.7.2 Open flames and lights.** Smoking, matches, flame-producing devices, open flames, firearms and firearms cartridges shall not be allowed inside of or within 50 feet (15 240 mm) of magazines.

- ❖ The carrying or use of open flames, spark-producing devices, matches and firearms is prohibited to prevent accidental ignition of explosives within the magazine.

**5604.7.3 Brush.** The area located around a magazine shall be kept clear of brush, dried grass, leaves, trash, debris and similar combustible materials for a distance of 25 feet (7620 mm).

- ❖ Brush and dry grass, leaves, trash and other easily ignitable debris must be kept clear for a distance of 25 feet (7620 mm) around magazines containing explosives to minimize the threat to magazine contents from fire exposure.

**5604.7.4 Combustible storage.** Combustible materials shall not be stored within 50 feet (15 240 mm) of magazines.

- ❖ Elimination of combustible materials within 50 feet (15 240 mm) of magazines eliminates both a fuel source and a possible source of ignition for stored explosives.

**5604.7.5 Unpacking and repacking explosive materials.** Containers of *explosive materials*, except fiberboard containers, and packages of damaged or deteriorated *explosive materials* or fireworks shall not be unpacked or repacked inside or within 50 feet (15 240 mm) of a magazine or in close proximity to other *explosive materials*.

- ❖ The packing or unpacking of boxes, crates, drums or other containers with metal staples, bands, nails or other ferrous parts may generate sparks, which could possibly ignite explosives stored within a magazine. The separation distance is intended to reduce the possibility of secondary explosions if an accident involving the explosives being handled occurs.

**5604.7.5.1 Storage of opened packages.** Packages of *explosive materials* that have been opened shall be closed before being placed in a magazine.

- ❖ The closing of the opened packages eliminates the hazard of mixing with other explosives, being available in case of an ignition source and causing an explosion or fire.

**5604.7.5.2 Nonsparking tools.** Tools used for the opening and closing of packages of *explosive materials*, other than metal slitters for opening paper, plastic or fiberboard containers, shall be made of nonsparking materials.

- ❖ Nonsparking tools are used to avoid producing sparks and igniting explosives. These tools must either be made from nonsparking materials or be painted to prevent them from producing sparks.

**5604.7.5.3 Disposal of packaging.** Empty containers and paper and fiber packaging materials that previously contained *explosive materials* shall be disposed of or reused in a *approved* manner.

- ❖ Debris from explosives shipments or use, including discarded packages, bags and cartons, must be disposed in accordance with the explosive manufacturer's instructions.

**5604.7.6 Tools and equipment.** Metal tools, other than non-ferrous transfer conveyors and ferrous metal conveyor stands

protected by a coat of paint, shall not be stored in a magazine containing *explosive materials* or detonators.

- ❖ Tools that can be stored in a magazine are limited to those needed to maintain the magazine and facilitate the transfer of explosives. These tools must be non-sparking or painted to prevent them from producing sparks. Ferrous tools with chipped or worn protective coatings must be removed from service and repainted before being placed back in use.

**5604.7.7 Contents.** Magazines shall be used exclusively for the storage of *explosive materials*, blasting materials and blasting accessories.

- ❖ Additional materials likely to pose a fire hazard or produce sparks when used cannot be stored inside magazines.

**5604.7.8 Compatibility.** Corresponding grades and brands of *explosive materials* shall be stored together and in such a manner that the grade and brand marks are visible. Stocks shall be stored so as to be easily counted and checked. Packages of *explosive materials* shall be stacked in a stable manner not exceeding 8 feet (2438 mm) in height.

- ❖ Identical grades and brands of explosives must be stored together, with the brands and grade marks showing. Explosive materials must be stored so they can be easily checked and counted.

**5604.7.9 Stock rotation.** When *explosive material* is removed from a magazine for use, the oldest usable stocks shall be removed first.

- ❖ Use of the oldest usable stock first assists in elimination of explosive material before it can deteriorate and become hazardous.

**5604.8 Maintenance.** Maintenance of magazines shall comply with Sections 5604.8.1 through 5604.8.3.

- ❖ This section addresses housekeeping, repairs and the floors on which the magazines are maintained.

**5604.8.1 Housekeeping.** Magazine floors shall be regularly swept and be kept clean, dry and free of grit, paper, empty packages and rubbish. Brooms and other cleaning utensils shall not have any spark-producing metal parts. Sweepings from magazine floors shall be disposed of in accordance with the manufacturers' *approved* instructions.

- ❖ Dirt and debris may contain materials that produce sparks or friction when explosives are moved within the magazine. Some blasting agents become sensitized or unstable when contaminated; therefore, regular cleaning and a maintenance schedule should be established and followed.

Cleaning implements with ferrous parts may produce sparks when used improperly. Only nonsparking tools may be used inside the magazine.

Finely divided residue on packages may pose an extreme fire hazard when improperly discarded. Most manufacturers recommend burning packages and debris from explosives at an approved remote location. The IME Safety Library Publication No. 21 con-

tains general guidance on the subject of disposing packages of explosives. Poor housekeeping often indicates other safety hazards.

**5604.8.2 Repairs.** *Explosive materials* shall be removed from the magazine before making repairs to the interior of a magazine. *Explosive materials* shall be removed from the magazine before making repairs to the exterior of the magazine where there is a possibility of causing a fire. *Explosive materials* removed from a magazine under repair shall either be placed in another magazine or placed a safe distance from the magazine, where they shall be properly guarded and protected until repairs have been completed. Upon completion of repairs, the *explosive materials* shall be promptly returned to the magazine. Floors shall be cleaned before and after repairs.

- ❖ Explosives must be removed from the magazine under repair and placed in another magazine or a safe distance away before beginning repair activities that could cause sparks or fire, and the floor must be cleaned before beginning repairs inside a magazine. Explosives must be properly guarded until they are returned to the magazine.

**5604.8.3 Floors.** Magazine floors stained with liquid shall be dealt with in accordance with instructions obtained from the manufacturer of the *explosive material* stored in the magazine.

- ❖ Floors stained with nitroglycerin must be cleaned according to the manufacturer's instructions. If the manufacturer cannot be identified or reached, another manufacturer, the nearest U.S. military installation, the ATF regional office or a local law enforcement agency must be contacted to request an explosive ordnance disposal (EOD) team.

**5604.9 Inspection.** Magazines containing *explosive materials* shall be opened and inspected at maximum seven-day intervals. The inspection shall determine whether there has been an unauthorized or attempted entry into a magazine or an unauthorized removal of a magazine or its contents.

- ❖ The importance of magazine security and explosives accountability cannot be overestimated, especially in light of the upsurge in incidents of international terrorists using bombs. In most cases of illicit use of explosives, the source of the explosive materials has been legitimate operating explosive material users. Magazines must be inspected at least weekly to determine that no theft or attempted theft has occurred. Thefts or tampering should be reported immediately to the fire code official and local and federal law enforcement officials.

**5604.10 Disposal of explosive materials.** *Explosive materials* shall be disposed of in accordance with Sections 5604.10.1 through 5604.10.7.

- ❖ Sections 5604.10.1 through 5604.10.7 cover the procedures for proper disposal of explosive materials. Areas covered are notification, deteriorated materials, qualified persons, storage of misfires, disposal sites, reuse of sites and personnel safeguards.

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**5604.10.1 Notification.** The *fire code official* shall be notified immediately where deteriorated or leaking *explosive materials* are determined to be dangerous or unstable and in need of disposal.

- ❖ The notification must include the following for each site where explosive material is stored: type of explosives, magazine capacity and location.

**5604.10.2 Deteriorated materials.** Where an *explosive material* has deteriorated to an extent that it is in an unstable or dangerous condition, or when a liquid has leaked from an *explosive material*, the person in possession of such material shall immediately contact the material's manufacturer to obtain disposal and handling instructions.

- ❖ Damaged or deteriorated explosives may become sensitized and unpredictable. Extreme caution must be used in handling such materials. Some explosives, such as nitroglycerin, become shock sensitive when contaminated or deteriorated because of age, exposure to ultraviolet light or excessive heating. Emergency forces should be summoned for standby while cleanup procedures are underway in situations involving sensitized or unstable explosives. If an accident occurs, fire fighters should attempt to protect exposures only from a distance and rescue individuals who are in immediate danger and safely reachable. Explosives manufacturers do not recommend fighting fires involving explosives because of the extreme danger associated with such operations. Manufacturers can provide advice and assistance in identifying a safe means of disposing of damaged explosives.

**5604.10.3 Qualified person.** The work of destroying *explosive materials* shall be directed by persons experienced in the destruction of *explosive materials*.

- ❖ Only an approved and experienced explosives technician is permitted to dispose of damaged, dangerous or unstable explosives. IME Safety Library Publication No. 21 contains general guidance on the safe destruction of damaged explosives and explosive waste. However, the manufacturer's specific guidance should always be followed first.

A military or law enforcement EOD team should be contacted if the licensee or permittee cannot provide a suitable explosives technician. Member companies of the IME have entered into a cooperative agreement to give advice and consultation to law enforcement agencies, fire departments and regulatory officials regarding the destruction or disposal of dangerous, damaged or unstable commercial explosives. Another manufacturer can lend assistance if the manufacturer of the damaged or dangerous goods cannot be identified or located.

**5604.10.4 Storage of misfires.** *Explosive materials* and fireworks recovered from blasting or display misfires shall be placed in a magazine until an experienced person has determined the proper method for disposal.

- ❖ Explosives recovered from misfires must be placed in a separate licensed magazine until they can be dis-

posed of according to the manufacturer's recommendations.

**5604.10.5 Disposal sites.** Sites for the destruction of *explosive materials* and fireworks shall be *approved* and located at the maximum practicable safe distance from inhabited buildings, public highways, operating buildings and all other exposures to ensure keeping air blast and ground vibration to a minimum. The location of disposal sites shall not be closer to magazines, inhabited buildings, railways, highways and other rights-of-way than is allowed by Tables 5604.5.2(1), 5604.5.2(2) and 5604.5.2(3). Where possible, *barricades* shall be utilized between the destruction site and inhabited buildings. Areas where *explosives* are detonated or burned shall be posted with adequate warning signs.

- ❖ A blasting shelter should be located near the burn area for protection from the blast and for emergency use of personnel.

**5604.10.6 Reuse of site.** Unless an *approved* burning site has been thoroughly saturated with water and has passed a safety inspection, 48 hours shall elapse between the completion of a burn and the placement of scrap explosive materials for a subsequent burn.

- ❖ Procedures and safeguards must be in place to prevent scrap explosive material from being placed in any burn location until at least 48 hours has passed since the last fires have gone out.

**5604.10.7 Personnel safeguards.** Once an *explosive* burn operation has been started, personnel shall relocate to a safe location where adequate protection from air blast and flying debris is provided. Personnel shall not return to the burn area until the person in charge has inspected the burn site and determined that it is safe for personnel to return.

- ❖ A warning device must be used when explosives and fireworks materials are being destroyed. This warning device may also be used to advise personnel when the area is safe for reentry.

### SECTION 5605 MANUFACTURE, ASSEMBLY AND TESTING OF EXPLOSIVES, EXPLOSIVE MATERIALS AND FIREWORKS

**5605.1 General.** The manufacture, assembly and testing of *explosives*, ammunition, blasting agents and fireworks shall comply with the requirements of this section and NFPA 495 or NFPA 1124.

#### Exceptions:

1. The hand loading of small arms ammunition prepared for personal use and not offered for resale.
  2. The mixing and loading of blasting agents at blasting sites in accordance with NFPA 495.
  3. The use of binary *explosives* or phosphoric materials in blasting or pyrotechnic special effects applications in accordance with NFPA 495 or NFPA 1126.
- ❖ This section covers emergency planning; separation of operating and manufacturing buildings; control

areas; operations and maintenance for the manufacturing, assembling and testing of explosives, blasting agents and fireworks. Section 5606 covers small arms ammunition. Exceptions 2 and 3 are addressed in NFPA standards.

Fireworks manufacturing is a relatively localized or concentrated industry. Most fireworks plants have settled and remain in predominantly rural locations for several reasons. Substantial sites are required to allow for isolation of manufacturing and storage buildings from one another to limit hazard exposures. These sites permit insulation from regulatory supervision. Skilled workers are required to assemble the fireworks; as a result, a loyal workforce usually develops in the regions where plants are located. Consequently, the local economy usually becomes heavily dependent on the industry's presence. Further, public concern and outcry is minimized by these factors, since occasional accidents are more or less expected. Increased regulatory attention and the prohibition of common fireworks in many states has, however, led to increased foreign competition that has further impacted the industry. Today, fewer than 100 American firms are engaged in this activity and they employ less than 3,000 persons. The U.S. Department of Treasury (DOTy) enforces regulations (DOTy 27 CFR; 55 and 181) restricting the import, manufacture, storage and use of fireworks and explosives.

**5605.2 Emergency planning and preparedness.** Emergency plans, emergency drills, employee training and hazard communication shall conform to the provisions of this section and Sections 404, 405, 406 and 407.

❖ Reference to Sections 404, 405 and 407 are also included for assistance with this section. See the commentary to those sections.

**5605.2.1 Hazardous Materials Management Plans and Inventory Statements required.** Detailed Hazardous Materials Management Plans (HMMP) and Hazardous Materials Inventory Statements (HMIS) complying with the requirements of Section 407 shall be prepared and submitted to the local emergency planning committee, the *fire code official* and the local fire department.

❖ Section 407.6 requires that Hazardous Materials Management Plans (HMMP) be in accordance with Section 2701.4.1, which gives the requirements for a facility site plan. Section 407.5 requires that the Hazardous Materials Inventory Statements (HMIS) be in accordance with Section 2701.4.2, which gives the items required in an HMIS.

**5605.2.2 Maintenance of plans.** A copy of the required HMMP and HMIS shall be maintained on site and furnished to the *fire code official* on request.

❖ A copy of the plant's plans must be kept in the office on the premises of each explosives, ammunition, blasting agent or fireworks manufacturing plant and must be made available to the *fire code official* or an authorized representative upon request.

**5605.2.3 Employee training.** Workers who handle *explosives* or *explosive* charges or dispose of *explosives* shall be trained in the hazards of the materials and processes in which they are to be engaged and with the safety rules governing such materials and processes.

❖ Employees who are required to handle the explosive materials need instructions concerning the hazards of the products. MSDS are a great source for the hazards of the materials. The employees must go through an orientation on the rules and regulations concerning the processes.

**5605.2.4 Emergency procedures.** *Approved* emergency procedures shall be formulated for each plant and shall include personal instruction in any anticipated emergency. Personnel shall be made aware of an emergency warning signal.

❖ Emergency procedures must be developed for each plant and building. Fire and disaster drills must be conducted and records of those drills must be kept at the plant office.

**5605.3 Intraplant separation of operating buildings.** *Explosives* manufacturing buildings and fireworks manufacturing buildings, including those where *explosive* charges are assembled, manufactured, prepared or loaded utilizing Division 1.1, 1.2, 1.3, 1.4 or 1.5 *explosives*, shall be separated from all other buildings, including magazines, within the confines of the manufacturing plant, at a distance not less than those shown in Table 5605.3 or 5604.5.2(3), as appropriate.

**Exception:** Fireworks manufacturing buildings separated in accordance with NFPA 1124.

The quantity of *explosives* in an operating building shall be the net weight of all *explosives* contained therein. Distances shall be based on the hazard division requiring the greatest separation, unless the aggregate *explosive* weight is divided by *approved* walls or shields designed for that purpose. Where dividing a quantity of *explosives* into smaller stacks, a suitable barrier or adequate separation distance shall be provided to prevent propagation from one stack to another.

Where distance is used as the sole means of separation within a building, such distance shall be established by testing. Testing shall demonstrate that propagation between stacks will not result. Barriers provided to protect against *explosive* effects shall be designed and installed in accordance with *approved* standards.

❖ Manufacturing operations frequently contain explosive materials that may fall into more than one division. When such is the case, Q-D relationships are established on the most severe case. The separation of explosives into piles by distance or the construction of substantial dividing walls (barrier wall) is a recognized means of mitigating the effects of conflagration by propagation. Propagation distances are established by testing. The construction of barriers can be accomplished by various means; however, the design of such structures must be specific to address the nature (impulse pressures) and time factors involved with the energy produced by explosive materials. The primary reference is U.S. Army

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Technical Manual TM 51300, Air Force Manual (AFM) 8822 and Navy NAVFAC P397, *Structures to Resist the Effects of Accidental Explosions*.

The exception recognizes that NFPA 1124 requirements cover site security; separation distances for manufacturing facilities; storage of salute and black powder; building construction and transportation of fireworks.

**TABLE 5605.3.** See below.

❖ Table 5605.3 has been designed to recognize explosives that either detonate or present a mass-explosion hazard (Divisions 1.1, 1.2 and 1.5). Under the classification system used by the code there is a need to recognize the various hazards of explosive materials when classified in other divisions, specifically Division 1.3 and 1.4 materials. The hazards of Division 1.3 materials are mass fire hazards where fire can involve the aggregate amount of undivided material. As finished goods, the hazards of Division

1.4 materials are limited to events with the individual articles. Division 1.5 materials are capable of detonation, and including them in Table 5605.3 represents the most conservative case. This table applies to the separation distances of buildings within an explosive manufacturing plant. Of course, the distance is related to the amount of explosives in storage. Distance and barricades are means of reducing damage to property and injury to personnel. With a barricade, the distance is sufficient, but without a barricade, the distance must be doubled to be the equivalent of a barricade. The quantity is calculated in pounds in each structure or building.

**5605.4 Separation of manufacturing operating buildings from inhabited buildings, public traffic routes and magazines.** Where an operating building on an *explosive* materials plant site is designed to contain *explosive* materials, such a building shall be located away from inhabited buildings, public traffic routes and magazines in accordance with Table 5604.5.2(2) or 5604.5.2(3) as appropriate, based on the maxi-

**TABLE 5605.3  
MINIMUM INTRALINE (INTRAPLANT) SEPARATION DISTANCES (ILD OR IPD) BETWEEN BARRICADED  
OPERATING BUILDINGS CONTAINING EXPLOSIVES—DIVISION 1.1, 1.2 OR 1.5 MASS-EXPLOSION HAZARD<sup>a</sup>**

NET EXPLOSIVE WEIGHT			NET EXPLOSIVE WEIGHT		
Pounds over	Pounds not over	Intraline Distance (ILD) or Intraplant Distance (IPD) (feet)	Pounds over	Pounds not over	Intraline Distance (ILD) or Intraplant Distance (IPD) (feet)
0	50	30	20,000	25,000	265
50	100	40	25,000	30,000	280
100	200	50	30,000	35,000	295
200	300	60	35,000	40,000	310
300	400	65	40,000	45,000	320
400	500	70	45,000	50,000	330
500	600	75	50,000	55,000	340
600	700	80	55,000	60,000	350
700	800	85	60,000	65,000	360
800	900	90	65,000	70,000	370
900	1,000	95	70,000	75,000	385
1,000	1,500	105	75,000	80,000	390
1,500	2,000	115	80,000	85,000	395
2,000	3,000	130	85,000	90,000	400
3,000	4,000	140	90,000	95,000	410
4,000	5,000	150	95,000	100,000	415
5,000	6,000	160	100,000	125,000	450
6,000	7,000	170	125,000	150,000	475
7,000	8,000	180	150,000	175,000	500
8,000	9,000	190	175,000	200,000	525
9,000	10,000	200	200,000	225,000	550
10,000	15,000	225	225,000	250,000	575
15,000	20,000	245	250,000	275,000	600
—	—	—	275,000	300,000	635

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg.

a. Where a building or magazine containing explosives is not barricaded, the intraline distances shown in this table shall be doubled.

mum quantity of *explosive* materials permitted to be in the building at one time (see Section 5601.8).

**Exception:** Fireworks manufacturing buildings constructed and operated in accordance with NFPA 1124.

- ❖ Buildings and other facilities used for mixing of blasting agents at a fixed location must comply with the separation requirements of Table 5604.5.2(1). The buildings must be isolated for the protection of life and nearby property. Suitable exterior barricades, natural or artificial, are to be provided on pressure-relief sides of buildings. The exception recognizes that NFPA 1124 requirements cover site security; separation distances for manufacturing facilities; storage of salute and black powder; building construction and transportation of fireworks.

**5605.4.1 Determination of net explosive weight for operating buildings.** In addition to the requirements of Section 5601.8 to determine the net *explosive* weight for materials stored or used in operating buildings, quantities of *explosive materials* stored in magazines located at distances less than intraline distances from the operating building shall be added to the contents of the operating building to determine the net *explosive* weight for the operating building.

- ❖ Manufacturing buildings are operating buildings within the context of the code. Explosive materials located in manufacturing buildings or process areas are classified as in-process materials and considered to be in use within the context of the code. The in-process materials are either located at workstations or are being staged as they enter or exit the manufacturing process.

It is common practice to utilize day boxes constructed to meet the requirements of a Type 3 magazine as a means to store explosives that are consumed over the course of a single workday or work shift so the magazine may be located either inside or immediately outside of the building in which the explosive materials are used. The use of pass-through type magazines that allow for delivery of explosive materials from the outside, and extraction of the explosive material from inside the building is commonplace. When pass-throughs are used, the magazine is located to abut the exterior building wall, with access to the inside limited to one or more access doors. In the most conservative sense, such magazines are considered to be outdoors and the exception granted by Section 5606.6.4.1 applicable to in-process material does not apply.

When the storage is located outside the building, there is a literal encroachment on the distances imposed by the code that require the magazines to be separated from the building in which the material is used. The net explosive weight (or contents) of the operating building or magazine is used to determine the separation distances required. Section 5604.5.1.3 allows the storage of up to 50 pounds (23 kg) of explosive material to be located in an indoor magazine when such magazines are not regulated by Section 5605.6.4.1. Quantities in excess of 50 pounds

(23 kg) in a storage magazine are required to be stored in outdoor magazines. For the storage of finished goods or raw materials there is seldom a problem because the outdoor magazines are normally located well away from the manufacturing area.

The problem arises with storage of explosives, other than those designated for in-process use, when small quantities of up to 50 pounds (23 kg) are to be located outdoors in a magazine that could otherwise be located indoors. Literally interpreted, the code requires a separation between any magazine and an operating building regardless of the contents of the magazine. Whether an indoor magazine limited to 50 pounds (23 kg) net explosive weight is located either immediately inside an access door to the work area or immediately outside the same door does not change the hazard of its contents. It is reasonable to restrict the quantities of explosive materials located outside the door to an amount not to exceed that which would otherwise be allowed to be located inside the door, i.e., 50 pounds (23 kg). Quantities that exceed the amount allowed indoors must be in magazines located at not less than the tabular distances specified by the IPD tables.

Explosives stored or used within the ILD assigned to an operating building must be accounted for in determining the location of the building with its proximity to others. This section requires that the aggregate quantity of explosives stored or used in an operating building be derived by adding the totals of all material stored in magazines inside or outside the building to the total of material in process.

Sections 5605.4.1.1 through 5605.4.1.4 limit the quantity of explosives allowed to be stored in magazines within the ILD whether located inside or outside of the building, or both, to not more than 50 pounds (23 kg), thereby maintaining the intent of the code, which is to move larger quantities of material away from the building to storage arrangements of a more permanent nature.

By establishing clear rules that recognize the need for operating buildings to have limited quantities of explosive materials other than in-process materials in storage proximate to the point of use, operational safety is enhanced and the concept of quantity control remains intact.

**5605.4.1.1 Indoor magazines.** The storage of *explosive* materials located in indoor magazines in operating buildings shall be limited to a net *explosive* weight not to exceed 50 pounds (23 kg).

- ❖ See the commentary to Section 5605.4.1.

**5605.4.1.2 Outdoor magazines with a net explosive weight less than 50 pounds.** The storage of *explosive materials* in outdoor magazines located at less than intraline distances from operating buildings shall be limited to a net *explosive* weight not to exceed 50 pounds (23 kg).

- ❖ See the commentary to Section 5605.4.1.

**5605.4.1.3 Outdoor magazines with a net explosive weight greater than 50 pounds.** The storage of *explosive materials*

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in outdoor magazines in quantities exceeding 50 pounds (23 kg) net *explosive* weight shall be limited to storage in outdoor magazines located not less than intraline distances from the operating building in accordance with Section 5604.5.2.

❖ See the commentary to Section 5605.4.1.

**5605.4.1.4 Net explosive weight of materials stored in combination indoor and outdoor magazines.** The aggregate quantity of *explosive materials* stored in any combination of indoor magazines or outdoor magazines located at less than the intraline distances from an operating building shall not exceed 50 pounds (23 kg).

❖ See the commentary to Section 5605.4.1.

**5605.5 Buildings and equipment.** Buildings or rooms that exceed the *maximum allowable quantity per control area* of *explosive materials* shall be operated in accordance with this section and constructed in accordance with the requirements of the *International Building Code* for Group H occupancies.

**Exception:** Fireworks manufacturing buildings constructed and operated in accordance with NFPA 1124.

❖ The IBC addresses the issue of buildings that exceed the maximum allowable quantities per control area (MAQ) found in Table 307.7(1) of the IBC as well as in Chapter 50 of the code. The exception recognizes that NFPA 1124 requirements cover site security, separation distances for manufacturing facilities, storage of salute and black powder, building construction and transportation of fireworks.

**5605.5.1 Explosives dust.** *Explosives* dust shall not be exhausted to the atmosphere.

❖ Exhausting explosive dust into the atmosphere creates an explosive hazard. When the concentration of air and dust reaches the ignition stage, explosions can occur and cause both physical and structural damage.

**5605.5.1.1 Wet collector.** When collecting *explosives* dust, a wet collector system shall be used. Wetting agents shall be compatible with the *explosives*. Collector systems shall be interlocked with process power supplies so that the process cannot continue without the collector systems also operating.

❖ Wet processes will be used wherever practicable in mixing explosive materials. Wet processing eliminates the probability of dust being an explosive hazard.

**5605.5.1.2 Waste disposal and maintenance.** *Explosives* dust shall be removed from the collection chamber as often as necessary to prevent overloading. The entire system shall be cleaned at a frequency that will eliminate hazardous concentrations of *explosives* dust in pipes, tubing and ducts.

❖ Ducts are to be grounded and be as short and straight as possible with no caps, outlets, pockets or other dead-end spaces where explosives might accumulate.

**5605.5.2 Exhaust fans.** Squirrel cage blowers shall not be used for exhausting hazardous fumes, vapors or gases. Only nonferrous fan blades shall be used for fans located within the

ductwork and through which hazardous materials are exhausted. Motors shall be located outside the duct.

❖ Ventilation and dust control equipment must be of such a type and installed and operated to not endanger employees by possible ignition of explosives.

**5605.5.3 Work stations.** Work stations shall be separated by distance, barrier or other *approved* alternatives so that fire in one station will not ignite material in another work station. Where necessary, the operator shall be protected by a personnel shield located between the operator and the *explosive* device or *explosive material* being processed. This shield and its support shall be capable of withstanding a blast from the maximum amount of *explosives* allowed behind it.

❖ Using safety precautions should eliminate most problems in a work station; however, sometimes accidents happen beyond our control. The separation requirements in this section are intended to protect workstations from accidents in another station and their operators from all accidental blasts. Protection of the worker must always be of high priority.

**5605.6 Operations.** Operations involving *explosives* shall comply with Sections 5605.6.1 through 5605.6.10.

❖ The following sections address the operations that involve explosives. These sections apply to isolating the operations; controlling static electricity; using approved containers for bulk materials; having quantity limits; properly disposing of waste; abiding by safety rules, posting limits and not storing explosive materials near a heat source.

**5605.6.1 Isolation of operations.** Where the type of material and processing warrants, mechanical operations involving *explosives* in excess of 1 pound (0.454 kg) shall be carried on at isolated stations or at intraplant distances, and machinery shall be controlled from remote locations behind *barricades* or at separations so that workers will be at a safe distance while machinery is operating.

❖ The machinery used in processing operations on explosive items weighing more than 1 pound (0.454 kg) must be controlled from remote locations and behind barricades for the safety of personnel. These extra safety controls are not required when no unit or separate article of any manufactured or assembled explosive device contains more than 1 pound (0.454 kg) of explosive material.

**5605.6.2 Static controls.** The work area where the screening, grinding, blending and other processing of static-sensitive *explosives* or pyrotechnic materials is done shall be provided with *approved* static controls.

❖ The working area must be maintained above 20-percent relative humidity. If the relative humidity drops below 20 percent, the above operations must be stopped and secured until the relative humidity can be raised above 20 percent. It is desirable to keep the relative humidity above 20 to 30 percent, except where metal powders are involved. In that case, the relative humidity should be between 50 and 60 per-

cent. Means must be provided and used to discharge static electricity from hand trucks, buggies and similar equipment before they enter buildings containing static-sensitive explosives. Conductive wheels, including metal wheels that could not cause sparks, are recommended for this equipment.

**5605.6.3 Approved containers.** Bulk *explosives* shall be kept in *approved*, nonsparking containers when not being used or processed. *Explosives* shall not be stored or transported in open containers.

- ❖ Explosive materials must be kept in covered containers except when being used or processed. The closed containers eliminate the possibility of an ignition source falling into the containers and causing an explosion.

**5605.6.4 Quantity limits.** The quantity of *explosives* at any particular work station shall be limited to that posted on the load limit signs for the individual work station. The total quantity of *explosives* for multiple workstations shall not exceed that established by the intraplant distances in Table 5605.3 or 5604.5.2(3), as appropriate.

- ❖ The maximum permissible quantities of explosive materials allowed by Table 5605.3 must be clearly indicated with suitable signs, usually with letters not less than 3 inches (76 mm) high.

**5605.6.4.1 Magazines.** Magazines used for storage in processing areas shall be in accordance with the requirements of Section 5604.5.1. *Explosive materials* shall be removed to appropriate storage magazines for unattended storage at the end of the work day. The contents of indoor magazines shall be added to the quantity of *explosives* contained at individual workstations and the total quantity of material stored, processed or used shall be utilized to establish the intraplant separation distances indicated by Table 5605.3 or 5604.5.2(3), as appropriate.

- ❖ This section makes it clear that indoor magazines can be used in manufacturing areas when in accordance with the requirements of the code, including quantity limits, separation distances and limitations on the number of magazines. Materials contained in magazines add to the net explosive weight (NEW) for the building, and intraplant separations are based on NEW.

This section also recognizes that there may be more than one workstation in a process area with the control on the location of process areas established by IPD. Removal of any residual stored contents at the end of the day is consistent with requirements of NFPA 495 and military standards governing process operations.

**5605.6.5 Waste disposal.** *Approved* receptacles with covers shall be provided for each location for disposing of waste material and debris. These waste receptacles shall be emptied and cleaned as often as necessary but not less than once each day or at the end of each shift.

- ❖ Waste receptacles with tight-fitting covers must be supplied at or just outside of each working area for

the disposal of waste material, cleaning rags and other combustible waste and debris. The containers must be emptied daily or at the end of each shift.

**5605.6.6 Safety rules.** General safety rules and operating instructions governing the particular operation or process conducted at that location shall be available at each location.

- ❖ Operating instructions must be posted at or near each working area. These instructions must include the technical steps for the process and the safety precautions the operators must follow for their personal safety.

**5605.6.7 Personnel limits.** The number of occupants in each process building and in each magazine shall not exceed the number necessary for proper conduct of production operations.

- ❖ The number of persons involved in performing the process must be held to a minimum to make sure there is enough room for those performing the operation. Too many occupants reduces operating space, increasing the potential for an accident that could result in injury or building damage.

**5605.6.8 Pyrotechnic and explosive composition quantity limits.** Not more than 500 pounds (227 kg) of pyrotechnic or *explosive* composition, including not more than 10 pounds (5 kg) of salute powder shall be allowed at one time in any process building or area. Compositions not in current use shall be kept in covered nonferrous containers.

**Exception:** Composition that has been loaded or pressed into tubes or other containers as consumer fireworks.

- ❖ The maximum amount of pyrotechnic or explosive materials contained at any one time in any building used for the manufacture or assembly of products using or containing explosive materials must not exceed the amounts listed above. This action will assist in eliminating the possibility of a catastrophic explosion.

**5605.6.9 Posting limits.** The maximum number of occupants and maximum weight of pyrotechnic and *explosive* composition permitted in each process building shall be posted in a conspicuous location in each process building or magazine.

- ❖ Only persons essential to the operation can be allowed in the mixing and packaging area. Usually, no more than one day's production of explosive material should be allowed in the mixing and packaging area. These limitations must be posted in an obvious location.

**5605.6.10 Heat sources.** Fireworks, *explosives* or *explosive* charges in *explosive materials* manufacturing, assembly or testing shall not be stored near any source of heat.

**Exception:** *Approved* drying or curing operations.

- ❖ Storing the explosive materials near heat sources obviously will be an explosion hazard. Stored explosive products must be separated an adequate distance from any heat source. The building heat source should be located outside the building.

## EXPLOSIVES AND FIREWORKS

**5605.7 Maintenance.** Maintenance and repair of *explosives*-manufacturing facilities and areas shall comply with Section 5604.8.

- ❖ Section 5604.8 covers the subjects of housekeeping, repairs and floors of buildings and facilities. Having a periodic maintenance program in place will keep hazards to a minimum.

**5605.8 Explosive materials testing sites.** *Detonation* of *explosive* materials or ignition of fireworks for testing purposes shall be done only in isolated areas at sites where distance, protection from missiles, shrapnel or flyrock, and other safeguards provides protection against injury to personnel or damage to property.

- ❖ Operations or activities on a site where explosive materials are used, stored or handled could be subject to additional or more restrictive requirements or conditions at the discretion of the local fire code official.

**5605.8.1 Protective clothing and equipment.** Protective clothing and equipment shall be provided to protect persons engaged in the testing, ignition or *detonation* of *explosive materials*.

- ❖ Personnel must be dressed in proper personal protective equipment to eliminate the hazard of physical injury.

**5605.8.2 Site security.** Where tests are being conducted or *explosives* are being detonated, only authorized persons shall be present. Areas where *explosives* are regularly or frequently detonated or burned shall be *approved* and posted with adequate warning signs. Warning devices shall be activated before burning or detonating *explosives* to alert persons approaching from any direction that they are approaching a danger zone.

- ❖ Only authorized personnel can be allowed in test area enclosures. Audible and visible warning devices must be used to warn nearby personnel before detonating or burning any explosive material.

**5605.9 Waste disposal.** Disposal of *explosive materials* waste from manufacturing, assembly or testing operations shall be in accordance with Section 5604.10.

- ❖ Section 5604.10 addresses the issues of notification, deteriorated materials, qualified people, storage of misfires, sites for disposal and reuse and safety for personnel.

### SECTION 5606

#### SMALL ARMS AMMUNITION AND SMALL ARMS AMMUNITION COMPONENTS

**5606.1 General.** Indoor storage and display of black powder, smokeless propellants, small arms primers and small arms ammunition shall comply with this section and NFPA 495.

- ❖ This section addresses the storage of small arms ammunition and its components, including proper packaging, in residential and commercial occupan-

cies. NFPA 495 also contains requirements for these materials.

**5606.2 Prohibited storage.** Small arms ammunition shall not be stored together with Division 1.1, Division 1.2 or Division 1.3 *explosives* unless the storage facility is suitable for the storage of *explosive materials*.

- ❖ Small arms ammunition must not be stored with explosives that have mass explosion, projection or fire hazards. If the storage facility meets the requirements of the local fire code official, however, this storage is allowed. Separation and explosive wave prevention are two requirements that should be met.

**5606.3 Packages.** Smokeless propellants shall be stored in *approved* shipping containers conforming to DOTn 49 CFR Part 173.

- ❖ Smokeless propellants must not be stored in their original factory containers. DOTn 49 CFR, Part 173 addresses precautions such as not allowing metal (nails, staples, etc.) to penetrate the interior of a container, interior packaging not allowing contents to shift and become loose and packaging being made compatible with the explosives kept in the container.

**5606.3.1 Repackaging.** The bulk repackaging of smokeless propellants, black powder and small arms primers shall not be performed in retail establishments.

- ❖ Bulk repackaging must be performed by qualified personnel. The product should be handled by trained explosives personnel and in the proper location for human and property safety.

**5606.3.2 Damaged packages.** Damaged containers shall not be repackaged.

**Exception:** *Approved* repackaging of damaged containers of smokeless propellant into containers of the same type and size as the original container.

- ❖ Damaged containers must not be repackaged. Smokeless propellants must not be transferred from the approved container into one that is not approved.

**5606.4 Storage in Group R occupancies.** The storage of small arms ammunition components in Group R occupancies shall comply with Sections 5606.4.1 through 5606.4.3.

- ❖ The following sections cover storage requirements for black powder, smokeless propellants and small arms primers in Group R occupancies [which do not include detached one- and two-family dwellings or townhouses constructed under the *International Residential Code*<sup>®</sup> (IRC<sup>®</sup>)].

**5606.4.1 Black powder.** Black powder for personal use in quantities not exceeding 20 pounds (9 kg) shall be stored in original containers in occupancies limited to Group R-3. Quantities exceeding 20 pounds (9 kg) shall not be stored in any Group R occupancy.

- ❖ Black powder used in muzzle-loading firearms intended for personal use in quantities not exceeding 20 pounds (9 kg) in original containers may be stored without restriction in Group R-3 occupancies. Quanti-

ties exceeding 20 pounds (9 kg) are not allowed, regardless of the type of container.

**5606.4.2 Smokeless propellants.** Smokeless propellants for personal use in quantities not exceeding 20 pounds (9 kg) shall be stored in original containers in occupancies limited to Group R-3. Smokeless propellants in quantities exceeding 20 pounds (9 kg) but not exceeding 50 pounds (23 kg) and kept in a wooden box or cabinet having walls of not less than 1 inch (25 mm) nominal thickness shall be allowed to be stored in occupancies limited to Group R-3. Quantities exceeding these amounts shall not be stored in any Group R occupancy.

- ❖ Small arms smokeless propellant intended for personal use in quantities not exceeding 20 pounds (9 kg) in original containers may be stored without restriction in Group R-3 occupancies; quantities exceeding 20 pounds (9 kg) but not exceeding 50 pounds (23 kg) must be stored in a strong box or cabinet constructed with 1-inch (25 mm) wood (minimum) or equivalent on all sides, top and bottom.

**5606.4.3 Small arms primers.** Not more than 10,000 small arms primers shall be stored in occupancies limited to Group R-3.

- ❖ This section mirrors the provisions of NFPA 495, which allows storage of no more than 10,000 primers in a private residence. Even the most avid small arms ammunition reloader should have no reason to store in excess of 1,000 each of large rifle, large rifle magnum, small rifle, large pistol, large pistol magnum, small pistol, small pistol magnum and shotgun primers, (a total of 8,000 primers). See the description of Group R-3 occupancies in Chapter 2.

**5606.5 Display and storage in Group M occupancies.** The display and storage of small arms ammunition components in Group M occupancies shall comply with Sections 5606.5.1 through 5606.5.2.3.

- ❖ Ignited stored powder can raise pressure within the storage area; therefore, there are specific requirements for keeping powder on hand. The first of these is never to transfer any propellant from its original container, which is designed to burst or partially open at very low pressures. Some container caps will simply just push off if the contents are ignited.

**5606.5.1 Display.** Display of small arms ammunition components in Group M occupancies shall comply with Sections 5606.5.1.1 through 5606.5.1.3.

- ❖ The display quantities of smokeless propellants, black powder and small arms primers are given in the following sections.

**5606.5.1.1 Smokeless propellant.** Not more than 20 pounds (9 kg) of smokeless propellants, in containers of 1 pound (0.454 kg) or less capacity each, shall be displayed in Group M occupancies.

- ❖ Displayed containers of smokeless propellant must be limited to 1 pound (0.454 kg) each. The total quantity of smokeless propellant not in an approved magazine is limited to 20 pounds (9 kg).

The 20-pound (9 kg) limit can be traced back to the

original edition of the legacy *Uniform Fire Code* in 1971. This quantity was considered by the International Conference of Building Officials (ICBO) membership to be the maximum allowable quantity in retail sales occupancies based on the potential risk posed to the public. There was no “magic reason” for establishing the 20-pound (9 kg) limit other than agreement by the various ICBO code development committees that it would be unreasonable to expose the public to potential accidents involving greater quantities. According to records, the 20-pound (9 kg) limitation originated from the Explosives Committee of the California Fire Chiefs Association/Southern Division, Fire Prevention Officers Section. Quoting from this committee, its reason for the limit was as follows:

“The quantities were arrived at over a protracted period of time by a mutual exchange of information between representatives of public and private sectors of the economy, who possessed experience in dealing with these materials. Specific regulations represented a compromise between the various points of view expressed during several meetings. In general, the public safety was the key issue in the final proposed regulations. The committee would like to point out that at some point the line must be drawn. A recent series of tests conducted by this committee on both smokeless and black powder indicated that there is an appreciable hazard involved when even small amounts of these materials are exposed to fire. Black powder is much more sensitive than smokeless and should be kept in a magazine at all times to reduce the chance of ignition and propagation. Smokeless powder, which is less sensitive than black powder, can be openly displayed, but the amount should be limited due to its capacity for increasing a fire hazard. It is our feeling that the current 20 pound limit on display should be the maximum.”

**5606.5.1.2 Black powder.** Not more than 1 pound (0.454 kg) of black powder shall be displayed in Group M occupancies.

- ❖ Safety must be the first priority when black powder is accessible to the public. The 1-pound (0.454 kg) limitation holds to the objective of keeping the public from having access to enough black powder to cause serious damage if mishandled.

**5606.5.1.3 Small arms primers.** Not more than 10,000 small arms primers shall be displayed in Group M occupancies.

- ❖ Because of their explosive nature, only the absolute minimum should be kept on display. With care in replacing exhausted supplies, it is not difficult to adhere to the 10,000-primer limit.

**5606.5.2 Storage.** Storage of small arms ammunition components shall comply with Sections 5606.5.2.1 through 5606.5.2.3.

- ❖ Generally, propellants used in sporting arms cartridges will not explode or detonate when ignited. Burning smokeless propellants do not generate the

shock wave produced by an explosive. Unlike smokeless propellants, shock waves produced by ignition of an explosive cannot be adequately vented, even when ignition occurs in the open.

**5606.5.2.1 Smokeless propellant.** Commercial stocks of smokeless propellants shall be stored as follows:

1. Quantities exceeding 20 pounds (9 kg), but not exceeding 100 pounds (45 kg) shall be stored in portable wooden boxes having walls of not less than 1 inch (25 mm) nominal thickness.
2. Quantities exceeding 100 pounds (45 kg), but not exceeding 800 pounds (363 kg), shall be stored in non-portable storage cabinets having walls not less than 1 inch (25 mm) nominal thickness. Not more than 400 pounds (182 kg) shall be stored in any one cabinet, and cabinets shall be separated by a distance of not less than 25 feet (7620 mm) or by a *fire partition* having a *fire-resistance rating* of not less than 1 hour.
3. Storage of quantities exceeding 800 pounds (363 kg), but not exceeding 5,000 pounds (2270 kg) in a building shall comply with all of the following:
  - 3.1. The warehouse or storage room is unaccessible to unauthorized personnel.
  - 3.2. Smokeless propellant shall be stored in nonportable storage cabinets having wood walls not less than 1 inch (25 mm) nominal thickness and having shelves with not more than 3 feet (914 mm) of separation between shelves.
  - 3.3. Not more than 400 pounds (182 kg) is stored in any one cabinet.
  - 3.4. Cabinets shall be located against walls of the storage room or warehouse with not less than 40 feet (12 192 mm) between cabinets.
  - 3.5. The minimum required separation between cabinets shall be 20 feet (6096 mm) provided that *barricades* twice the height of the cabinets are attached to the wall, midway between each cabinet. The *barricades* must extend not less than 10 feet (3048 mm) outward, be firmly attached to the wall and be constructed of steel not less than  $\frac{1}{4}$  inch thick (6.4 mm), 2-inch (51 mm) nominal thickness wood, brick or concrete block.
  - 3.6. Smokeless propellant shall be separated from materials classified as *combustible liquids*, flammable liquids, flammable solids or oxidizing materials by a distance of 25 feet (7620 mm) or by a *fire partition* having a *fire-resistance rating* of 1 hour.
  - 3.7. The building shall be equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.
4. Smokeless propellants not stored in accordance with Item 1, 2, or 3 above shall be stored in a Type 2 or 4

magazine in accordance with Section 5604 and NFPA 495.

- ❖ Storage cabinets are often made of 1-inch-thick (25 mm) wood with one or more walls designed to open outward or blow free at very low pressures. They should be many times larger than necessary to store the minimum quantities of powder. Propellants must not be stored in the same area with solvents, flammable gases, primers or highly combustible materials. Smoking should never be allowed in the storage areas or while handling or using powder.

**5606.5.2.2 Black powder.** Commercial stocks of black powder in quantities less than 50 pounds (23 kg) shall be allowed to be stored in Type 2 or 4 indoor or outdoor magazines. Quantities greater than 50 pounds (23 kg) shall be stored in outdoor Type 2 or 4 magazines. Where black powder and smokeless propellants are stored together in the same magazine, the total quantity shall not exceed that permitted for black powder.

- ❖ Black powder must be stored in a magazine no matter the quantity. The guideline quantity of 50 pounds (23 kg) is the dividing line between storage in an indoor or outdoor magazine. The code does allow storage of smokeless propellants along with black powder as long as the total quantity given in this section for black powder is not exceeded. The maximum quantity is given to limit the explosive potential in considering life safety and property damage.

**5606.5.2.3 Small arms primers.** Commercial stocks of small arms primers shall be stored as follows:

1. Quantities not to exceed 750,000 small arms primers stored in a building shall be arranged such that not more than 100,000 small arms primers are stored in any one pile and piles are not less than 15 feet (4572 mm) apart.
2. Quantities exceeding 750,000 small arms primers stored in a building shall comply with all of the following:
  - 2.1. The warehouse or storage building shall not be accessible to unauthorized personnel.
  - 2.2. Small arms primers shall be stored in cabinets. Not more than 200,000 small arms primers shall be stored in any one cabinet.
  - 2.3. Shelves in cabinets shall have vertical separation of not less than 2 feet (610 mm).
  - 2.4. Cabinets shall be located against walls of the warehouse or storage room with not less than 40 feet (12 192 mm) between cabinets. The minimum required separation between cabinets shall be allowed to be reduced to 20 feet (6096 mm) provided that *barricades* twice the height of the cabinets are attached to the wall, midway between each cabinet. The *barricades* shall be firmly attached to the wall and shall be constructed of steel not less than  $\frac{1}{4}$  inch thick (6.4

mm), 2-inch (51 mm) nominal thickness wood, brick or concrete block.

2.5. Small arms primers shall be separated from materials classified as *combustible liquids*, flammable liquids, flammable solids or oxidizing materials by a distance of 25 feet (7620 mm) by a *fire partition* having a *fire-resistance rating* of 1 hour.

2.6. The building shall be protected throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.

3. Small arms primers not stored in accordance with Item 1 or 2 of this section shall be stored in a magazine meeting the requirements of Section 5604 and NFPA 495.

- ❖ Primers must be stored in a remote area away from any possible source of ignition, including bullet impact. Primers are by nature explosive. As a result, they may explode if subjected to friction, percussion, crushing or excessive heat from any cause, whether open flame or not. Static electricity and many other abuses can cause primers to explode; therefore, public access to storage containers must not be allowed.

Primers must be stored away from oxidizing agents and flammable liquids and solids. Naturally, smoking should be prohibited around primers. The storage cabinet is strongly recommended. The cabinet should be constructed of 1-inch-thick (25 mm) lumber to delay the transfer of heat to contents in the event of a fire or other mishap.

## SECTION 5607 BLASTING

**5607.1 General.** Blasting operations shall be conducted only by *approved*, competent operators familiar with the required safety precautions and the hazards involved and in accordance with the provisions of NFPA 495.

- ❖ Personnel using explosives must be at least 21 years old and possess all required federal [see Title 18 U.S. Code (USC), Chapter 40], state and local approvals or permits. Employees under 21 years old but at least 18 years old may serve as apprentices or assistants under direct supervision of a permittee. In addition to these requirements, individuals who handle explosives must not:

1. Be under the influence of alcohol or drugs.
2. Smoke or carry matches or firearms.
3. Use or carry an open flame or open flame-producing device.

Many states require individuals who handle explosives to obtain a certificate of fitness, which is dubbed a “blaster’s permit,” before being authorized to handle or use explosives. The individual must be bonded or show acceptable proof of insurance, pass a written examination demonstrating an adequate understand-

ing of the applicable codes and ordinances and demonstrate adequate experience (usually a minimum of three years) in handling explosives safely in an approved apprenticeship program to obtain a fitness certificate.

**5607.2 Manufacturer’s instructions.** Blasting operations shall be performed in accordance with the instructions of the manufacturer of the *explosive materials* being used.

- ❖ No blasting operation will be performed in a manner contrary to the instructions of the manufacturer of the explosive materials being used. Each manufacturer has its own instructions for discharging its explosives.

**5607.3 Blasting in congested areas.** Where blasting is done in a congested area or in close proximity to a structure, railway or highway, or any other installation, precautions shall be taken to minimize earth vibrations and air blast effects. Blasting mats or other protective means shall be used to prevent fragments from being thrown.

- ❖ Precautions must be taken to minimize damage from blasting operations where those operations are likely to generate projectiles, scatter debris or produce significant blast-wave effects.

**5607.4 Restricted hours.** Surface-blasting operations shall only be conducted during daylight hours between sunrise and sunset. Other blasting shall be performed during daylight hours unless otherwise *approved* by the *fire code official*.

- ❖ Darkness impairs the effectiveness of the most important sense involved in setting surface explosive charges—sight. This section improves the safety of surface blasting by allowing it only between sunrise and sunset when ample natural light is available. Care must be taken throughout blasting operations to inspect all elements of the explosive setup.

Nighttime nonsurface blasting operations require approved artificial illumination. The lighting could pose a hazard if improper equipment or procedures are used. Only the fire code official may authorize nighttime blasting operations.

**5607.5 Utility notification.** Where blasting is being conducted in the vicinity of utility lines or rights-of-way, the blaster shall notify the appropriate representatives of the utilities not less than 24 hours in advance of blasting, specifying the location and intended time of such blasting. Verbal notices shall be confirmed with written notice.

**Exception:** In an emergency situation, the time limit shall not apply where *approved*.

- ❖ Steps must be taken to prevent disruption of public utility services. Location of underground utilities in many areas must be designated by a utility locator service before blasting or construction begins. Notification may not relieve the blaster of liability if operations disrupt utility service. Therefore, great care must be exercised when blasting in the vicinity of utilities. Blasting must not proceed without the approval of utility officials and the fire code official.

The exception recognizes that there may be emergency conditions under which it is not possible to

strictly comply with the full 24-hour advance notice requirement. Conditions represented as an emergency must be approved as such by the fire code official. (Note: Both verbal and written notification must still be made in as timely a manner as the emergency will permit prior to blasting operations.)

**5607.6 Electric detonator precautions.** Precautions shall be taken to prevent accidental discharge of electric detonators from currents induced by radar and radio transmitters, lightning, adjacent power lines, dust and snow storms, or other sources of extraneous electricity.

❖ Wires connecting elements of the explosive train may act as an antenna or conduct electricity from sources outside of those controlled by the blaster. Therefore, special precautions are required to prevent inadvertent detonation of explosive materials:

1. The 350-foot (106 m) separation distance provides a significant safety margin. Recommended minimum clearances for citizens band, VHF, UHF and cellular telephone transmitters with up to 50 watts vary from 5 to 180 feet (1524 to 54 864 mm). Nearly all mobile transmitters operate between 3 and 30 watts.
2. Power lines may also emit radio frequency energy (see IME Safety Library Publication No. 20 for guidance on separation from other radio frequency sources).
3. Lightning produces more than sufficient energy to detonate explosive materials. Charges should not be placed when there has been adequate warning of an approaching storm. If charges have been set before warning of an approaching storm is received, blast site workers should abandon their operations and take cover until the storm passes.

**5607.7 Nonelectric detonator precautions.** Precautions shall be taken to prevent accidental initiation of nonelectric detonators from stray currents induced by lightning or static electricity.

❖ All elements of pneumatic loading devices must be electrically bonded and a positive grounding device for the equipment must be used to prevent the accumulation of static electricity. Water lines, air lines, rails or permanent electric grounding systems for other equipment must not be used to ground pneumatic loading equipment.

**5607.8 Blasting area security.** During the time that holes are being loaded or are loaded with *explosive materials*, blasting agents or detonators, only authorized persons engaged in drilling and loading operations or otherwise authorized to enter the site shall be allowed at the blast site. The blast site shall be guarded or barricaded and posted. Blast site security shall be maintained until after the post-blast inspection has been completed.

❖ Loading and firing operations are the most hazardous steps in the blasting process. To prevent inadvertent detonation while electrically fired charges are being

set, only the individual making lead wire connections must fire the shot [see DOL 29 CFR, Parts 1910.109 (e)(4)(viii) and 1926.906(s)]. Similar precautions must be taken when firing explosives using other methods. Individuals performing or supervising loading and firing operations must hold all required federal (see 18 USC Chapter 40 and DOTy 27 CFR 55, Subpart D), state and local approvals or permits.

**5607.9 Drill holes.** Holes drilled for the loading of *explosive* charges shall be made and loaded in accordance with NFPA 495.

❖ Drill holes must be large enough to allow free insertion of cartridges of explosive materials and cannot be collared in bootlegs or in holes that previously contained explosive materials. Holes must not be drilled where there is a danger of intersecting another hole containing explosive material. Of utmost importance, all drill holes must be inspected and cleared of any obstruction before loading. NFPA 495 gives other requirements for drilling the holes.

**5607.10 Removal of excess explosive materials.** After loading for a blast is completed and before firing, excess *explosive materials* shall be removed from the area and returned to the proper storage facilities.

❖ After loading is completed, surplus explosive materials must be returned to an approved magazine before firing.

**5607.11 Initiation means.** The initiation of blasts shall be by means conforming to the provisions of NFPA 495.

❖ Cap and fuse cannot be used to initiate blasts on or adjacent to highways open to traffic or in congested areas. NFPA 495 gives the burning rate and safety fuse length in units of time.

**5607.12 Connections.** The blaster shall supervise the connecting of the blastholes and the connection of the loadline to the power source or initiation point. Connections shall be made progressively from the blasthole back to the initiation point.

Blasting lead lines shall remain shunted (shorted) and shall not be connected to the blasting machine or other source of current until the blast is to be fired.

❖ Connections must be made progressively from the blast holes to the source of firing current. The shorted lead wire must remain unconnected until the blast is ready for firing. Only insulated leading wire of adequate current-carrying capacity can be used.

**5607.13 Firing control.** A blast shall not be fired until the blaster has made certain that all surplus *explosive materials* are in a safe place in accordance with Section 5607.10, all persons and equipment are at a safe distance or under sufficient cover and that an adequate warning signal has been given.

❖ The blaster must conduct a complete survey of the blast site before blasting begins. Surplus charges must be placed in a magazine or day box and individuals and vehicles must be cleared from the blast site.

A loud warning signal (claxon horn or whistle) must be sounded before charges are fired to alert workers that blasting is about to begin (see also IME Safety Library Publication Nos. 3, 4 and 17).

**5607.14 Post-blast procedures.** After the blast, the following procedures shall be observed.

1. No person shall return to the blast area until allowed to do so by the blaster in charge.
2. The blaster shall allow sufficient time for smoke and fumes to dissipate and for dust to settle before returning to or approaching the blast area.
3. The blaster shall inspect the entire blast site for misfires before allowing other personnel to return to the blast area.

❖ Blast areas must not be reentered after firing until concentrations of smoke, dust and fumes have been reduced to safe limits as determined by the blaster in charge. The blaster must determine the length of time before any person is permitted in the blast area. When a misfire is known or suspected, no person should enter the area for at least 1 hour.

**5607.15 Misfires.** Where a misfire is suspected, all initiating circuits shall be traced and a search made for unexploded charges. Where a misfire is found, the blaster shall provide proper safeguards for excluding all personnel from the blast area. Misfires shall be reported to the blasting supervisor immediately. Misfires shall be handled under the direction of the person in charge of the blasting operation in accordance with NFPA 495.

❖ All misfires are potential accidents. A misfire may be caused by many different factors. Only qualified and experienced personnel should attempt to handle disposal of a misfire. DOL 29 CFR, Parts 1910.109(e)(4)(v) and 1926.911(c) prohibit the extraction of explosives from a blasthole unless it is impossible to detonate the unexploded charge by insertion of a fresh primer.

No one should enter the blasting area to handle a misfire or investigate the cause until it is safe to do so. Recommended waiting periods for investigating misfires are listed in Commentary Figure 5607.15. The IME waiting periods correspond with the recommendation in IME Safety Library Publication No. 17.

Description	IME	OSHA
Blasting cap and fuse	30 minutes	1 hour
Electric blasting cap, shock tube, gas tube or detonating cord	15 minutes	30 minutes
Refiring of a misfired charge	1 hour	1 hour

Source: DOL 29 CFR 1910 and IME Safety Library Publication No. 17.

**Figure 5607.15  
RECOMMENDED WAITING PERIODS  
FOR INVESTIGATING MISFIRES**

Occupational Safety and Health Administration (OSHA) waiting periods are those specified in DOL 29 CFR, Parts 1910.109 and 1926.911(d).

The safest way to dispose of most misfires is by detonation; however, even this method has distinct hazards. Misfired explosives may be unstable or sensitive, so any procedure to dispose of a misfire must be carried out with extreme caution. Removing a misfired explosive charge should be attempted only if all other alternatives are unsuccessful or unadvisable. After a misfired charge has been removed, it must be transported immediately to a storage magazine and disposed of as soon as possible.

**SECTION 5608  
FIREWORKS DISPLAY**

**5608.1 General.** Outdoor fireworks displays, use of pyrotechnics before a *proximate audience* and pyrotechnic special effects in motion picture, television, theatrical and group entertainment productions shall comply with Sections 5608.2 through 5608.10 and NFPA 1123 or NFPA 1126.

❖ The only discharge of fireworks permissible under the code is a public display conducted by competent pyrotechnicians in accordance with the requirements of NFPA 1123 and NFPA 1126 and authorized by the fire code official.

The use of pyrotechnic special effects in theatrical performances has become a topic of some concern. In December 1990, a pyrotechnic effect exploded during a band concert in a Florida hotel lounge, injuring seven people, one critically. NFPA 1126 was published in response to this event.

**5608.2 Permit application.** Prior to issuing permits for a fireworks display, plans for the fireworks display, inspections of the display site and demonstrations of the display operations shall be *approved*. A plan establishing procedures to follow and actions to be taken in the event that a shell fails to ignite in, or discharge from, a mortar or fails to function over the fallout area or other malfunctions shall be provided to the *fire code official*.

❖ This section addresses approval and permit issuance for fireworks displays. A 15-day time limitation is suggested to give the fire code official reasonable time to verify the completeness and accuracy of the information in the application and to allow a thorough inspection of the display site. Customarily, only the display operator or pyrotechnician may apply for approval and a permit. Issuing approvals and permits to corporations, associations, boards or other corporate entities may hamper accountability. Because only a single individual can be assigned overall control of the discharge of fireworks, only the individual responsible for operating the display should be issued an approval, and ultimately a permit. However, all other organizations, institutions or individuals acting together or alone to contract the display should also be named in the permit application and, if considered appropriate by the fire code official, named as addi-

tional insureds in the bond indemnifying the jurisdiction for the display. Strict prohibitions against transfers and extensions are needed for the continuing supervision of fireworks operations.

This section also requires the applicant for approval and permit to provide an action plan for those occasions during the conduct of a fireworks display when a shell fails in some manner (often referred to as a “misfire,” a term which is often misinterpreted since it is not defined in either the code or NFPA 1123). The terminology used in this section makes it clear that the concerns are specifically with malfunctions of shells that either fail to discharge from a mortar or fail to function properly within the fallout area of the display venue, which could jeopardize safety of the audience or display operators. The fireworks display industry has established procedures for responding to various types and degrees of incidents that may occur as a result of a malfunction. This section enables the fire code official to be aware of the proposed procedures in order to evaluate their appropriateness to the particular event. The terminology used is consistent with that found in NFPA 1123.

**5608.2.1 Outdoor fireworks displays.** In addition to the requirements of Section 403, permit applications for outdoor fireworks displays using Division 1.3G fireworks shall include a diagram of the location at which the fireworks display will be conducted, including the site from which fireworks will be discharged; the location of buildings, highways, overhead obstructions and utilities; and the lines behind which the audience will be restrained.

❖ The best sites are free of overhead obstructions and are well isolated, with clear viewing paths and landing areas. Fallout areas should be large, open areas, clear of spectators, vehicles and combustible materials. Generally, the discharge site must have a minimum radius of 70 feet (21 336 mm) for each inch of aerial shell diameter.

**5608.2.2 Use of pyrotechnics before a proximate audience.** Where the separation distances required in Section 5608.4 and NFPA 1123 are unavailable or cannot be secured, fireworks displays shall be conducted in accordance with NFPA 1126 for *proximate audiences*. Applications for use of pyrotechnics before a *proximate audience* shall include plans indicating the required clearances for spectators and combustibles, crowd control measures, smoke control measures and requirements for standby personnel and equipment where provision of such personnel or equipment is required by the *fire code official*.

❖ This section applies to any outdoor use of pyrotechnics at distances less than those required by NFPA 1123. The use of pyrotechnics before a proximate audience is not a display of fireworks as regulated by NFPA 1123 but is regulated by NFPA 1126.

The separation distance between the audience and where the pyrotechnic device is fired during a performance must be at least 15 feet (4572 mm) but not less than twice the fallout radius of the device. The

audience must be separated from concussion mortars by a minimum of 25 feet (7620 mm) and there must be no glowing or flaming particles within 10 feet (3048 mm) of the audience.

**5608.3 Approved fireworks displays.** *Approved* fireworks displays shall include only the *approved* fireworks 1.3G, fireworks 1.4G, fireworks 1.4S and pyrotechnic articles, 1.4G, which shall be handled by an *approved*, competent operator. The *approved* fireworks shall be arranged, located, discharged and fired in a manner that will not pose a hazard to property or endanger any person.

❖ The competence of the display operator is foremost among the important safeguards that must be observed for a safe and enjoyable public display. NFPA 1123 details the qualifications of competent fireworks display operators. Many jurisdictions require display operators to possess a license or certificate of fitness. To obtain such a certificate, the operator must be bonded or indemnified, pass a written examination and serve an apprenticeship under another licensed or certified pyrotechnician.

**5608.4 Clearance.** Spectators, spectator parking areas, and *dwellings*, buildings or structures shall not be located within the display site.

**Exceptions:**

1. This provision shall not apply to pyrotechnic special effects and fireworks displays using Division 1.4G materials before a *proximate audience* in accordance with NFPA 1126.
2. This provision shall not apply to unoccupied *dwellings*, buildings and structures with the approval of the building *owner* and the *fire code official*.

❖ Aerial displays must meet the requirements of NFPA 1123. The site for the outdoor display should have at least a 70-foot (21 336 mm) radius per inch of the internal mortar diameter of the largest aerial shell being fired, except as noted in NFPA 1123. Some jurisdictions require 100 feet (30 480 mm) of radius per inch of diameter of aerial shell. No spectators, dwellings or spectator parking areas can be located within the display site.

**5608.5 Storage of fireworks at display site.** The storage of fireworks at the display site shall comply with the requirements of this section and NFPA 1123 or NFPA 1126.

❖ NFPA 1123 addresses weather protection, inspection, sorting and ready boxes for fireworks. The standard also addresses construction of display fireworks aerial shells.

**5608.5.1 Supervision and weather protection.** Beginning as soon as fireworks have been delivered to the display site, they shall not be left unattended.

❖ Never leave fireworks unattended. Too many events can cause serious problems during the show. For example, someone could replace good fireworks with faulty ones. Constant supervision is necessary both after and before inspection of the fireworks.

**5608.5.2 Weather protection.** Fireworks shall be kept dry after delivery to the display site.

- ❖ Protecting the fireworks from inclement weather is the responsibility of everyone involved in the display. If the fireworks get wet from rain, they will not fire properly, thus possibly causing harm to personnel and spectators. A tarpaulin will serve nicely for protection from rain.

**5608.5.3 Inspection.** Shells shall be inspected by the operator or assistants after delivery to the display site. Shells having tears, leaks, broken fuses or signs of having been wet shall be set aside and shall not be fired. Aerial shells shall be checked for proper fit in mortars prior to discharge. Aerial shells that do not fit properly shall not be fired. After the fireworks display, damaged, deteriorated or dud shells shall either be returned to the supplier or destroyed in accordance with the supplier's instructions and Section 5604.10.

**Exception:** Minor repairs to fuses shall be allowed. For electrically ignited displays, attachment of electric matches and similar tasks shall be allowed.

- ❖ Prior to acceptance of display fireworks from a wholesaler, the permit holder or designated agent must confirm that the outside of all cartons, containers or cases is in good condition and all documentation is in order. Shells can be damaged during transport from the factory. It is good safety practice to examine all shells before placing them into the mortars for firing. If there is any sign of damage, the shells should be set aside and not fired, reducing the risk of injury to personnel. The exception does allow minor repairs that are safe in the judgement of the pyrotechnician.

**5608.5.4 Sorting and separation.** After delivery to the display site and prior to the fireworks display, all shells shall be separated according to their size and their designation as salutes.

**Exception:** For electrically fired displays, or displays where all shells are loaded into mortars prior to the show, there is no requirement for separation of shells according to their size or their designation as salutes.

- ❖ Where aerial shells are to be stored at the discharge site for subsequent loading into mortars during the display, the mortars must be placed usually at one-sixteenth, but not more than one-third, the distance from the center of the display site toward the main spectator area.

**5608.5.5 Ready boxes.** Display fireworks, 1.3G, that will be temporarily stored at the site during the fireworks display shall be stored in ready boxes located upwind and not less than 25 feet (7620 mm) from the mortar placement and separated according to their size and their designation as salutes.

**Exception:** For electrically fired fireworks displays, or fireworks displays where all shells are loaded into mortars prior to the show, there is no requirement for separation of

shells according to their size, their designation as salutes or for the use of ready boxes.

- ❖ A ready box should be a weather-resistant container that protects contents from burning debris with a self-closing cover or equivalent means of closure required. If the wind shifts during a display, the ready boxes must be relocated to again be upwind from the discharge site. Tarpaulins can be used as weather protection for ready boxes but not considered as ready boxes.

**5608.6 Installation of mortars.** Mortars for firing fireworks shells shall be installed in accordance with NFPA 1123 and shall be positioned so that shells are propelled away from spectators and over the fallout area. Under no circumstances shall mortars be angled toward the spectator viewing area. Prior to placement, mortars shall be inspected for defects, such as dents, bent ends, damaged interiors and damaged plugs. Defective mortars shall not be used.

- ❖ Mortars can be buried to a depth of at least two-thirds to three-quarters of their length in the ground, in above-ground troughs or drums or however the local fire code official considers necessary. Eliminating as much of a risk as possible from spectator injury is a good reason for angling away from the viewing area. See also the commentary to the definition of "Fallout area" for further information.

**5608.7 Handling.** Aerial shells shall be carried to mortars by the shell body. For the purpose of loading mortars, aerial shells shall be held by the thick portion of the fuse and carefully loaded into mortars.

- ❖ During the firing of the display, personnel in the discharge site should wear head, eye, hearing and foot protection, and cotton, wool or similarly flame-resistant, long-sleeved, long-legged clothing. Personal protective equipment, as necessary, should be worn by the operator and assistants during the setup and cleanup of the display. Shells must be carried from the storage area to the discharge site only by their bodies and shall never be carried by their fuses.

**5608.8 Fireworks display supervision.** Whenever in the opinion of the *fire code official* or the operator a hazardous condition exists, the fireworks display shall be discontinued immediately until such time as the dangerous situation is corrected.

- ❖ All displays must be set up using methods that allow an interruption in firing in case an unforeseen danger becomes evident. The judgement of the display operator and the fire code official will determine whether an ongoing display or one that has been set up and is ready to begin must be stopped or delayed because of hazardous conditions.

**5608.9 Post-fireworks display inspection.** After the fireworks display, the firing crew shall conduct an inspection of the fallout area for the purpose of locating unexploded aerial

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shells or live components. This inspection shall be conducted before public access to the site shall be allowed. Where fireworks are displayed at night and it is not possible to inspect the site thoroughly, the operator or designated assistant shall inspect the entire site at first light.

A report identifying any shells that fail to ignite in, or discharge from, a mortar or fail to function over the fallout area or otherwise malfunction, shall be filed with the *fire code official*.

❖ This section is intended to identify those display fireworks shells that fail to discharge or function properly over the fallout area of the fireworks display site, and provide a means of notification to the fire code official of the disposition of malfunctioning or misfired fireworks within the jurisdiction.

The firing crew will consist of the operator and assistants. For the public's own safety, no one should be allowed entry into the fallout area of the display site until inspection is completed. Mortar inspection and removal should be conducted within 10 minutes after show completion. When fireworks are displayed at night and it is impossible to thoroughly inspect the site, the crew must reinspect the entire site early the following morning. Preparation of an inspection report will enhance the level of safety provided for displays and is consistent with the requirements of Section 5608.2. See the commentary to that section for a further discussion of fireworks malfunctions.

**5608.10 Disposal.** Any shells found during the inspection required in Section 5608.9 shall not be handled until not less than 15 minutes have elapsed from the time the shells were fired. The fireworks shall then be doused with water and allowed to remain for not less than 5 additional minutes before being placed in a plastic bucket or fiberboard box. The disposal instructions of the manufacturer as provided by the fireworks supplier shall then be followed in disposing of the fireworks in accordance with Section 5604.10.

❖ In addition to the above requirements, any aerial shell that misfires in a mortar should be left alone for a minimum of 30 minutes, carefully loaded into a bucket of water and left for a minimum of 15 minutes and then properly disposed of.

### SECTION 5609 TEMPORARY STORAGE OF CONSUMER FIREWORKS

**5609.1 General.** Where the temporary storage of consumer fireworks, 1.4G is allowed by Section 5601.1.3, Exception 4, such storage shall comply with the applicable requirements of NFPA 1124.

❖ Where approved by the fire code official, this section allows for the temporary storage of consumer fireworks in accordance with Chapter 6 of NFPA 1124. NFPA 1124 defines "permanent" as any building or structure constructed on a foundation that has fixed

utility connections for more than 180 consecutive calendar days—if the utilities remain in use for 90 consecutive days or less and the building is not permanent as defined by NFPA 1124, it is defined as temporary. See also Section 5601.1.3, Exception 4.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

*1997 Uniform Fire Code Applications Manual.* Whittier, CA: International Fire Code Institute, 1998.

*Structures to Resist the Effects of Accidental Explosions.* U.S. Army Technical Manual TM 51300. Air Force Manual (AFM) 8822 and Navy NAVFAC P397. Washington, DC: U.S. Government Printing Office.

# Chapter 57: Flammable and Combustible Liquids

## General Comments

Flammable and combustible liquids are essential in our modern lifestyles. These liquids are used for fuel, lubricants, cleaners, solvents, medicine and even drinking. The danger associated with flammable and combustible liquids is that the vapors from these liquids, when combined with air in their flammable range, will burn or explode at temperatures near our normal living and working environment.

The use of these liquids is accepted in all occupancies if the liquids are in appropriate containers and the quantity is very limited. When the quantities exceed these limited amounts or the use of the flammable or combustible liquids increases the potential danger, the code requires that measures be taken to control the potential danger. These measures are to prevent the possibility of flammable and combustible liquids igniting.

Although the dangers of flammable liquids are well known, accidents involving flammable liquids remain one of the most common fire scenarios in the United States. Statistically, the more common flammable or combustible liquids (gasoline) rather than the most dangerous flammable or combustible liquids account for the most fires. There are five factors that account for the involvement of flammable liquids in these fires: 1. Personnel inadequately trained in safe operating procedures; 2. Hazardous operations not isolated from other operations; 3. Equipment and flammable or combustible liquids improperly used; 4. Poor property maintenance and supervision and 5. Inadequate control systems.

These five factors suggest that a holistic approach to flammable and combustible liquid fire safety is required. By beginning with people, a safety system has a better chance of working successfully and consistently. Trained personnel recognize the importance of safe practices to their personal safety, and are more likely to demand that necessary safeguards be installed in their homes and workplaces. Because all of us tend to become complacent as time passes, inspectors, owners, operators, managers and employees must work together to maintain vigilance over the system's continued operation.

## Hazardous characteristics

Although the classification boundaries are somewhat arbitrary, flammable and combustible liquids are distinguished by their flash points. The flash point is that temperature at which the liquid produces sufficient vapor to form an ignitable vapor-air mixture above its surface. Because Class I flammable liquids all have flash points below 100°F (38°C), it is prudent to assume that they may be capable of igniting when unconfined under nor-

mal environmental conditions. On the other hand, combustible liquids [those materials with flash points above 100°F (38°C)] must usually be heated above their flash points, or in the case of extremely high flash point liquids, above their boiling points, before they will ignite.

## Physical characteristics

Flammable liquids possess other characteristics besides their low flash points. Significant characteristics when evaluating relative fire hazards include ignition temperature, autoignition temperature, flammable (explosive) range, viscosity, vapor density, vapor pressure, boiling point, evaporation rate, specific gravity and water solubility. Once the liquid is ignited, these variables have little influence over the material's heat release rate; however, factors such as evaporation rate, viscosity and water solubility may profoundly affect how these fires are extinguished.

## Hazards

In general, flammable and combustible liquids have low specific gravities, high vapor densities and narrow flammable (explosive) ranges. These characteristics mean that the liquids will usually float on water, the vapors will usually hug the ground and ignitable vapor-air mixtures will be confined to a range between 6 and 15 percent in air. Thus, smothering is difficult and ignition sources near the ground are more likely to pose a hazard. Low and high concentrations within the flammable range are likely to produce deflagrations, while concentrations near the middle of the flammable (explosive) range are more likely to produce detonations.

## Protection

The protection provided by the code is to prevent the flammable and combustible liquids from becoming ignited. This is accomplished by one or more of the following procedures:

1. Preventing the flammable and combustible liquids from vaporizing. Equipment and devices are used to safely store, transport, dispense, mix or use the flammable and combustible liquids so that the liquid does not have the opportunity to evaporate except where intended.
2. Preventing the concentration of vapors of flammable and combustible liquids from reaching the vapor-air mixture between the lower flammable limit (LFL) and the upper flammable limit (UFL). Ventilation of the area is used to dilute and

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

- disperse the vapors before the vapor-air mixture reaches the LFL.
3. Preventing an accumulation of the vapor-air mixture of flammable and combustible liquids. The ventilation of the area as well as the design of the area is used to prevent the vapors from collecting.
  4. Removing ignition sources from the area. These ignition sources are from people, equipment or static electricity sources.
  5. Precautions against spontaneous ignition.
  6. Removing other combustibles from the area. Other combustibles may become involved in a fire, creating the ignition source for the flammable and combustible liquid.
  7. Designing the equipment (piping, vessels, containers, etc.) and facilities to prevent the loss of flammable and combustible liquids and to protect the flammable and combustible liquids from exterior fire exposure. This protection is also used to protect other property and flammable and combustible liquids from fire exposure.
  8. Controlling the volume of flammable and combustible liquids to reduce the size of a potential fire.
  9. Providing fire-fighting equipment to control fire from combustibles other than flammable and combustible liquids as well as fire from flammable and combustible liquids.
  10. Security to ensure that only trained personnel have access to flammable and combustible liquids.
  11. Training of personnel to ensure they are aware of the potential dangers and know the operating procedures and safety procedures.

### Purpose

The requirements of this chapter are intended to reduce the likelihood of fires involving the storage, handling, use or transportation of flammable and combustible liquids. Adherence to these practices may also limit damage in the event of an accidental fire involving these materials.

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## SECTION 5701 GENERAL

**5701.1 Scope and application.** Prevention, control and mitigation of dangerous conditions related to storage, use, dispensing, mixing and handling of flammable and *combustible liquids* shall be in accordance with Chapter 50 and this chapter.

❖ This chapter regulates the storage, handling and use of flammable and combustible liquids. Although U.S. Department of Transportation (DOT) regulations govern the construction of tank vehicles and the interstate transportation of flammable and combustible liquids, this chapter regulates the parking, garaging, filling and discharging of tank vehicles. This chapter is used in conjunction with Chapter 50 to regulate flammable and combustible liquids. Related operations, materials and processes are regulated elsewhere in the code.

**5701.2 Nonapplicability.** This chapter shall not apply to liquids as otherwise provided in other laws or regulations or chapters of this code, including:

1. Specific provisions for flammable liquids in motor fuel-dispensing facilities, repair garages, airports and marinas in Chapter 23.
2. Medicines, foodstuffs, cosmetics and commercial or institutional products containing not more than 50 percent by volume of water-miscible liquids and with the remainder of the solution not being flammable,

provided that such materials are packaged in individual containers not exceeding 1.3 gallons (5 L).

3. Quantities of alcoholic beverages in retail or wholesale sales or storage occupancies, provided that the liquids are packaged in individual containers not exceeding 1.3 gallons (5 L).
4. Storage and use of fuel oil in tanks and containers connected to oil-burning equipment. Such storage and use shall be in accordance with Section 603. For abandonment of fuel oil tanks, this chapter applies.
5. Refrigerant liquids and oils in refrigeration systems (see Section 606).
6. Storage and display of aerosol products complying with Chapter 51.
7. Storage and use of liquids that do not have a fire point when tested in accordance with ASTM D92.
8. Liquids with a *flash point* greater than 95°F (35°C) in a water-miscible solution or dispersion with a water and inert (noncombustible) solids content of more than 80 percent by weight, which do not sustain combustion.
9. Liquids without *flash points* that can be flammable under some conditions, such as certain halogenated hydrocarbons and mixtures containing halogenated hydrocarbons.
10. The storage of distilled spirits and wines in wooden barrels and casks.

11. Commercial cooking oil storage tank systems located within a building and designed and installed in accordance with Section 610 and NFPA 30.

- ❖ This section is an acknowledgment that some flammable and combustible liquids are regulated by other laws or by other chapters of the code. The application of these other laws or code chapters takes precedence over the requirements in this chapter. Note that most of the items listed in this section correlate to Section 9.1.4 of NFPA 30 (see also commentary, Section 5001.1).

Item 1 covers the unique use of flammable liquids at motor fuel-dispensing facilities, airports and marinas, which require specific regulations that are addressed in Chapter 23.

Item 2 indicates that individually packaged consumer products consisting of medicines, foodstuffs, cosmetics and commercial and institutional products with a limited quantity of flammable liquid used in the product are exempt from the requirements of this chapter. Such products present a reduced hazard due to their limited ignitability and because the packaging limitation helps in keeping spills, due to a leaking package or broken container, to a manageable size. A similar exception appears in Section 5001.1.

Item 3 indicates that alcoholic beverages in retail or wholesale Group M occupancies or in storage occupancies are not regulated by this chapter where the individual containers do not exceed 1.3 gallons (4.92 L). The packaging limitation helps in keeping spills, due to a leaking package or broken container, to a manageable size. A similar exception appears in Section 5001.1.

Item 4 states that fuel oil tanks and containers connected to oil-burning equipment are regulated by Chapter 6. See the commentary to Sections 603.3 through 603.3.3. This chapter regulates abandoned fuel tanks.

Item 5 notes that refrigerant liquids and oils in refrigeration systems are also regulated by Chapter 6.

Item 6 refers the reader to Chapter 51 for requirements covering the storage and display of aerosol products. Where the storage or display of aerosols does not comply with Chapter 51, this chapter will regulate the storage and display of aerosols in those specific circumstances.

Item 7 notes that the storage and use of a liquid whose vapor cannot be ignited and sustain burning for a minimum of 5 seconds (fire point) is not regulated by this chapter. The test procedure for determining the fire point of a petroleum product is ASTM D92. The fire point is based on a specific barometric pressure established by ASTM International (ASTM). An example of such a liquid would be water-based paints.

Item 8 exempts certain liquids that, although they have a flash point, will not sustain combustion.

Item 9 notes that some liquids do not have a flash point except in specific circumstances; for example, halogenated hydrocarbons that may become explosive when exposed to aluminum. These liquids are

not regulated by the code.

Item 10 makes the storage of distilled spirits and wines in wooden barrels and casks exempt from this chapter. Although their contents are classified as flammable liquids, the containers do not pose the rupture hazard that other containers do. Barrels and casks will leak their contents and contribute to the fire as the metal bands that secure the staves expand and loosen. Even this hazard feature is generally mitigated by the operation of automatic sprinklers that prevent the fire from progressing to the point where the metal bands get hot enough to expand. A similar exception also appears in Section 5001.1.

Item 11 exempts high flash point cooking oil (Class IIIB liquid) storage in a restaurant back-of-house setting because it presents a different, and generally lower, hazard than commonly anticipated by Chapter 57, which is more relevant to industrial flammable and combustible liquid tank requirements. This exemption to Section 5701.2 unifies all pertinent fire safety requirements into Section 610 and the standards referenced therein and establishes the level of safety commensurate with this hazard. This approach is consistent with other exceptions in this section, in particular the exception for fuel oil tanks connected with oil burning equipment.

**5701.3 Referenced documents.** The applicable requirements of Chapter 50, other chapters of this code, the *International Building Code* and the *International Mechanical Code* pertaining to flammable liquids shall apply.

- ❖ The requirements to regulate the design, construction and maintenance of facilities using flammable and combustible liquids are contained in more than one document. The code contains several chapters that address requirements for the storage, handling, dispensing, processing, transportation and use of flammable and combustible liquids. The *International Building Code*® (IBC®) covers the construction requirements for the structure, while the *International Mechanical Code*® (IMC®) covers the construction requirements for mechanical systems.

**5701.4 Permits.** Permits shall be required as set forth in Sections 105.6 and 105.7.

- ❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit, Section 105.6.17 for discussion of specific quantity-based operational permits for the materials regulated in this chapter and Section 105.7.8 for a discussion of activities requiring a construction permit. The permit process also notifies the fire department of the need for prefire planning for the hazardous property.

**5701.5 Material classification.** Flammable and *combustible liquids* shall be classified in accordance with the definitions in Chapter 2.

When mixed with lower flash-point liquids, Class II or III liquids are capable of assuming the characteristics of the lower flash-point liquids. Under such conditions, the appropriate provisions of this chapter for the actual *flash point* of the mixed liquid shall apply.

When heated above their *flash points*, Class II and III liquids assume the characteristics of Class I liquids. Under such conditions, the appropriate provisions of this chapter for flammable liquids shall apply.

❖ Flammable and combustible liquids are defined in Chapter 2. Mixing or heating the liquid may modify flammable and combustible liquids. This process will change the flash point of the liquid. The mixed liquid is to be classified and handled based on the flash point determined by the appropriate test procedure and apparatus as specified in ASTM D56, ASTM D93 or ASTM D3278. A Class II or III liquid that is heated above its flash point during handling or processing must be treated as a Class I liquid.

## SECTION 5702 DEFINITIONS

**5702.1 Definitions.** The following terms are defined in Chapter 2:

**ALCOHOL-BASED HAND RUB.**

**BULK PLANT OR TERMINAL.**

**BULK TRANSFER.**

**COMBUSTIBLE LIQUID.**

Class II.

Class IIIA.

Class IIIB.

**FIRE POINT.**

**FLAMMABLE LIQUID.**

Class IA.

Class IB.

Class IC.

**FLASH POINT.**

**FUEL LIMIT SWITCH.**

**LIQUID STORAGE ROOM.**

**LIQUID STORAGE WAREHOUSE.**

**MOBILE FUELING.**

**PROCESS TRANSFER.**

**REFINERY.**

**REMOTE EMERGENCY SHUTOFF DEVICE.**

**REMOTE SOLVENT RESERVOIR.**

**SOLVENT DISTILLATION UNIT.**

**TANK, PRIMARY.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4).

## SECTION 5703 GENERAL REQUIREMENTS

**5703.1 Electrical.** Electrical wiring and equipment shall be installed and maintained in accordance with Section 605 and NFPA 70.

❖ The installation of electrical wiring and equipment is regulated by NFPA 70.

**5703.1.1 Classified locations for flammable liquids.** Areas where flammable liquids are stored, handled, dispensed or mixed shall be in accordance with Table 5703.1.1. A classified area shall not extend beyond an unpierced floor, roof or other solid partition.

The extent of the classified area is allowed to be reduced, or eliminated, where sufficient technical justification is provided to the *fire code official* that a concentration in the area in excess of 25 percent of the lower flammable limit (LFL) cannot be generated.

❖ Electrical systems can create sparks that can be a source of ignition. Areas of a building where flammable liquids are present are to have the electrical wiring and equipment installed to prevent the electrical system from becoming an ignition source. This type of electrical installation is not required in other areas of the building where the construction prevents the spread of flammable liquids and their vapors. This construction can be accomplished only by eliminating penetrations. Class I equipment locations, which require special installation of wiring and equipment, are listed in Table 5703.1.1.

**TABLE 5703.1.1.** See page 57-5.

❖ The table lists the Class I, Group D locations that require installation of the electrical system or its components to prevent them from becoming an ignition source. Class I is defined as a location where flammable liquids or gases may be present in sufficient quantities to produce an explosive or ignitable mixture. Group D is defined as an atmosphere containing flammable or combustible liquids or gases. Group D is divided into two divisions: Division 1 is for locations where flammable or combustible vapors are present; Division 2 is for locations where flammable or combustible vapors may be present.

TABLE 5703.1.1  
CLASS I ELECTRICAL EQUIPMENT LOCATIONS\*

LOCATION	GROUP D DIVISION	EXTENT OF CLASSIFIED AREA
<b>Underground tank fill opening</b>	1	Pits, boxes or spaces below grade level, any part of which is within the Division 1 or 2 classified area.
	2	Up to 18 inches above grade level within a horizontal radius of 10 feet from a loose-fill connection and within a horizontal radius of 5 feet from a tight-fill connection.
<b>Vent—Discharging upward</b>	1	Within 3 feet of open end of vent, extending in all directions.
	2	Area between 3 feet and 5 feet of open end of vent, extending in all directions.
<b>Drum and container filling</b> Outdoor or indoor with adequate ventilation	1	Within 3 feet of vent and fill opening, extending in all directions.
	2	Area between 3 feet and 5 feet from vent of fill opening, extending in all directions. Also up to 18 inches above floor or grade level within a horizontal radius of 10 feet from vent or fill opening.
<b>Pumps, bleeders, withdrawal fittings, meters and similar devices</b> Indoor	2	Within 5 feet of any edge of such devices, extending in all directions, and up to 3 feet above floor or grade level within 25 feet horizontally from any edge of such devices.
	2	Within 3 feet of any edge of such devices, extending in all directions, and up to 18 inches above floor or grade level within 10 feet horizontally from an edge of such devices.
<b>Pits</b> Without mechanical ventilation With mechanical ventilation Containing valves, fittings or piping, and not within a Division 1 or 2 classified area	1	Entire area within pit if any part is within a Division 1 or 2 classified area.
	2	Entire area within pit if any part is within a Division 1 or 2 classified area.
	2	Entire pit.
<b>Drainage ditches, separators, impounding basins</b> Indoor Outdoor	1 or 2	Same as pits.
	2	Area up to 18 inches above ditch, separator or basin, and up to 18 inches above grade within 15 feet horizontal from any edge.
<b>Tank vehicle and tank car<sup>b</sup></b> Loading through open dome Loading through bottom connections with atmospheric venting	1	Within 3 feet of edge of dome, extending in all directions.
	2	Area between 3 feet and 15 feet from edge of dome, extending in all directions.
	1	Within 3 feet of point of venting to atmosphere, extending in all directions.
	2	Area between 3 feet and 15 feet from point of venting to atmosphere, extending in all directions. Also up to 18 inches above grade within a horizontal radius of 10 feet from point of loading connection.

(continued)

TABLE 5703.1.1—continued  
CLASS I ELECTRICAL EQUIPMENT LOCATIONS<sup>a</sup>

LOCATION	GROUP D DIVISION	EXTENT OF CLASSIFIED AREA
<b>Tank vehicle and tank car<sup>b</sup>—continued</b> Loading through closed dome with atmospheric venting	1	Within 3 feet of open end of vent, extending in all directions.
	2	Area between 3 feet and 15 feet from open end of vent, extending in all directions, and within 3 feet of edge of dome, extending in all directions.
Loading through closed dome with vapor control	2	Within 3 feet of point of connection of both fill and vapor lines, extending in all directions.
Bottom loading with vapor control or any bottom unloading	2	Within 3 feet of point of connection, extending in all directions, and up to 18 inches above grade within a horizontal radius of 10 feet from point of connection.
<b>Storage and repair garage for tank vehicles</b>	1	Pits or spaces below floor level.
	2	Area up to 18 inches above floor or grade level for entire storage or repair garage.
<b>Garages for other than tank vehicles</b>	Ordinary	Where there is an opening to these rooms within the extent of an outdoor classified area, the entire room shall be classified the same as the area classification at the point of the opening.
<b>Outdoor drum storage</b>	Ordinary	—
<b>Indoor warehousing where there is no flammable liquid transfer</b>	Ordinary	Where there is an opening to these rooms within the extent of an indoor classified area, the room shall be classified the same as if the wall, curb or partition did not exist.
<b>Indoor equipment where flammable vapor/air mixtures could exist under normal operations</b>	1	Area within 5 feet of any edge of such equipment, extending in all directions.
	2	Area between 5 feet and 8 feet of any edge of such equipment, extending in all directions, and the area up to 3 feet above floor or grade level within 5 feet to 25 feet horizontally from any edge of such equipment.
<b>Outdoor equipment where flammable vapor/air mixtures could exist under normal operations</b>	1	Area within 3 feet of any edge of such equipment, extending in all directions.
	2	Area between 3 feet and 8 feet of any edge of such equipment extending in all directions, and the area up to 3 feet above floor or grade level within 3 feet to 10 feet horizontally from any edge of such equipment.
<b>Tank—Above ground</b> Shell, ends or roof and dike area	1	Area inside dike where dike height is greater than the distance from the tank to the dike for more than 50 percent of the tank circumference.
	2	Area within 10 feet from shell, ends or roof of tank. Area inside dikes to level of top of dike.
Vent	1	Area within 5 feet of open end of vent, extending in all directions.
	2	Area between 5 feet and 10 feet from open end of vent, extending in all directions.
Floating roof	1	Area above the roof and within the shell.
<b>Office and restrooms</b>	Ordinary	Where there is an opening to these rooms within the extent of an indoor classified location, the room shall be classified the same as if the wall, curb or partition did not exist.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Locations as classified in NFPA 70.

b. When classifying extent of area, consideration shall be given to the fact that tank cars or tank vehicles can be spotted at varying points. Therefore, the extremities of the loading or unloading positions shall be used.

c. The release of Class I liquids can generate vapors to the extent that the entire building, and possibly a zone surrounding it, are considered a Class I, Division 2 location.

**5703.1.2 Classified locations for combustible liquids.**

Areas where Class II or III liquids are heated above their *flash points* shall have electrical installations in accordance with Section 5703.1.1.

**Exception:** Solvent distillation units in accordance with Section 5705.4.

- ❖ Electrical systems can create sparks that can be a source of ignition. The sparks may be caused by electrical current or static electricity. Areas of a building where combustible liquids are heated to or above their flash points are treated the same as areas containing flammable liquids. Class I equipment locations, which require special installation of the wiring and equipment, are listed in Table 5703.1.1.

The exception indicates that use of a solvent distillation unit for the recovery of combustible liquids is not considered a Class I, Group D location. See the commentary to Section 2705.4 for information on solvent distillation units.

**5703.1.3 Other applications.** The *fire code official* is authorized to determine the extent of the Class I electrical equipment and wiring location where a condition is not specifically covered by these requirements or NFPA 70.

- ❖ There may be situations when the code does not specifically cover the hazardous location that should have Class I electrical equipment and wiring. The fire code official has the authority to require Class I electrical equipment and wiring in a location not specifically identified by the code for Division 1 or 2 locations.

**5703.2 Fire protection.** Fire protection for the storage, use, dispensing, mixing, handling and on-site transportation of flammable and *combustible liquids* shall be in accordance with this chapter and applicable sections of Chapter 9.

- ❖ The requirements of Chapter 9 apply to flammable and combustible liquids. Fire protection is a principal means of preventing and controlling the spread of fire.

**5703.2.1 Portable fire extinguishers and hose lines.** Portable fire extinguishers shall be provided in accordance with Section 906. Hose lines shall be provided in accordance with Section 905.

- ❖ Portable fire extinguishers and hose lines are to be installed where flammable and combustible liquids are stored, used or dispensed. These fire protection devices, operated by trained personnel, are to handle small emergencies. They are not an alternative to fire protection systems mandated by this section, Chapter 9 of the code or the IBC.

**5703.3 Site assessment.** In the event of a spill, leak or discharge from a tank system, a site assessment shall be completed by the *owner* or operator of such tank system if the *fire code official* determines that a potential fire or explosion hazard exists. Such site assessments shall be conducted to ascertain potential fire hazards and shall be completed and

submitted to the fire department within a time period established by the *fire code official*, not to exceed 60 days.

- ❖ Site assessment is to ensure that a spill, leak or discharge of flammable or combustible liquid is investigated and corrective action is taken. The corrective action may involve only cleaning the area and covering the cause of the problem during personnel safety meetings or it may require a revision to the equipment or operation procedures. The fire code official is to establish the deadline for completion of the site assessment. The maximum time for completing a site assessment is 60 days. The corrective actions may take longer than the time to complete the site assessment.

**5703.4 Spill control and secondary containment.** Where the *maximum allowable quantity per control area* is exceeded, and where required by Section 5004.2, rooms, buildings or areas used for storage, dispensing, use, mixing or handling of Class I, II and IIIA liquids shall be provided with spill control and secondary containment in accordance with Section 5004.2.

- ❖ Where the maximum allowable quantity per control area (MAQ) of flammable or Class II or IIIA combustible liquids is exceeded, spills must be controlled to prevent the spread of liquid and vapors. Section 5004.2 discusses the use of liquid-tight floors, curbs, dikes and drainage systems to divert the liquid to a location where it can be contained and safely handled. Section 5004.3 discusses mechanical and natural exhaust systems. The exhaust system is to remove the vapors to prevent them from accumulating in concentrations in the flammable range of the vapor. See also Section 5704.3.7.3.

**5703.5 Labeling and signage.** The *fire code official* is authorized to require warning signs for the purpose of identifying the hazards of storing or using flammable liquids. Signage for identification and warning such as for the inherent hazard of flammable liquids or smoking shall be provided in accordance with this chapter and Sections 5003.5 and 5003.6.

- ❖ Signs are used to identify the flammable or combustible liquid being stored or used and to provide any warning or information necessary for its storage or use. Sections 5003.5 and 5003.6 include a reference to NFPA 704, which details the locations and construction of the signs. NFPA 704 uses a diamond with each of its four points colored either red, blue, yellow or white. Each diamond point represents a different hazard. For flammable and combustible liquids, the red diamond point (uppermost point) represents flammability. The number in this diamond point will vary from 0 (will not burn) to 4 (rapidly burn). For flammable and combustible reference, numbers 2 to 4 usually represent flammable and combustible liquids. These signs are permanent, durable signs that are to be readily visible and are not to be covered or removed.

**5703.5.1 Style.** Warning signs shall be of a durable material. Signs warning of the hazard of flammable liquids shall have white lettering on a red background and shall read: DANGER—FLAMMABLE LIQUIDS. Letters shall be not less than 3 inches (76 mm) in height and 1/2 inch (12.7 mm) in stroke.

❖ The signs used with flammable liquids are to read “DANGER—FLAMMABLE LIQUIDS.” The code defines color and size of lettering to ensure uniformity.

**5703.5.2 Location.** Signs shall be posted in locations as required by the *fire code official*. Piping containing flammable liquids shall be identified in accordance with ASME A13.1.

❖ The location of signs is discussed in Section 5003.5 for containers, tanks, entrances, etc., by reference to NFPA 704. Signage for piping containing flammable liquids is covered under ASME A13.1. The signage is in English text and requires arrows to indicate flow direction.

**5703.5.3 Warning labels.** Individual containers, packages and cartons shall be identified, marked, labeled and placarded in accordance with federal regulations and applicable state laws.

❖ The warning labels on individual containers, packages and cartons may be different than what is required under NFPA 704. Other federal and state laws may address the warning label for these individual containers, packages and cartons.

**5703.5.4 Identification.** Color coding or other *approved* identification means shall be provided on each loading and unloading riser for flammable or *combustible liquids* to identify the contents of the tank served by the riser.

❖ More than one flammable or combustible liquid may be present at a facility in addition to other liquids. The loading and unloading risers are to be color coded or identified by other approved identification means to ensure that operators know which material is being used. If color coding is not used, the fire code official is to approve any other identification means.

**5703.6 Piping systems.** Piping systems, and their component parts, for flammable and *combustible liquids* shall be in accordance with Sections 5703.6.1 through 5703.6.11.

❖ Piping must be designed to provide protection against overpressure or other conditions that could create leaks at joints or rupture the pipes.

**5703.6.1 Nonapplicability.** The provisions of Section 5703.6 shall not apply to gas or oil well installations; piping that is integral to stationary or portable engines, including aircraft, watercraft and motor vehicles; and piping in connection with boilers and pressure vessels regulated by the *International Mechanical Code*.

❖ Piping of some applications of flammable and combustible liquids is addressed under other code documents or other laws. Other state and federal agencies have laws and authority to regulate the piping for oil

and gas wells. Stationary and portable engines are manufactured under other standards that are enforced by other state and federal agencies. Because the piping associated with heating equipment (fuel oil and pressure systems) is addressed by the IMC, those requirements are not repeated.

**5703.6.2 Design and fabrication of piping systems and components.** Piping system components shall be designed and fabricated in accordance with the applicable standard listed in Table 5703.6.2 and Chapter 27 of NFPA 30, except as modified by Section 5703.6.2.1.

❖ Rather than include lengthy requirements for piping systems in the body of the code, this section provides correlation with Chapter 27 of NFPA 30, which references the ASME B31 series of piping standards, not all of which are suitable or necessary for flammable or combustible liquid piping. By including a table listing the four specific standards within ASME B31 that are applicable for flammable liquid piping, the code is made more user friendly. It is left to the code user to select the correct standard to apply.

TABLE 5703.6.2  
PIPING STANDARDS

PIPING USE	STANDARD
Power Piping	ASME B31.1
Process Piping	ASME B31.3
Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids	ASME B31.4
Building Services Piping	ASME B31.9

❖ See the commentary to Section 5703.6.2.

**5703.6.2.1 Special materials.** Low-melting-point materials (such as aluminum, copper or brass), materials that soften on fire exposure (such as nonmetallic materials) and nonductile material (such as cast iron) shall be acceptable for use underground in accordance with the applicable standard listed in Table 5703.6.2. Where such materials are used outdoors in above-ground piping systems or within buildings, they shall be in accordance with the applicable standard listed in Table 5703.6.2 and one of the following:

1. Suitably protected against fire exposure.
2. Located where leakage from failure would not unduly expose people or structures.
3. Located where leakage can be readily controlled by operation of accessible remotely located valves.

In all cases, nonmetallic piping shall be used in accordance with Section 27.4.6 of NFPA 30.

❖ Piping that may fail under fire exposure as a result of heat reducing its material strength is limited to specific installations and locations. Pipes that have “low melting points” can fail by sagging when exposed to fire. Sagging can cause a joint to separate or the pipes to burst if piping is under pressure. These failures would result in the flammable and combustible liquids being exposed to the fire and air. The limitations on the use of these piping materials reduces their exposure to a fire, or where a failure occurs,

does not increase the potential danger. This kind of piping can also be used where the piping system can be isolated in an emergency.

**5703.6.3 Testing.** Unless tested in accordance with the applicable section of ASME B31.9, piping, before being covered, enclosed or placed in use, shall be hydrostatically tested to 150 percent of the maximum anticipated pressure of the system, or pneumatically tested to 110 percent of the maximum anticipated pressure of the system, but not less than 5 pounds per square inch gauge (psig) (34.47 kPa) at the highest point of the system. This test shall be maintained for a sufficient time period to complete visual inspection of joints and connections. For not less than 10 minutes, there shall be no leakage or permanent distortion. Care shall be exercised to ensure that these pressures are not applied to vented storage tanks. Such storage tanks shall be tested independently from the piping.

- ❖ Piping must be tested to a minimum pressure of 5 pounds per square inch gauge (psig) (34.47 kPa) or to a pressure greater than the anticipated pressure of the system. The pipe joints and connections are to be visually inspected. The test pressure is to be maintained for a minimum of 10 minutes, but not less than the time required for a visual inspection.

**5703.6.3.1 Existing piping.** Existing piping shall be tested in accordance with this section where the *fire code official* has reasonable cause to believe that a leak exists. Piping that could contain flammable or *combustible liquids* shall not be tested pneumatically. Such tests shall be at the expense of the *owner* or operator.

**Exception:** Vapor-recovery piping is allowed to be tested using an inert gas.

- ❖ The fire code official may require testing of existing piping. Existing piping is to be tested to the same criteria as new piping, except that piping containing flammable or combustible liquids is not to be pneumatically tested. The introduction of air into these pipes can create a vapor and air mixture that reaches the flammable range.

The exception allows pneumatic testing of a vapor-recovery system with an inert gas (such as nitrogen, carbon dioxide, etc.). Because vapor-recovery systems are designed to remove the flammable or combustible vapors and recycle the liquid, these vapors could be removed from the piping during the recovery process; however, the inert gas is still required to prevent the vapor and air mixture from reaching the flammable range before or during the recovery process.

**5703.6.4 Protection from vehicles.** Guard posts or other *approved* means shall be provided to protect piping, valves or fittings subject to vehicular damage in accordance with Section 312.

- ❖ Protection from vehicle impact is provided by guard posts or other approved barriers. Section 312 states

that the specifications for guard posts or the design forces required for an approved barrier should comply with the code.

**5703.6.5 Protection from external corrosion and galvanic action.** Where subject to external corrosion, piping, related fluid-handling components and supports for both underground and above-ground applications shall be fabricated from noncorrosive materials, and coated or provided with corrosion protection. Dissimilar metallic parts that promote galvanic action shall not be joined.

- ❖ Deterioration of piping and components can cause leaks and spillage of flammable and combustible liquids. Using uncorrodible materials, protective coatings, galvanic protection or a combination of these methods can protect the piping and components. Dissimilar metals are prohibited because of the localized galvanic action that could occur between them. This localized galvanic action could cause one of the metals to corrode so that the other metal is protected from corrosion. See Section 5704.2.7.9 for corrosion protection for tanks.

**5703.6.6 Valves.** Piping systems shall contain a sufficient number of manual control valves and check valves to operate the system properly and to protect the plant under both normal and emergency conditions. Piping systems in connection with pumps shall contain a sufficient number of such valves to control properly the flow of liquids in normal operation and in the event of physical damage or fire exposure.

- ❖ Valves are essential to proper operation. Check valves prevent the backflow or siphonage of flammable and combustible liquids. Other valves are used to isolate piping sections and equipment for maintenance. Valves are also used to stop the flow of flammable and combustible liquids.

**5703.6.6.1 Backflow protections.** Connections to pipelines or piping by which equipment (such as tank cars, tank vehicles or marine vessels) discharges liquids into storage tanks shall be provided with check valves or block valves for automatic protection against backflow where the piping arrangement is such that backflow from the system is possible. Where loading and unloading is done through a common pipe system, a check valve is not required. However, a block valve, located so as to be readily accessible or remotely operable, shall be provided.

- ❖ Check valves prevent the backflow or siphonage of flammable and combustible liquids. A check valve cannot be used for a common pipe used to both load and unload flammable and combustible liquids because check valves are designed to allow flow in only one direction. This type of valve would prohibit a common pipe for both loading and unloading. A block valve is to be used for this common pipe. The block valve control mechanism must be readily accessible or remotely operable in the event that the valve is needed to stop a spill or accidental discharge.

**5703.6.6.2 Manual drainage.** Manual drainage-control valves shall be located at *approved* locations remote from the tanks, diked area, drainage system and impounding basin to ensure their operation in a fire condition.

❖ In case of a fire, it may be necessary to drain the piping system. This is to be accomplished by a manual drainage-control valve. The number of manual drainage-control valves will depend on the facility. The manual drainage-control valves are to be located to isolate sections of the piping and equipment for maintenance, repair, replacement and control of flammable and combustible liquids during an emergency.

**5703.6.7 Connections.** Above-ground tanks with connections located below normal liquid level shall be provided with internal or external isolation valves located as close as practical to the shell of the tank. Except for liquids whose chemical characteristics are incompatible with steel, such valves, where external, and their connections to the tank shall be of steel.

❖ The isolation valve is located as near as practical to above-ground tanks to control the flow of flammable and combustible liquids. This location is to reduce the quantity of flammable and combustible liquids that may be discharged during an emergency. The loss of a portion of the piping system between an above-ground tank and the isolation valve may allow the discharge of the flammable and combustible liquids under gravity flow.

The isolation valve is to be of steel unless the flammable and combustible liquids are not compatible with steel. Other valve materials may be damaged and fail under the heat from a fire. If the isolation valve fails, the flammable and combustible liquids may be discharged under gravity flow and increase the fire potential.

**5703.6.8 Piping supports.** Piping systems shall be substantially supported and protected against physical damage and excessive stresses arising from settlement, vibration, expansion, contraction or exposure to fire. The supports shall be protected against exposure to fire by one of the following:

1. Draining liquid away from the piping system at a minimum slope of not less than 1 percent.
2. Providing protection with a *fire-resistance rating* of not less than 2 hours.
3. Other *approved* methods.

❖ Pipe supports are necessary to reduce stress on the pipe from both external and internal sources. Personnel are an external source of potential damage to piping, as is unattached equipment hitting the piping system. The pipe supports are to absorb these impact loads to protect the pipe from excess deflection.

Internal forces are caused by the positive and negative pressures created by the operation of pumps and valves. Pumping of flammable and combustible

liquids will generate positive pressure in the pipe. This pressure, combined with any pressure required to support the dead weight of the piping system and flammable and combustible liquids in the piping system, can cause the pipe wall to rupture.

The pumping action and the operation of the valve can cause shock waves to travel through the flammable and combustible liquids in a pipe, which can create internal pressures several times larger than normal operating pressures. One type of shock wave is caused by the fast opening and closing of a valve. This pressure wave can place high internal pressures on the piping system.

This section lists three methods of protecting pipe supports from a fire:

1. The piping is required to have a minimum slope of 1 percent to allow for drainage. The viscosity of the flammable and combustible liquids may mandate a greater drainage slope.
2. The pipe supports must support the piping in a fire for a minimum of 2 hours based on ASTM E119 test criteria. This fire protection of the supports is to keep any flammable and combustible liquids in the pipe from adding to an existing fire.
3. The code always recognizes that there may be other methods available for accomplishing the intent. The fire code official has the responsibility to review these alternative methods and the authority to approve an alternative method, but only if it has been demonstrated or documented to comply with the intent of the code requirement.

**5703.6.9 Flexible joints.** Flexible joints shall be *listed* and *approved* and shall be installed on underground liquid, vapor and vent piping at all of the following locations:

1. Where piping connects to underground tanks.
2. Where piping ends at pump islands and vent risers.
3. At points where differential movement in the piping can occur.

❖ Flexible joints are necessary to handle expansion and contraction of the piping system and control vibration. Expansion and contraction of the piping system will create stresses in the pipe and pipe joints because of the increase or decrease in pipe length. These changes in pipe length may cause the pipe to buckle, or pull or push a joint apart. The vibration of a pipe may cause a fatigue failure. Fatigue failures result from the reversal of stresses in a material. The flexing of the pipe wall or pipe joint from a positive pressure to a negative pressure over time will create a fatigue failure in the pipe wall. This fatigue can cause the pipe or pipe joint to finally break open because of internal operating pressures or external loading, such as dead weight or an impact load.

This section lists three locations where flexible joints must be used:

1. *Piping connected to an underground tank.* An underground tank is unmovable; therefore, the flexible joint connecting the piping to the tank must handle the expansion and contraction of the pipe system.
2. *Piping ending at pump islands and vent risers.* The mechanical equipment vibrations make it necessary to isolate the piping with flexible joints at a pumping island. Equipment vibrations can cause failure of vent risers or joints in vent risers. Vent risers may vibrate more than other piping because there is no liquid in the pipe to help dampen the vibrations.
3. *Points of differential movement.* Any location where differential settlement may occur will need to be isolated by a flexible joint. Differential settlement can cause the piping to become the support or to have inadequate support. Either case can cause the pipe to buckle or fail.

**5703.6.9.1 Fiberglass-reinforced plastic piping.** Fiberglass-reinforced plastic (FRP) piping is not required to be provided with flexible joints in locations where both of the following conditions are present:

1. Piping does not exceed 4 inches (102 mm) in diameter.
2. Piping has a straight run of not less than 4 feet (1219 mm) on one side of the connection where such connections result in a change of direction.

In lieu of the minimum 4-foot (1219 mm) straight run length, *approved* and *listed* flexible joints are allowed to be used under dispensers and suction pumps, at submerged pumps and tanks, and where vents extend above ground.

❖ Fiberglass-reinforced plastic piping is more flexible than metal piping. This flexibility of fiberglass-reinforced plastic piping can be used to handle expansion and contraction of piping, or vibrations that would be handled by a flexible joint under a set of conditions of pipe diameter and minimum straight section of fiberglass-reinforced plastic piping. This section lists two conditions that must be met:

1. *Maximum 4 inches (102 mm) in diameter.* Fiberglass-reinforced plastic piping greater than 4 inches (102 mm) in diameter can be too stiff to have the flexibility necessary to be an alternative to a flexible joint. The greater the diameter of the pipe, the greater the stiffness of the pipe.
2. *Minimum 4-foot (1219 mm) straight run.* Straight runs of less than 4 feet (1219 mm) are too stiff to have the flexibility necessary to be an alternative to a flexible joint. The longer a pipe run is, the more the pipe can flex without causing stresses that will damage the pipe.

These two conditions are required before fiberglass-reinforced plastic piping can be used as the flexible joint. Flexible joints can be used with fiberglass-reinforced plastic piping. There are locations where there is not sufficient space to meet the two requirements for fiberglass-reinforced plastic piping as a flexible joint or where the use of fiberglass-reinforced plastic piping is not desired. These locations can use a flexible joint.

**5703.6.10 Pipe joints.** Joints shall be liquid tight and shall be welded, flanged or threaded except that *listed* flexible connectors are allowed in accordance with Section 5703.6.9. Threaded or flanged joints shall fit tightly by using *approved* methods and materials for the type of joint. Joints in piping systems used for Class I liquids shall be welded where located in concealed spaces within buildings.

Nonmetallic joints shall be *approved* and shall be installed in accordance with the manufacturer's instructions.

Pipe joints that are dependent on the friction characteristics or resiliency of combustible materials for liquid tightness of piping shall not be used in buildings. Piping shall be secured to prevent disengagement at the fitting.

❖ Pipe joints are to be liquid tight. The code recognizes only three types of generic mechanical joints as being adequate for pipes carrying flammable and combustible liquids. Welded joints, flanged joints and threaded joints provide a liquid-tight joint. ANSI B31.3 contains criteria for the welding of piping. This reference is not in this chapter, but is cited in Chapter 50.

Flanged joints are to be made with materials that are compatible with the piping system and the flammable and combustible liquids in the pipe.

Threaded joints are to be fabricated by methods that ensure a liquid-tight joint by the selection of thread pitch and length of the threaded connection. Listed flexible joints are to be approved by the fire code official.

Pipe joints in a building's concealed space that carry Class I flammable liquids are limited to welded joints. Because Class I flammable liquids can become vapor at ambient temperature, a joint leak in a concealed space could go unnoticed. There could be no liquid escaping the concealed space for personnel to notice. A welded joint that has passed the test requirements of Section 5703.6.3 would be a liquid-tight joint that meets code requirements.

**5703.6.11 Bends.** Pipe and tubing shall be bent in accordance with ASME B31.9.

❖ Pipe direction can be changed using either fittings or bends. Bends are to be done according to ANSI B31.9. Bending a pipe can damage the pipe. An improper bend may kink the interior portion of the pipe wall and that could cause increased pipe stresses resulting from the kink restricting flow. An improper bend could stretch the outer portion of the pipe wall. The stretched portion of pipe would have a thinner wall thickness. This thinner wall could develop pinhole leaks or even cause the pipe to rupture.

## SECTION 5704 STORAGE

**5704.1 General.** The storage of flammable and *combustible liquids* in containers and tanks shall be in accordance with this section and the applicable sections of Chapter 50.

❖ This section and Chapter 50 cover the storage of flammable and combustible liquids in containers and tanks.

**5704.2 Tank storage.** The provisions of this section shall apply to:

1. The storage of flammable and *combustible liquids* in fixed above-ground and underground tanks.
2. The storage of flammable and *combustible liquids* in fixed above-ground tanks inside of buildings.
3. The storage of flammable and *combustible liquids* in portable tanks whose capacity exceeds 660 gallons (2498 L).
4. The installation of such tanks and portable tanks.

❖ The scope of this section is limited to the storage of flammable and combustible liquids in above-ground tanks, underground tanks, above-ground tanks in buildings, portable tanks exceeding 660 gallons (2498 L) and the installation of these tanks.

**5704.2.1 Change of tank contents.** Tanks subject to change in contents shall be in accordance with Section 5704.2.7. Prior to a change in contents, the *fire code official* is authorized to require testing of a tank.

Tanks that have previously contained Class I liquids shall not be loaded with Class II or Class III liquids until such tanks and all piping, pumps, hoses and meters connected thereto have been completely drained and flushed.

❖ The type of flammable or combustible liquid stored in a tank can change. When the type of flammable or combustible liquid is changed, the design and construction of the tank is to comply with NFPA 30 for the type of flammable or combustible liquid to be stored. A change in the tank contents can effect safety by altering the flashpoint of the contents through contamination. Accordingly, the fire code official has the authority to require the tank to be tested before placing the tank in operation with the new type of flammable and combustible liquid.

If the change of flammable and combustible liquid is from a Class I to a Class II or III liquid, the tank and accessory piping and equipment are to be drained and cleaned of the Class I liquid. The Class I liquid left in the tank and accessory piping and equipment can generate vapors that could create a hazard not associated with the Class II or III liquid that has replaced the Class I liquid.

**5704.2.2 Use of tank vehicles and tank cars as storage tanks.** Tank cars and tank vehicles shall not be used as storage tanks.

❖ Even if the wheels were removed and the tank supported on adequate foundations, the use of tank cars

or tank vehicles for permanent storage of flammable or combustible liquids is prohibited by this section because, in many cases, these “tanks” do not comply with the requirements of the referenced standard, NFPA 30. The U.S. Department of Transportation (DOTn) allows motor carriers to transport flammable and combustible liquids in tank vehicles constructed of aluminum. Section 5704.2.7 requires that tanks be constructed in accordance with Section 21.4 of NFPA 30, which, in turn, requires that they be constructed in accordance with good engineering practices. All of the standards adopted in NFPA 30 for shop-fabricated and field-erected above-ground storage tanks prohibit the use of aluminum as a material of construction for storage tanks because of its low melting point. In addition, it is quite possible, for example, that someone could attempt to convert a milk tanker into an above-ground storage tank for flammable or combustible liquids. Such a tank would not, for one thing, have an emergency vent, which is required by Section 5704.2.7.4 of the code. Note that this section does not include the demountable intermediate bulk containers (IBCs) frequently seen in transport secured on flatbed trucks. These portable tanks are regulated by Section 5704.3.

**5704.2.3 Labeling and signs.** Labeling and signs for storage tanks and storage tank areas shall comply with Sections 5704.2.3.1 and 5704.2.3.2.

❖ Above-ground tanks, underground tanks, above-ground tanks in buildings and portable tanks exceeding 660 gallons (2498 L) are to be provided with warning and identification signs.

**5704.2.3.1 Smoking and open flame.** Signs shall be posted in storage areas prohibiting open flames and smoking. Signs shall comply with Section 5703.5.

❖ Warning signs prohibiting smoking and open flames are to comply with NFPA 704.

**5704.2.3.2 Label or placard.** Tanks more than 100 gallons (379 L) in capacity, which are permanently installed or mounted and used for the storage of Class I, II or III liquids, shall bear a label and placard identifying the material therein. Placards shall be in accordance with NFPA 704.

### Exceptions:

1. Tanks of 300-gallon (1136 L) capacity or less located on private property and used for heating and cooking fuels in single-family *dwelling*s.
2. Tanks located underground.

❖ In order to provide warning and information on the hazards of their contents, permanently installed tanks in excess of 100-gallon (379 L) capacity used to store Class I, II or III liquids are to be labeled to identify the flammable or combustible liquid.

There are two exceptions to this labeling of storage tanks based on the use of the storage tank and its location. First, a 300-gallon (1136 L) storage tank for use by a single-family dwelling does not need to be

labeled. This exception is based on the tank's sole use for the storage of heating or cooking fuel used by the occupants of the single-family dwelling. Second, underground tanks do not need to be labeled since their location precludes it.

**5704.2.4 Sources of ignition.** Smoking and open flames are prohibited in storage areas in accordance with Section 5003.7.

**Exception:** Areas designated as smoking and hot work areas, and areas where hot work permits have been issued in accordance with this code.

❖ Smoking and open flames are strictly limited around above-ground tanks, underground tanks, above-ground tanks in buildings and portable tanks exceeding 660 gallons (2498 L). Section 5003.7 prohibits smoking or open flames within 25 feet (7620 mm) of outdoor storage of flammable and combustible liquids and indoors where there are flammable and combustible liquids or where vapors from flammable and combustible liquids may occur.

The exception allows establishment of designated smoking areas and hot work areas. Hot work may be done in areas not designated as a hot work area when a hot work permit is obtained.

**5704.2.5 Explosion control.** Explosion control shall be provided in accordance with Section 911 for indoor tanks.

❖ The vapor from flammable and combustible liquids can cause an explosion when the vapor-air mixture is in an explosive ratio. Explosion control is required for a facility storing or using Class IA liquids or for a facility that has open use or dispensing of Class IIB liquids. Section 911 requires deflagration venting to direct the force of an explosion out of the structure and into an unoccupied area. This section also references NFPA 69, which may require monitoring of gases and other methods to suppress factors affecting an explosion.

**5704.2.6 Separation from incompatible materials.** Storage of flammable and *combustible liquids* shall be separated from *incompatible materials* in accordance with Section 5003.9.8.

Grass, weeds, combustible materials and waste Class I, II or IIIA liquids shall not be accumulated in an unsafe manner at a storage site.

❖ Materials that could create a fire or explosive hazard when in contact with flammable or combustible liquids are to be separated from flammable or combustible liquids by either distance or physical barriers.

Materials that may not be incompatible with flammable or combustible liquids but may be an ignition source or a fuel source are to be removed.

**5704.2.7 Design, fabrication and construction requirements for tanks.** The design, fabrication and construction of tanks shall comply with NFPA 30. Each tank shall bear a per-

manent nameplate or marking indicating the standard used as the basis of design.

❖ Tanks are to be designed according to NFPA 30 and labeled to indicate the design standard.

**5704.2.7.1 Materials used in tank construction.** The materials used in tank construction shall be in accordance with NFPA 30. The materials of construction for tanks and their appurtenances shall be compatible with the liquids to be stored.

❖ The preferred material for tank construction is steel or concrete, materials that have high levels of resistance to heat. Because combustible and flammable liquid tanks are being used to store an ever increasing number of liquids, including gasoline/ethanol blends and diesel/biodiesels blends, this section requires that tank construction materials be compatible with the stored liquids. This is consistent with NFPA 30, Section 21.4.1.1. Petroleum products containing mixtures that are not petroleum based may be incompatible with components in the underground tank. The nonpetroleum products could attack liners, gaskets, etc., and the loss of or damage to these components may cause the underground tank or piping system to develop leaks.

**5704.2.7.2 Pressure limitations for tanks.** Tanks shall be designed for the pressures to which they will be subjected in accordance with NFPA 30.

❖ Tanks may be designed for operation under atmospheric pressure, low pressure or high pressure. The design criteria for pressure are in NFPA 30.

**5704.2.7.3 Tank vents for normal venting.** Tank vents for normal venting shall be installed and maintained in accordance with Sections 5704.2.7.3.1 through 5704.2.7.3.5.3.

❖ Tanks are vented to maintain the internal tank pressure within the design operating range. A low pressure can increase the generation of vapors while a high pressure can damage the tank or piping system. Any pressure outside of the design pressure range can have an adverse affect on the operation of the system as well as the piping and equipment.

**5704.2.7.3.1 Vent lines.** Vent lines from tanks shall not be used for purposes other than venting unless *approved*.

❖ Vent lines are to be used only as vents unless an additional use is approved by the fire code official.

**5704.2.7.3.2 Vent-line flame arresters and pressure-vacuum vents.** *Listed or approved* flame arresters or pressure-vacuum (PV) vents that remain closed unless venting under pressure or vacuum conditions shall be installed in normal vents of tanks containing Class IB and IC liquids.

**Exception:** Where determined by the *fire code official* that the use of such devices can result in damage to the tank.

Vent-line flame arresters shall be installed in accordance with their listing or API 2000 and maintained in accordance

with Section 21.8.6 of NFPA 30 or API 2000. In-line flame arresters in piping systems shall be installed and maintained in accordance with their listing or API 2028. Pressure-vacuum vents shall be installed in accordance with Section 21.4.3 of NFPA 30 or API 2000 and maintained in accordance with Section 21.8.6 of NFPA 30 or API 2000.

❖ The vapors from a vent will mix with air and become an ignitable mixture. This condition requires that measures be taken to either suppress an ignition source or to disperse the ignitable mixture with additional air to drop the vapor-air mixture below the LFL. Previously, the code required that a flame arrester or pressure-vacuum (PV) vent be installed in the normal vent of only protected above-ground tanks containing flammable or combustible liquids, but did not have a similar requirement for other above-ground tanks with a design and construction that provides significantly less protection than a protected above-ground tank. This section has been revised to be consistent with NFPA 30 in that, regardless of tank type, a listed flame arrester or PV vent is only required for tanks containing Class IB and IC liquids, which are less prone to vaporization than Class IA liquids.

Because the primary function of a flame arrester is to prevent the unrestricted propagation of flame through flammable gas or vapor mixtures, it is not necessary to install a flame arrester on tanks containing combustible liquids. Additionally, because flame arresters cannot prevent detonation or control flame propagation speeds associated with a detonation (flame speeds greater than the speed of sound), flame arresters are not effective when installed on tanks containing Class IA liquids. This revision establishes a requirement for a tank-vent flame arrester only when there is a sound technical reason to provide one. The exception allows omitting the use of a PV vent or flame arrester in situations where the properties of the liquid can cause the tank to be damaged by their use. Properties of some Class IB and IC liquids (e.g., crystallization, polymerization, corrosion) can present obstructions in flame arresters that may justify omitting the device.

This section clarifies that API 2028 addresses in-line flame arresters for piping systems. An end-of-line flame arrester is a flame arrester that is mounted at the end of a pipe (flanged or threaded inlet connection) and vents directly to the atmosphere, whereas an in-line flame arrester may be mounted upstream of a PV relief vent or may be located upstream of a specified maximum length of vent piping to the atmosphere. Both in-line and end-of-line flame arresters are acceptable devices. Not only is proper installation of these devices important, but their maintenance is critical. A blocked or corroded flame arrester can render the device ineffective and lead to catastrophic results. As such, this section also addresses maintenance of flame arresters and PV vents in accordance with NFPA 30 or API 2000.

**5704.2.7.3.3 Vent pipe outlets.** Vent pipe outlets for tanks storing Class I, II or IIIA liquids shall be located such that the vapors are released at a safe point outside of buildings and not less than 12 feet (3658 mm) above the finished ground level. Vapors shall be discharged upward or horizontally away from adjacent walls to assist in vapor dispersion. Vent outlets shall be located such that flammable vapors will not be trapped by eaves or other obstructions and shall be not less than 5 feet (1524 mm) from building openings or *lot lines* of properties that can be built upon. Vent outlets on atmospheric tanks storing Class IIIB liquids are allowed to discharge inside a building where the vent is a normally closed vent.

**Exception:** Vent pipe outlets on tanks storing Class IIIB liquid inside buildings and connected to fuel-burning equipment shall be located such that the vapors are released to a safe location outside of buildings.

❖ Vent pipes must be terminated to direct vapors away from the building. Vapors from flammable liquids are normally heavier than air so that the vapor will settle to lower levels. The termination of a vent pipe a minimum of 12 feet (3658 mm) above grade will provide space for the vapors to disperse to below the LFL. This high termination elevation also reduces the potential for the termination being close to grade-level ignition sources. Because flammable liquid vapors are heavier than air, attention needs to be placed on the building design near the termination. Building design and features that may allow the flammable liquid vapors to reenter the building or to collect on the building are to be eliminated. Because Class IIIB liquids have a relatively high boiling point, the vent termination for atmospheric tanks containing these combustible liquids may terminate inside the building, if the vent is normally closed.

Because of the increasing use of alternative fuels derived from biological mass, the requirements for above-ground storage tanks located inside of buildings and that are connected to fuel-burning equipment have been modified to address the use of biodiesel blends. Even though this section allows tanks storing Class IIIB liquids to discharge their vents inside the building, the exception applies to tanks providing fuel to fuel-burning equipment and recognizes that a facility could discover after installation that the fuel-burning equipment either isn't working as efficiently as desired with the Class IIIB liquid biofuel, or the biofuel becomes unavailable or more costly than traditional diesel fuel. Under such circumstances, the facility may elect to switch to a higher-hazard fuel such as Class II diesel fuel without a permit as required by Section 105.6.16(8) or other notification to the jurisdiction. The result of such a switch could be a significantly noncompliant tank system where the quantity of Class II liquid fuel could far exceed the code-allowed quantity of Class II liquid fuel. Such quantities of Class II diesel fuel in excess of that allowed inside of buildings in steel above-

ground tanks would otherwise require providing a Group H occupancy or a protected above-ground tank. Accordingly, tanks connected to and supplying fuel to fuel-burning equipment must be vented to an approved location outside the building.

The exception does not specify a minimum termination height for the vent opening nor a minimum separation distance from property lines or building eaves. Instead, the terminus of the normal vent is required to be at a safe location outside of buildings. Given that biodiesel and many biodiesel blends are classified as Class IIIA or IIIB liquids, it will be difficult to ignite the vapors exhausted through the normal vent opening from a storage tank inside of a building. The exception will provide flexibility to the design professional and fire code official in the placement of the termination point for a normal vent discharging Class IIIB liquid vapors.

**5704.2.7.3.4 Installation of vent piping.** Vent piping shall be designed, sized, constructed and installed in accordance with Section 5703.6. Vent pipes shall be installed such that they will drain toward the tank without sags or traps in which liquid can collect. Vent pipes shall be installed in such a manner so as not to be subject to physical damage or vibration.

❖ Section 5703.6 covers the design, installation, testing and protection of vent pipes. Vent pipes are to drain to the tank and not accumulate condensation in the vent pipe.

**5704.2.7.3.5 Manifolding.** Tank vent piping shall not be manifolded unless required for special purposes such as vapor recovery, vapor conservation or air pollution control.

❖ The combining of vent pipes into a manifold is not permitted as a function for venting unless it is required for the purposes stated in this section. Manifolding of several vents can cause pressure problems during tank-filling operations or in case of a fire in or near the tanks. When vapor recovery, vapor conservation or pollution control is necessary, the vents can be manifolded so that the same equipment can be used for multiple vents.

**5704.2.7.3.5.1 Above-ground tanks.** For above-ground tanks, manifolded vent pipes shall be adequately sized to prevent system pressure limits from being exceeded where manifolded tanks are subject to the same fire exposure.

❖ Manifolding of above-ground tanks requires the manifold to be designed to handle the additional pressure generated by the heating of the flammable or combustible liquid. This additional pressure could cause pressure to build up in other tanks or in the piping system. This additional pressure could create leaks or failure of other tanks or piping.

**5704.2.7.3.5.2 Underground tanks.** For underground tanks, manifolded vent pipes shall be sized to prevent system pressure limits from being exceeded when manifolded tanks are filled simultaneously.

❖ Manifolding of underground tanks must consider the buildup of pressure when the underground tanks are

filled simultaneously. The introduction of flammable or combustible liquids into several tanks at the same time will require the vent system to release the vapor in the tank being displaced by the flammable or combustible liquids. This displaced vapor could exceed the capacity of the vent, causing a buildup of pressure.

**5704.2.7.3.5.3 Tanks storing Class I liquids.** Vent piping for tanks storing Class I liquids shall not be manifolded with vent piping for tanks storing Class II and III liquids unless positive means are provided to prevent the vapors from Class I liquids from entering tanks storing Class II and III liquids, to prevent contamination and possible change in classification of less volatile liquid.

❖ Vapor from a Class I liquid is not to be vented with Class II or III liquid vapors unless a positive means is provided to prevent the Class I vapors from entering tanks storing Class II or III liquids. The flash point of the Class I liquid vapor may affect the flash point of the vapors in the tanks storing the Class II or III liquids.

**5704.2.7.4 Emergency venting.** Stationary, above-ground tanks shall be equipped with additional venting that will relieve excessive internal pressure caused by exposure to fires. Emergency vents for Class I, II and IIIA liquids shall not discharge inside buildings. The venting shall be installed and maintained in accordance with Section 22.7 of NFPA 30.

#### Exceptions:

1. Tanks larger than 12,000 gallons (45 420 L) in capacity storing Class IIIB liquids that are not within the diked area or the drainage path of Class I or II liquids do not require emergency relief venting.
  2. Emergency vents on protected above-ground tanks complying with UL 2085 containing Class II or IIIA liquids are allowed to discharge inside the building.
- ❖ Stationary above-ground tanks can be exposed to an external fire that will heat the tank, generating a greater volume of flammable or combustible liquid vapors in the tank. These vapors can create pressures that could damage the tank or piping system, so these tanks are vented to relieve this additional pressure. If the tank is installed inside of a building and exposed to a fire, the tank is required to vent itself, releasing flammable or combustible liquid vapors into the building, which is already involved in a fire. Since the tank will be venting flammable vapors into a fire scenario, vapor ignition would be immediate and the reaction would be continuous and uncontrolled. This hazard is mitigated by requiring that the emergency vents for Class I, II and IIIA liquid tanks discharge outside the building.

Recognizing the reduced hazard of Class IIIB liquids, Exception 1 provides that stationary above-ground tanks storing more than 12,000 gallons (45 420 L) of Class IIIB liquids do not need emergency venting if the tank is not in the same containment area or drainage path as tanks with Class I or II liq-

uids. The high boiling point of Class IIIB liquids and the high volume provide a degree of safety before the buildup of internal pressure. With the tank safety features, the volume of Class IIIB liquid and having the tank located so that it does not affect tanks storing Class I or II liquids, emergency venting is not required.

Exception 2 recognizes the higher level of protection afforded by a UL 2085-protected above-ground tank storing Class II or IIIA liquid by allowing the emergency vent to discharge inside the building. This is made possible by the fact that UL 2085 tanks are designed and constructed to withstand a 2-hour pool fire test of 2,000°F (1111°C) during which no single point temperature may exceed 400°F (204°C) and the average temperature rise throughout the internal tank can be no greater than 260°F (126.67°C). Given the stringent UL 2085 testing requirements, activation of the emergency vent is likely only under extreme fire conditions over an extended period of time. Further, NFPA 30 requires that emergency vents placed on vent pipes that extend beyond 12 inches (305 mm) from the tank be reengineered to account for the potential back pressure and ensure activation at the appropriate pressure. It is not unusual to see vent lines extending 30 or 40 feet (9.14 or 12.19 m) or more through a building in order to achieve the exterior discharge. Allowing the emergency vent to discharge inside eliminates the need to reengineer the venting and ensures proper sizing and activation of the emergency vent.

**5704.2.7.5 Tank openings other than vents.** Tank openings for other than vents shall comply with Sections 5704.2.7.5.1 through 5704.2.7.5.8.

- ❖ Tanks will have openings other than a vent opening. It will be necessary to have openings for the transfer of flammable and combustible liquids to monitor the contents, sampling, etc. These openings will need to be controlled to avoid the escape of vapors of flammable and combustible liquids or the entrance of air.

**5704.2.7.5.1 Connections below liquid level.** Connections for tank openings below the liquid level shall be liquid tight.

- ❖ Connections below the liquid level for flammable and combustible liquids are to be liquid tight. A connection that is not liquid tight may allow the flammable or combustible liquid to leak from the connection. The leakage could cause a vapor-air mixture that is between the lower flammable limit and the upper flammable limit.

**5704.2.7.5.2 Filling, emptying and vapor recovery connections.** Filling, emptying and vapor recovery connections to tanks containing Class I, II or IIIA liquids shall be located outside of buildings in accordance with Section 5704.2.7.5.6 at a location free from sources of ignition and not less than 5 feet (1524 mm) away from building openings or *lot lines* of property that can be built upon. Such openings shall be prop-

erly identified and provided with a liquid-tight cap that shall be closed when not in use.

Filling and emptying connections to indoor tanks containing Class IIIB liquids and connected to fuel-burning equipment shall be located at a finished ground level location outside of buildings. Such openings shall be provided with a liquid-tight cap that shall be closed when not in use. A sign in accordance with Section 5003.6 that displays the following warning shall be permanently attached at the filling location:

**TRANSFERRING FUEL OTHER THAN  
CLASS IIIB COMBUSTIBLE LIQUID TO  
THIS TANK CONNECTION IS A VIOLATION  
OF THE FIRE CODE AND IS STRICTLY  
PROHIBITED**

- ❖ In order to eliminate the hazards associated with inside connections, tanks for Class I, II and IIIA liquids are to have openings for filling, emptying and vapor recovery connections outside of the building and away from property lines and ignition sources in accordance with Section 5704.2.7.5.6. The flash point of the liquids creates a hazard that is not acceptable inside a building where vapors could accumulate and find their way to an ignition source.

The English-language sign complying with Section 5003.6 required by this section is to warn delivery drivers that liquids other than Class IIIB liquids are not to be delivered to the subject fill pipe. Since some tanks storing Class IIIB liquid biodiesel fuels are allowed to vent inside the building in accordance with Section 5704.2.7.3.3, this is intended to prevent the inadvertent delivery of higher hazard (i.e., lower flash point) liquids to the tank with the corresponding discharge of vapors inside the building (see comment, Section 5704.2.7.3.3).

**5704.2.7.5.3 Piping, connections and fittings.** Piping, connections, fittings and other appurtenances shall be installed in accordance with Section 5703.6.

- ❖ Section 5703.6 covers the design, installation, testing and protection of vent pipes.

**5704.2.7.5.4 Manual gauging.** Openings for manual gauging, if independent of the fill pipe, shall be provided with a liquid-tight cap or cover. Covers shall be kept closed when not gauging. If inside a building, such openings shall be protected against liquid overflow and possible vapor release by means of a spring-loaded check valve or other *approved* device.

- ❖ A manual gauge opening that has a liquid-tight cap and protection against overflow and vapor release is acceptable in tanks located inside a building. The manual gauge opening is permitted if it meets the safety requirements to prevent spillage, leakage and vapor release and has the operation feature that the opening has to be closed except when used to check the contents of the tank.

**5704.2.7.5.5 Fill pipes and discharge lines.** For top-loaded tanks, a metallic fill pipe shall be designed and installed to minimize the generation of static electricity by terminating the pipe within 6 inches (152 mm) of the bottom of the tank, and it shall be installed in a manner that avoids excessive vibration.

- ❖ The filling of a tank with flammable or combustible liquids can generate static electricity. To reduce the generation of static electricity for a top-loaded tank, the fill pipe is to be metallic and extend to within 6 inches (152 mm) of the tank bottom.

**5704.2.7.5.5.1 Class I liquids.** For Class I liquids other than crude oil, gasoline and asphalt, the fill pipe shall be designed and installed in a manner that will minimize the possibility of generating static electricity by terminating within 6 inches (152 mm) of the bottom of the tank.

- ❖ Class I liquids other than crude oil, gasoline and asphalt are to comply with Section 5704.2.7.5.5.

**5704.2.7.5.5.2 Underground tanks.** For underground tanks, fill pipe and discharge lines shall enter only through the top. Fill lines shall be sloped toward the tank. Underground tanks for Class I liquids having a capacity greater than 1,000 gallons (3785 L) shall be equipped with a tight fill device for connecting the fill hose to the tank.

- ❖ Underground tanks are to have the fill pipe and discharge pipe through the top. These fill and discharge pipes are to slope to the top to prevent the accumulation of flammable and combustible liquid. The tight fill device for tanks having a capacity of 1,000 gallons (3785 L) of Class I liquid is to ensure a liquid-tight mechanical connection of the fill hose to the tank. This connection will reduce the potential for spills or leakage and the mixing of Class I vapors with air.

**5704.2.7.5.6 Location of connections that are made or broken.** Filling, withdrawal and vapor-recovery connections for Class I, II and IIIA liquids that are made and broken shall be located outside of buildings, not more than 5 feet (1524 mm) above the finished ground level, in an *approved* location in close proximity to the parked delivery vehicle. Such location shall be away from sources of ignition and not less than 5 feet (1524 mm) away from building openings. Such connections shall be closed and liquid tight when not in use and shall be properly identified.

- ❖ The low flash point of liquids creates a hazard that is not acceptable inside of a building where vapors could accumulate. In order to eliminate the hazards associated with inside connections that are made or broken, tanks for Class I, II and IIIA liquids are to have their filling, emptying and vapor-recovery connections outside of the building and away from property lines and ignition sources in accordance with this section. The flash point of the liquids creates a hazard that is not acceptable inside a building where vapors could accumulate and find their way to an ignition source.

This section also requires that the tank-fill connection location is required to be at ground level where the fuel delivery truck driver has direct access to it.

This is to prevent designs that propose to hoist fuel delivery truck hose lines up the exterior of the building to rooftops and other building levels above the finished ground level (see also commentary, Section 5704.2.7.5.2).

**5704.2.7.5.7 Protection against vapor release.** Tank openings provided for purposes of vapor recovery shall be protected against possible vapor release by means of a spring-loaded check valve or dry-break connections, or other *approved* device, unless the opening is a pipe connected to a vapor processing system. Openings designed for combined fill and vapor recovery shall also be protected against vapor release unless connection of the liquid delivery line to the fill pipe simultaneously connects the vapor recovery line. Connections shall be vapor tight.

- ❖ Connections are to be vapor tight to prevent the release of vapor from flammable or combustible liquids into the area surrounding the tank. The release of vapor from flammable or combustible liquids could create a vapor-air mixture that exceeds the LFL. The code does permit connections that are not vapor tight if the connection is part of the vapor-recovery system. This exception is permitted because the vapor-recovery system should be operating at a pressure lower than atmospheric pressure. This lower pressure should prevent vapor from escaping the vapor-recovery system.

**5704.2.7.5.8 Overfill prevention.** An *approved* means or method in accordance with Section 5704.2.9.7.6 shall be provided to prevent the overfill of all Class I, II and IIIA liquid storage tanks. Storage tanks in refineries, bulk plants or terminals regulated by Section 5706.4 or 5706.7 shall have overfill protection in accordance with API 2350.

An *approved* means or method in accordance with Section 5704.2.9.7.6 shall be provided to prevent the overfilling of Class IIIB liquid storage tanks connected to fuel-burning equipment inside buildings.

**Exception:** Outside above-ground tanks with a capacity of 1,320 gallons (5000 L) or less.

- ❖ In the 2003 and earlier editions and drafts of the code, this section required that all above-ground storage tanks, regardless of capacity, be provided with an approved means or method of overfill prevention. For smaller tanks [less than 200- to 300-gallon (757 to 1136 L) capacity], technology exists to provide such protection. However, it must be an engineered design using a liquid-level limit switch and shutoff valve in the tank fill opening, which can cost thousands of dollars. Off-the-shelf overfill prevention devices are generally not available in the marketplace because most tank manufacturers provide fill openings that are less than 2 inches (51 mm) in diameter on smaller tanks and the off-the-shelf overfill prevention devices currently available are designed for use with tank openings 2 inches (51 mm) or larger in diameter.

A second issue relates to the frequency and size of spills. The United States Coast Guard maintains data

on spill amounts and locations in accordance with the Federal Water Pollution Control Act. A review of that data disclosed that the volume of spills has been on a downward trend since 1974. For spills of 101 to 1,000 gallons (382 to 3785 L), 1,457 events occurred in 1974, but in 2001, only 216 such spill events occurred. Also, 87.6 percent of all the spills reported to the Coast Guard are less than 100 gallons (379 L). Certainly, while no spill is acceptable, the data clearly shows that when spills do occur, they are typically less than 100 gallons (379 L).

Overfill protection is important for flammable and combustible liquids but not necessary on small tanks. Those code requirements for overfill prevention for above-ground petroleum storage tanks align with the federal requirements for Spill Prevention Control and Countermeasures (SPCC) Plans. An SPCC plan is required in accordance with the U.S. Oil Pollution Act for most sites with an aggregate tank volume of over 1,320 gallons (4996 L). Additionally, tanks over 660 gallons (2498 L) typically have 2-inch (51 mm) or larger openings that can accommodate off-the-shelf overfill prevention devices discussed above.

API 2350 includes recommended practices on prevention of overfills of above-ground tanks of greater than 1,320 gallons (4996 L) storing Class I and II liquids associated with marketing, refining, pipeline and similar facilities (see commentary, Section 5704.2.9.7.5).

Even though this section does not otherwise require overfill protection on tanks storing Class IIIB liquids, it recognizes one of the major concerns about Class IIIB liquid biodiesel tanks connected to fuel-burning equipment. That concern is that a facility could discover after installation that the fuel-burning equipment either isn't working as efficiently as desired with the Class IIIB liquid biofuel, or the biofuel becomes unavailable or more costly than traditional diesel fuel. Under such circumstances, the facility may elect to switch to a higher hazard fuel such as Class II diesel fuel without a permit as required by Section 105.6.16(8) or other notification to the jurisdiction. The result of such a switch could be a significantly noncompliant tank system where now a Class II liquid fuel storage tank exists where none did before and is without the safeguard of overfill protection. The lower flash point of the Class II liquid creates an overfill hazard potential that is not acceptable inside a building where vapors could accumulate and find their way to an ignition source.

**5704.2.7.6 Repair, alteration or reconstruction of tanks and piping.** The repair, *alteration* or reconstruction, including welding, cutting and hot tapping of storage tanks and piping that have been placed in service, shall be in accordance with NFPA 30. Hot work, as defined in Section 202, on such tanks shall be conducted in accordance with Section 3510.

❖ Tanks and piping for flammable and combustible liquids can be repaired, altered or reconstructed under the criteria of NFPA 30 and in accordance with Section 3510.

**5704.2.7.7 Design of supports.** The design of the supporting structure for tanks shall be in accordance with the *International Building Code* and NFPA 30.

❖ Footings, foundations and structural supports for tanks must comply with the IBC and NFPA 30.

**5704.2.7.8 Locations subject to flooding.** Where a tank is located in an area where it is subject to buoyancy because of a rise in the water table, flooding or accumulation of water from fire suppression operations, uplift protection shall be provided in accordance with Sections 22.14 and 23.14 of NFPA 30.

❖ The tank, with its content of flammable or combustible liquid, may weigh less than an equivalent volume of water. If this occurs and the tank is subjected to flooding, the tank will float. This will place stresses on piping systems that could fail, causing the flammable or combustible liquid to spill. The flooding may be from natural causes or from fire suppression operations. The application of water by a fire department could cause flooding in the area of the tank. Section 26.6 of NFPA 30 contains the criteria for designing anchorage for both above-ground and underground tanks. Flood hazard areas are defined in IBC Section 202.

**5704.2.7.9 Corrosion protection.** Where subject to external corrosion, tanks shall be fabricated from corrosion-resistant materials, coated or provided with corrosion protection in accordance with Section 23.3.5 of NFPA 30.

❖ Soil conditions and environmental conditions can cause tanks to deteriorate. Corrosion can weaken the tank, creating a potential for leakage. The tank is to be protected from corrosion by use of corrosion-resistant material, coatings, cathodic protection or methods described in Section 23.3.4 of NFPA 30. See Section 5703.6.5 for requirements for corrosion protection for piping.

**5704.2.7.10 Leak reporting.** A consistent or accidental loss of liquid, or other indication of a leak from a tank system, shall be reported immediately to the fire department, the *fire code official* and other authorities having jurisdiction.

❖ The leakage of flammable or combustible liquids is a serious fire hazard. This hazard is to be immediately reported to the fire department, the fire code official and other authorities having jurisdiction.

The leaking tank will have to be repaired or taken out of service. The fire code official will have to review plans and issue a permit for the repair.

**5704.2.7.10.1 Leaking tank disposition.** Leaking tanks shall be promptly emptied, repaired and returned to service, abandoned or removed in accordance with Section 5704.2.13 or 5704.2.14.

❖ Leaking tanks must be repaired, taken out of service or removed. The fire code official must review plans and issue a permit for these activities.

**5704.2.7.11 Tank lining.** Steel tanks are allowed to be lined only for the purpose of protecting the interior from corrosion or providing compatibility with a material to be stored. Only

those liquids tested for compatibility with the lining material are allowed to be stored in lined tanks.

- ❖ Tanks are lined to prevent corrosion from attacking the interior surface. Water vapor can condense inside a tank or the flammable or combustible liquid stored can be corrosive. The type of lining will limit the use of the tank to flammable and combustible liquids that are compatible with the lining.

**5704.2.8 Vaults.** Vaults shall be allowed to be either above or below grade and shall comply with Sections 5704.2.8.1 through 5704.2.8.18.

- ❖ Vaults are designed and constructed for the protection of tanks and as a secondary containment for flammable and combustible liquids. Above-ground tanks may be installed in vaults.

**5704.2.8.1 Listing required.** Vaults shall be *listed* in accordance with UL 2245.

**Exception:** Where *approved* by the *fire code official*, below-grade vaults are allowed to be constructed on site, provided that the design is in accordance with the *International Building Code* and that special inspections are conducted to verify structural strength and compliance of the installation with the *approved* design in accordance with Section 1707 of the *International Building Code*. Installation plans for below-grade vaults that are constructed on site shall be prepared by, and the design shall bear the stamp of, a professional engineer. Consideration shall be given to soil and hydrostatic loading on the floors, walls and lid; anticipated seismic forces; uplifting by groundwater or flooding; and to loads imposed from above such as traffic and equipment loading on the vault lid.

- ❖ Vaults must be listed to UL 2245. The fire code official can approve below-grade vaults that are constructed on site. These below-grade vaults must be designed by a professional engineer to comply with the IBC. The construction is to be inspected by a design professional. Flood hazard areas are defined in IBC Section 202.

**5704.2.8.2 Design and construction.** The vault shall completely enclose each tank. There shall not be openings in the vault enclosure except those necessary for access to, inspection of, and filling, emptying and venting of the tank. The walls and floor of the vault shall be constructed of reinforced concrete not less than 6 inches (152 mm) thick. The top of an above-grade vault shall be constructed of noncombustible material and shall be designed to be weaker than the walls of the vault, to ensure that the thrust of an explosion occurring inside the vault is directed upward before significantly high pressure can develop within the vault.

The top of an at-grade or below-grade vault shall be designed to relieve safely or contain the force of an explosion occurring inside the vault. The top and floor of the vault and the tank foundation shall be designed to withstand the anticipated loading, including loading from vehicular traffic, where applicable. The walls and floor of a vault installed below grade shall be designed to withstand anticipated soil and hydrostatic loading.

Vaults shall be designed to be wind and earthquake resistant, in accordance with the *International Building Code*.

- ❖ The vault is to be of noncombustible materials with openings required only for the operation and maintenance of the enclosed tank. Reinforced concrete is to be used for the walls and floor and the top is designed to vent an explosion.

**5704.2.8.3 Secondary containment.** Vaults shall be substantially liquid tight and there shall not be backfill around the tank or within the vault. The vault floor shall drain to a sump. For premanufactured vaults, liquid tightness shall be certified as part of the listing provided by a nationally recognized testing laboratory. For field-erected vaults, liquid tightness shall be certified in an *approved* manner.

- ❖ The vault is to function as a secondary containment for the tank in the event of a leak or spillage. Any leakage or spillage must be removed by draining to a sump in the vault floor. Premanufactured vaults are required to be listed in accordance with UL 2245 by Section 5704.2.8.1, and part of the analysis program performed is an evaluation during the listing process of the effectiveness of secondary containment provided by a vault. It is much more difficult to accomplish a liquid-tight installation on a field-erected vault, as evidenced by the proliferation of leaky basements found throughout the country; therefore, to enhance the quality of field-erected vaults, such units must be certified for liquid tightness to the satisfaction of the fire code official. Methods that might be used include third-party inspection/evaluation and full-scale liquid retention testing.

**5704.2.8.4 Internal clearance.** There shall be sufficient clearance between the tank and the vault to allow for visual inspection and maintenance of the tank and its appurtenances. Dispensing devices are allowed to be installed on tops of vaults.

- ❖ Maintenance and inspection of the tank requires that the clearance between the tank and the vault be sufficient for personnel to perform these functions.

**5704.2.8.5 Anchoring.** Vaults and their tanks shall be suitably anchored to withstand uplifting by ground water or flooding, including when the tank is empty.

- ❖ The tank and the vault may float if the water table is high or flooding occurs. The tank is to be anchored to the vault to prevent the tank from floating, while the vault is also to be anchored to prevent it from floating. Anchoring is also required under Section 5704.2.7.8. Flood hazard areas are defined in IBC Section 202.

**5704.2.8.6 Vehicle impact protection.** Vaults shall be resistant to damage from the impact of a motor vehicle, or vehicle impact protection shall be provided in accordance with Section 312.

- ❖ Protection from impact by vehicles is provided by guard posts or other approved barriers. Section 312 contains the specifications for guard posts or the design forces required for an approved barrier to

comply with the code. Protection from vehicle impact is also required under Section 5703.6.4.

**5704.2.8.7 Arrangement.** Tanks shall be *listed* for above-ground use, and each tank shall be in its own vault. Compartmentalized tanks shall be allowed and shall be considered as a single tank. Adjacent vaults shall be allowed to share a common wall. The common wall shall be liquid and vapor tight and shall be designed to withstand the load imposed when the vault on either side of the wall is filled with water.

- ❖ Above-ground tanks installed in vaults are to be independent of each other; a separate vault is to be constructed for each tank. The individual vaults can use a common separation wall if it does not allow the flammable and combustible liquids or their vapors from one vault to enter another vault. This common wall must be able to resist the hydrostatic loads if the adjacent vault is flooded.

**5704.2.8.8 Connections.** Connections shall be provided to permit venting of each vault to dilute, disperse and remove vapors prior to personnel entering the vault.

- ❖ Because flammable and combustible vapors are normally heavier than air, the vault must have connections for venting these vapors.

**5704.2.8.9 Ventilation.** Vaults that contain tanks of Class I liquids shall be provided with an exhaust ventilation system installed in accordance with Section 5004.3. The ventilation system shall operate continuously or be designed to operate upon activation of the vapor or liquid detection system. The system shall provide ventilation at a rate of not less than 1 cubic foot per minute (cfm) per square foot of floor area [ $0.00508 \text{ m}^3/(\text{s} \cdot \text{m}^2)$ ], but not less than 150 cfm ( $4 \text{ m}^3/\text{min}$ ). The exhaust system shall be designed to provide air movement across all parts of the vault floor. Supply and exhaust ducts shall extend to within 3 inches (76 mm), but not more than 12 inches (305 mm), of the floor. The exhaust system shall be installed in accordance with the *International Mechanical Code*.

- ❖ The removal of Class I vapors from a vault requires that a ventilation system be installed according to Section 5004.3 and the IMC. The ventilation system must have supply and exhaust ducts within 3 inches (76 mm) to 12 inches (305 mm) of the vault floor. These ducts are to provide ventilation across the entire vault floor to remove the vapors and provide breathable air.

**5704.2.8.10 Liquid detection.** Vaults shall be equipped with a detection system capable of detecting liquids, including water, and activating an alarm.

- ❖ The liquid detection system is to identify any leakage or spillage of flammable or combustible liquids. There are two concerns for liquid detection: flammable or combustible liquids and water leaking into the vault.

**5704.2.8.11 Monitoring and detection.** Vaults shall be provided with *approved* vapor and liquid detection systems and equipped with on-site audible and visual warning devices with battery backup. Vapor detection systems shall sound an

alarm when the system detects vapors that reach or exceed 25 percent of the lower explosive limit (LEL) of the liquid stored. Vapor detectors shall be located not higher than 12 inches (305 mm) above the lowest point in the vault. Liquid detection systems shall sound an alarm upon detection of any liquid, including water. Liquid detectors shall be located in accordance with the manufacturer's instructions. Activation of either vapor or liquid detection systems shall cause a signal to be sounded at an *approved*, constantly attended location within the facility serving the tanks or at an *approved* location. Activation of vapor detection systems shall also shut off dispenser pumps.

- ❖ The vault is to have liquid and vapor detection systems that sound an alarm when either is present. The systems are to have battery backup in the event of a power failure.

The liquid and vapor detection systems are to sound an alarm at a constantly attended location that is approved by the fire code official.

The vapor detection system is to sound an alarm and shut off dispensing pumps when the detection system senses a vapor concentration of 25 percent or greater of the flammable or combustible LFL.

**5704.2.8.12 Liquid removal.** Means shall be provided to recover liquid from the vault. Where a pump is used to meet this requirement, the pump shall not be permanently installed in the vault. Electric-powered portable pumps shall be suitable for use in Class I, Division 1, or Zone 0 locations, as defined in NFPA 70.

- ❖ A method for removing liquid from the vault must be provided. This can be through a gravity drain, if the site is appropriate, or by manual or portable electric pumps.

**5704.2.8.13 Normal vents.** Vent pipes that are provided for normal tank venting shall terminate not less than 12 feet (3658 mm) above ground level.

- ❖ Vault vent pipe termination must comply with Section 5704.2.7.3.3.

**5704.2.8.14 Emergency vents.** Emergency vents shall be vapor tight and shall be allowed to discharge inside the vault. Long-bolt manhole covers shall not be allowed for this purpose.

- ❖ An emergency vent is necessary to release any pressure that develops in a tank when it is exposed to fire. The fire will cause a release of vapor from the flammable or combustible liquid, greatly exceeding pressures expected during normal operation. The emergency vent on a tank is to prevent the tank from rupturing, which would expose a greater volume of flammable or combustible liquids to the fire.

**5704.2.8.15 Accessway.** Vaults shall be provided with an *approved* personnel accessway with a minimum dimension of 30 inches (762 mm) and with a permanently affixed, nonferrous ladder. Accessways shall be designed to be nonsparking. Travel distance from any point inside a vault to an accessway shall not exceed 20 feet (6096 mm). At each entry point, a warning sign indicating the need for procedures for safe entry

into confined spaces shall be posted. Entry points shall be secured against unauthorized entry and vandalism.

❖ Access to the vault must have a minimum dimension of 30 inches (762 mm) for ease of personnel passage. Because there is the possibility of vapors from flammable and combustible liquids in the vault, the accessway and ladder are to be nonsparking. Vapor from flammable and combustible liquids can replace the air in a vault. For personnel safety, the travel distance is limited and warning signs must be posted to remind personnel of potential hazards.

**5704.2.8.16 Fire protection.** Vaults shall be provided with a suitable means to admit a fire suppression agent.

❖ The fire suppression agent used to control a flammable or combustible liquid fire in a vault may be water, foam or some combination. The vault must be equipped with a suitable means for applying the fire suppression agent.

**5704.2.8.17 Classified area.** The interior of a vault containing a tank that stores a Class I liquid shall be designated a Class I, Division 1, or Zone 0 location, as defined in NFPA 70.

❖ The interior of a vault storing Class I liquid is a Class I, Division 1, location for determining the type of electrical system and components to be installed.

**5704.2.8.18 Overfill protection.** Overfill protection shall be provided in accordance with Section 5704.2.9.7.6. The use of a float vent valve shall be prohibited.

❖ Overfill protection is covered in Section 5704.2.9.7.6 and applies to all flammable and combustible liquids.

**5704.2.9 Above-ground tanks.** Above-ground storage of flammable and *combustible liquids* in tanks shall comply with Section 5704.2 and Sections 5704.2.9.1 through 5704.2.9.7.9.

❖ The storage of flammable and combustible liquids is permitted in above-ground tanks if the tanks are equipped to prevent the flammable and combustible liquid from escaping and becoming a vapor-air mixture in the flammable range. Operation of these above-ground tanks, sources of ignition, locations, security, etc., are covered to ensure a safe facility and operation.

**5704.2.9.1 Existing noncompliant installations.** Existing above-ground tanks shall be maintained in accordance with the code requirements that were applicable at the time of installation. Above-ground tanks that were installed in violation of code requirements applicable at the time of installation shall be made code compliant or shall be removed in accordance with Section 5704.2.14, regardless of whether such tank has been previously inspected (see Section 106.4).

❖ For existing, noncompliant above-ground storage tanks that constitute a hazard, such as an underground tank being used above ground, straightforward guidance and a clear-cut authorization, as provided by this section, to remove the tank is needed. These situations are different from an aban-

doned or out-of-service tank, yet require similar mitigation, such that the removal of such an unsafe tank needs to be in accordance with the safeguards otherwise required.

The reference to Section 106.4 addresses the issue of previous approvals that were mistakenly given by an inspector when a violation may have gone unnoticed.

**5704.2.9.2 Fire protection.** Fire protection for above-ground tanks shall comply with Sections 5704.2.9.2.1 through 5704.2.9.2.4.

❖ Above-ground tanks are equipped with fire protection to control exterior fire exposure, control fire from flammable and combustible liquid, protect the tank structure and protect the facility.

**5704.2.9.2.1 Required foam fire protection systems.** Where required by the *fire code official*, foam fire protection shall be provided for above-ground tanks, other than pressure tanks operating at or above 1 pound per square inch gauge (psig) (6.89 kPa) where such tank, or group of tanks spaced less than 50 feet (15 240 mm) apart measured shell to shell, has a liquid surface area in excess of 1,500 square feet (139 m<sup>2</sup>), and is in accordance with one of the following:

1. Used for the storage of Class I or II liquids.
2. Used for the storage of crude oil.
3. Used for in-process products and is located within 100 feet (30 480 mm) of a fired still, heater, related fractionating or processing apparatus or similar device at a processing plant or petroleum refinery as herein defined.
4. Considered by the *fire code official* as posing an unusual exposure hazard because of topographical conditions; nature of occupancy, proximity on the same or adjoining property, and height and character of liquids to be stored; degree of private fire protection to be provided; and facilities of the fire department to cope with flammable liquid fires.

❖ The fire code official has the authority to require a foam fire protection system for above-ground tanks when the tanks satisfy the criteria in this section. These limits are based on the capacity of the foam fire protection system.

**5704.2.9.2.2 Foam fire protection system installation.** Where foam fire protection is required, it shall be installed in accordance with NFPA 11.

❖ Foam fire protection systems are to comply with NFPA 11. Such systems are for use on flammable and combustible liquid hazards in local areas of a building, for storage tanks and for indoor or outdoor processing areas. NFPA 11 also covers systems for use on liquid fuel fires in small enclosed or partially enclosed spaces.

Foam can provide quick and effective coverage for flammable liquid spill fires where rapid vapor suppression is essential. High-expansion foams are for use on liquid fuel fires where depth of coverage is

important to fill volumes where fire exists at various levels. High-expansion foams are more effective indoors than outdoors.

**5704.2.9.2.2.1 Foam storage.** Where foam fire protection is required, foam-producing materials shall be stored on the premises.

**Exception:** Storage of foam-producing materials off the premises is allowed as follows:

1. Such materials stored off the premises shall be of the proper type suitable for use with the equipment at the installation where required.
2. Such materials shall be readily available at the storage location at all times.
3. Adequate loading and transportation facilities shall be provided.
4. The time required to deliver such materials to the required location in the event of fire shall be consistent with the hazards and fire scenarios for which the foam supply is intended.
5. At the time of a fire, these off-premises supplies shall be accumulated in sufficient quantities before placing the equipment in operation to ensure foam production at an adequate rate without interruption until extinguishment is accomplished.

❖ When the fire code official requires a foam fire protection system, the foam must be stored on site.

The exception allows the fire code official to authorize off-site foam storage if the off-site storage does not hamper the foam fire protection. Consideration must be given to type of foam, availability, time needed to get the foam material to the site and the quantity of foam material required before authorization for off-site foam storage is approved.

**5704.2.9.2.3 Fire protection of supports.** Supports or pilings for above-ground tanks storing Class I, II or IIIA liquids elevated more than 12 inches (305 mm) above grade shall have a *fire-resistance rating* of not less than 2 hours in accordance with the fire exposure criteria specified in ASTM E1529.

**Exceptions:**

1. Structural supports tested as part of a protected above-ground tank in accordance with UL 2085.
  2. Stationary tanks located outside of buildings where protected by an *approved* water-spray system designed in accordance with Chapter 9 and NFPA 15.
  3. Stationary tanks located inside of buildings equipped throughout with an *approved* automatic sprinkler system designed in accordance with Section 903.3.1.1.
- ❖ Above-ground tank supports extending more than 12 inches (305 mm) above grade must have no less than 2-hour fire protection. This fire rating is based on ASTM E1529, which is based on a hydrocarbon pool

fire instead of the ASTM E119 estimate of fuel content in a building.

The exceptions to this fire rating for the structural support are based on the fire protection provided by other means listed under UL 2085, protection provided by a waterspray system under NFPA 15 or for a tank inside a sprinklered building.

**5704.2.9.2.4 Inerting of tanks storing boilover liquids.** Liquids with boilover characteristics shall not be stored in fixed roof tanks larger than 150 feet (45 720 mm) in diameter unless an *approved* gas enrichment or inerting system is provided on the tank.

**Exception:** Crude oil storage tanks in production fields with no other exposures adjacent to the storage tank.

❖ The application of water to a liquid with boilover characteristics can cause a rapid increase in the fire. The boilover liquid may be hot enough to vaporize water that has been added to the fire or water that may be under the boilover liquid. The sudden release of steam can cause the fire to greatly increase in intensity or cause an explosion. Using an inert system to suppress a fire in a large diameter tank will reduce the potential danger from boilover.

The exception notes that where the hazard is limited to an isolated crude oil tank in a production field, the inert system is not required.

**5704.2.9.3 Supports, foundations and anchorage.** Supports, foundations and anchorages for above-ground tanks shall be designed and constructed in accordance with NFPA 30 and the *International Building Code*.

❖ Footings, foundations and structural supports for above-ground tanks must comply with the IBC and NFPA 30.

**5704.2.9.4 Stairways, platforms and walkways.** *Stairways*, platforms and walkways shall be of noncombustible construction and shall be designed and constructed in accordance with NFPA 30 and the *International Building Code*.

❖ Stairways, platforms and walkways for above-ground tanks must be of noncombustible construction and comply with the IBC and NFPA 30.

**5704.2.9.5 Above-ground tanks inside of buildings.** Above-ground tanks inside of buildings shall comply with Sections 5704.2.9.5.1 and 5704.2.9.5.2.

❖ This section introduces the requirements for above-ground storage tanks inside buildings.

**5704.2.9.5.1 Overfill prevention.** Above-ground tanks storing Class I, II and IIIA liquids inside buildings shall be equipped with a device or other means to prevent overflow into the building including, but not limited to: a float valve; a preset meter on the fill line; a valve actuated by the weight of the tank's contents; a low-head pump that is incapable of producing overflow; or a liquid-tight overflow pipe not less than one pipe size larger than the fill pipe and discharging by gravity back to the outside source of liquid or to an *approved* location. Tanks containing Class IIIB liquids and connected

to fuel-burning equipment shall be provided with a means to prevent overflow into buildings in accordance with Section 5704.2.7.5.8.

- ❖ Overfilling of tanks containing Class I, II and IIIA liquids inside a building can release vapors that could reach concentrations at or above the LFL. Devices and equipment for filling of these tanks must be designed to prevent spillage and damage to the storage tank.

Note that tanks storing Class IIIB liquids and not connected to fuel-burning equipment, such as waste motor oil, are not subject to these requirements due to the higher flash point (lower volatility) and thus the lower relative hazard of the liquid.

Tanks storing Class IIIB liquids and connected to fuel burning equipment, however, are subject to over-fill protection requirements in accordance with Section 5704.2.7.5.8 due to the potential for the creation of hazardous conditions as discussed in the commentary to that section.

**5704.2.9.5.2 Fill pipe connections.** Fill pipe connections for tanks storing Class I, II and IIIA liquids and Class IIIB liquids connected to fuel-burning equipment shall be in accordance with Section 5704.2.9.7.7.

- ❖ This section requires fill pipes on above-ground tanks located inside buildings to be equipped with a means to make a direct connection with the tank vehicle's fuel-delivery hose. Essentially, it requires a "camlock" or other similar device and prohibits filling a tank located inside a building through the use of a hand-held nozzle. This requirement exists already for protected above-ground tanks in Section 5704.2.9.7.6, so a reference in this section establishes parity between protected tanks and other types of tanks.

**5704.2.9.6 Above-ground tanks outside of buildings.** Above-ground tanks outside of buildings shall comply with Sections 5704.2.9.6.1 through 5704.2.9.6.3.

- ❖ Above-ground tanks outside of a building are separated from other tanks and facilities to minimize the exposure to fire and transfer of fire from tank to tank or to another facility.

**5704.2.9.6.1 Locations where above-ground tanks are prohibited.** Storage of Class I and II liquids in above-ground tanks outside of buildings is prohibited within the limits established by law as the limits of districts in which such storage is prohibited (see Section 3 of the Sample Legislation for Adoption of the *International Fire Code* on page xxi).

- ❖ This section enables the adopting jurisdiction to prohibit the installation of above-ground tanks in certain geographic areas of the jurisdiction by enumerating them in the adopting legislation. The code book includes a sample adopting ordinance that contains a blank space for the jurisdiction to fill in describing the particular areas where above-ground tank installations are to be prohibited.

**5704.2.9.6.1.1 Location of tanks with pressures 2.5 psig or less.** Above-ground tanks operating at pressures not exceeding 2.5 psig (17.2 kPa) for storage of Class I, II or IIIA liquids, which are designed with a floating roof, a weak roof-to-shell seam or equipped with emergency venting devices limiting pressure to 2.5 psig (17.2 kPa), shall be located in accordance with Table 22.4.1.1(a) of NFPA 30.

**Exceptions:**

1. Vertical tanks having a weak roof-to-shell seam and storing Class IIIA liquids are allowed to be located at one-half the distances specified in Table 22.4.1.1(a) of NFPA 30, provided the tanks are not within a diked area or drainage path for a tank storing Class I or II liquids.
2. Liquids with boilover characteristics and unstable liquids in accordance with Sections 5704.2.9.6.1.3 and 5704.2.9.6.1.4.
3. For protected above-ground tanks in accordance with Section 5704.2.9.7 and tanks in at-grade or above-grade vaults in accordance with Section 5704.2.8, the distances in Table 22.4.1.1(b) of NFPA 30 shall apply and shall be reduced by one-half, but not to less than 5 feet (1524 mm).

- ❖ Above-ground tanks for Class I, II and IIIA liquids are to be located at clearances specified by Table 22.4.1.1(a) of NFPA 30.

Exception 1 permits locating above-ground tanks for Class IIIA liquids at half the clearances of Table 22.4.1.1(a) of NFPA 30 if the tanks are isolated from tanks containing Class I and II liquids.

Exception 2 recognizes the special hazards of boilover and unstable liquids by deferring to Section 5704.2.9.6.1.3 or 5704.2.9.6.1.4, respectively.

Exception 3 recognizes the additional fire protection provided by protected above-ground tanks and tanks in vaults by allowing reduced separation distances.

**5704.2.9.6.1.2 Location of tanks with pressures exceeding 2.5 psig.** Above-ground tanks for the storage of Class I, II or IIIA liquids operating at pressures exceeding 2.5 psig (17.2 kPa) or equipped with emergency venting allowing pressures to exceed 2.5 psig (17.2 kPa) shall be located in accordance with Table 22.4.1.3 of NFPA 30.

**Exception:** Liquids with boilover characteristics and unstable liquids in accordance with Sections 5704.2.9.6.1.4 and 5704.2.9.6.1.5.

- ❖ Above-ground tanks for Class I, II and IIIA liquids are to be located at clearances specified by Table 22.4.1.3 of NFPA 30.

The exception prohibits this tank spacing if the tanks contain liquids with boilover characteristics and unstable liquids (see commentary, Sections 5704.2.9.6.1.4 and 5704.2.9.6.1.5).

**5704.2.9.6.1.3 Location of tanks storing boilover liquids.** Above-ground tanks for storage of liquids with boilover char-

acteristics shall be located in accordance with Table 22.4.1.4 of NFPA 30.

- ❖ Above-ground tanks containing boiler liquids are to be located at clearances specified by Table 22.4.1.4 of NFPA 30.

**5704.2.9.6.1.4 Location of tanks storing unstable liquids.** Above-ground tanks for the storage of unstable liquids shall be located in accordance with Table 22.4.1.5 of NFPA 30.

- ❖ Above-ground tanks for unstable liquids are to be located at clearances specified by Table 22.4.1.5 of NFPA 30.

**5704.2.9.6.1.5 Location of tanks storing Class IIIB liquids.** Above-ground tanks for the storage of Class IIIB liquids, excluding unstable liquids, shall be located in accordance with Table 22.4.1.6 of NFPA 30, except where located within a diked area or drainage path for a tank or tanks storing Class I or II liquids. Where a Class IIIB liquid storage tank is within the diked area or drainage path for a Class I or II liquid, distances required by Section 5704.2.9.6.1.1 shall apply.

- ❖ Above-ground tanks for Class IIIB liquids, excluding unstable liquids, are to be located at clearances specified by Table 22.4.1.6 of NFPA 30. Because of the hazards of Class I and II liquids, when an above-ground tank for Class IIIB liquids is not isolated from these liquids, the clearances specified by NFPA 30 are to apply.

**5704.2.9.6.1.6 Reduction of separation distances to adjacent property.** Where two tank properties of diverse ownership have a common boundary, the *fire code official* is authorized to, with the written consent of the *owners* of the two properties, apply the distances in Sections 5704.2.9.6.1.2 through 5704.2.9.6.1.5 assuming a single property.

- ❖ The fire code official has the authority to consider two independent properties as a single property for tank farms for determining the clearances. This authority is limited to having the written consent from both property owners. This does not reduce the clearances between above-ground tanks.

**5704.2.9.6.2 Separation between adjacent stable or unstable liquid tanks.** The separation between tanks containing stable liquids shall be in accordance with Table 22.4.2.1 of NFPA 30. Where tanks are in a diked area containing Class I or II liquids, or in the drainage path of Class I or II liquids, and are compacted in three or more rows or in an irregular pattern, the *fire code official* is authorized to require greater separation than specified in Table 22.4.2.1 of NFPA 30 or other means to make tanks in the interior of the pattern accessible for fire-fighting purposes.

**Exception:** Tanks used for storing Class IIIB liquids are allowed to be spaced 3 feet (914 mm) apart unless within a diked area or drainage path for a tank storing Class I or II liquids.

The separation between tanks containing unstable liquids shall be not less than one-half the sum of their diameters.

- ❖ NFPA 30 specifies clearances between above-ground tanks containing stable and unstable liquids.

Because the placement of tanks can create an access problem for fire department equipment, the fire code official has the authority to require a greater separation than required by Table 22.4.2.1 of NFPA 30 to ensure fire equipment access.

The exception allows a 3-foot (914 mm) clearance between above-ground tanks containing Class IIIB liquid if they meet the requirements stated.

The minimum clearance for above-ground tanks containing unstable liquids must be greater because of the greater hazard they pose.

**5704.2.9.6.3 Separation between adjacent tanks containing flammable or combustible liquids and LP-gas.** The minimum horizontal separation between an LP-gas container and a Class I, II or IIIA liquid storage tank shall be 20 feet (6096 mm) except in the case of Class I, II or IIIA liquid tanks operating at pressures exceeding 2.5 psig (17.2 kPa) or equipped with emergency venting allowing pressures to exceed 2.5 psig (17.2 kPa), in which case the provisions of Section 5704.2.9.6.2 shall apply.

An *approved* means shall be provided to prevent the accumulation of Class I, II or IIIA liquids under adjacent LP-gas containers such as by dikes, diversion curbs or grading. Where flammable or *combustible liquid* storage tanks are within a diked area, the LP-gas containers shall be outside the diked area and not less than 10 feet (3048 mm) away from the centerline of the wall of the diked area.

**Exceptions:**

1. Liquefied petroleum gas containers of 125 gallons (473 L) or less in capacity installed adjacent to fuel-oil supply tanks of 660 gallons (2498 L) or less in capacity.
2. Horizontal separation is not required between above-ground LP-gas containers and underground flammable and *combustible liquid* tanks.

- ❖ Liquefied petroleum gas (LP-gas) above-ground tanks need a minimum clearance of 20 feet (6069 mm) from above-ground tanks containing Class I, II or IIIA liquids. When the above-ground tanks containing Class I, II and IIIA liquids are under pressure exceeding 2.5 psig (17.2 kPa), the minimum clearance is according to Section 5704.2.9.6.3.

LP-gas tanks require additional protection from Class I, II and IIIA liquids. Spills and leakage of the flammable and combustible liquids are to be kept away from the LP-gas tank by not placing the tanks in a common diked area. Drainage from the above-ground tanks containing Class I, II and IIIA liquids is to be directed away from the LP-gas tank.

The exception states that small tanks of LP-gas and small fuel oil tanks need not be separated. There is no separation required between LP-gas tanks and underground tanks of flammable and combustible liquids.

**5704.2.9.7 Additional requirements for protected above-ground tanks.** In addition to the requirements of this chapter for above-ground tanks, the installation of protected above-

ground tanks shall be in accordance with Sections 5704.2.9.7.1 through 5704.2.9.7.9.

❖ Besides being located to have the required clearance between above-ground tanks and between above-ground tanks and property lines or other structures, the above-ground tanks are to be designed and constructed with safety features to protect and control flammable and combustible liquids. These features include venting, flame arresters, secondary containment, impact protection, overfill protection and antisiphon devices.

**5704.2.9.7.1 Tank construction.** The construction of a protected above-ground tank and its primary tank shall be in accordance with Section 5704.2.7.

❖ Tanks are to be designed according to NFPA 30 and labeled to indicate the design standard according to Section 5704.2.7.

**5704.2.9.7.2 Normal and emergency venting.** Normal and emergency venting for protected above-ground tanks shall be provided in accordance with Sections 5704.2.7.3 and 5704.2.7.4. The vent capacity reduction factor shall not be allowed.

❖ Tanks must be vented to maintain the internal tank pressure within the design operating range. A low pressure can increase the generation of vapors. A high pressure can damage the tank or piping system. Any pressure outside of the design pressure range can have an adverse effect on the operation of the system as well as on the piping and equipment. Vent lines are to be used solely as vents unless other uses are approved by the fire code official. The termination of a vent pipe is to direct the vapors away from the building. Vapors from flammable liquids are normally heavier than air so that the vapor will settle to lower levels. The termination of a vent pipe a minimum of 12 feet (3658 mm) above grade will provide space for the vapors to disperse to concentrations below the LFL. This high termination elevation also reduces the potential for the termination to be close to grade-level ignition sources. Because flammable liquid vapors are heavier than air, attention needs to be given to the building design near the termination. Building design and features that may allow the flammable liquid vapors to reenter the building or to collect on the building must be eliminated. Because Class IIIB has a relatively high boiling point, the vent termination for this combustible liquid may terminate inside the building if the vent is normally closed. Section 5703.6 covers the design, installation, testing and protection of vent pipes. Vent pipes must drain to the tank and not accumulate condensation in the vent pipe.

**5704.2.9.7.3 Secondary containment.** Protected above-ground tanks shall be provided with secondary containment, drainage control or diking in accordance with Section 5004.2. A means shall be provided to establish the integrity of the secondary containment in accordance with NFPA 30.

❖ Protected above-ground tanks are to be located within secondary containment according to Section

5004.2 and NFPA 30. Section 5004.2 discusses the use of liquid-tight curbs, dikes and drainage systems to divert the liquid to a location where it can be contained and safely handled (see commentary, Section 5004.2).

**5704.2.9.7.4 Vehicle impact protection.** Where protected above-ground tanks, piping, electrical conduit or dispensers are subject to vehicular impact, they shall be protected therefrom, either by having the impact protection incorporated into the system design in compliance with the impact test protocol of UL 2085, or by meeting the provisions of Section 312, or where necessary, a combination of both. Where guard posts or other *approved* barriers are provided, they shall be independent of each above-ground tank.

❖ Above-ground tanks can be protected from vehicle impact in one of two ways. Either the above-ground tank system can be designed to satisfy the impact criteria of UL 2085 or guard posts or other approved barriers complying with Section 312 can be used for protection from vehicle impact. Section 312 contains the specifications for guard posts or the design forces required for an approved barrier to comply with the code.

**5704.2.9.7.5 Overfill prevention.** Protected above-ground tanks shall not be filled in excess of 95 percent of their capacity. An overfill prevention system shall be provided for each tank. During tank-filling operations, the system shall comply with one of the following:

1. The system shall:

1.1. Provide an independent means of notifying the person filling the tank that the fluid level has reached 90 percent of tank capacity by providing an audible or visual alarm signal, providing a tank level gauge marked at 90 percent of tank capacity, or other *approved* means; and

1.2. Automatically shut off the flow of fuel to the tank when the quantity of liquid in the tank reaches 95 percent of tank capacity. For rigid hose fuel-delivery systems, an *approved* means shall be provided to empty the fill hose into the tank after the automatic shutoff device is activated.

2. The system shall reduce the flow rate to not more than 15 gallons per minute (0.95 L/s) so that at the reduced flow rate, the tank will not overfill for 30 minutes, and automatically shut off flow into the tank so that none of the fittings on the top of the tank are exposed to product because of overfilling.

❖ To prevent spillage during filling, above-ground tanks must be limited to 95 percent of their capacity by an overfill protection system. Several methods are acceptable that provide design flexibility utilizing either an audible or visible alarm when the tank becomes 90-percent full, including draining the fill hose into the above-ground tank without exceeding the 95-percent capacity; an automatic shutoff at 95-percent full or by a means of reducing the fill rate to not more than 15

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gallons per minute (gpm) (0.95 L/sec) so that, at that reduced flow rate, the tank will not overflow for 30 minutes, after which the fill flow will stop automatically.

**5704.2.9.7.5.1 Information signs.** A permanent sign shall be provided at the fill point for the tank, documenting the filling procedure and the tank calibration chart.

**Exception:** Where climatic conditions are such that the sign may be obscured by ice or snow, or weathered beyond readability or otherwise impaired, said procedures and chart shall be located in the office window, lock box or other area accessible to the person filling the tank.

❖ A permanent sign displaying filling instructions and a tank calibration chart must be located at the fill point. If weather conditions exist that make an outdoor permanent sign impractical, the exception allows storing the instructions and calibration charts at another location that is accessible to the individual filling the tank.

**5704.2.9.7.5.2 Determination of available tank capacity.** The filling procedure shall require the person filling the tank to determine the gallonage (literage) required to fill it to 90 percent of capacity before commencing the fill operation.

❖ As an additional safety measure, the filling procedure is to include a requirement that the operator determine the gallonage (literage) required to fill the tank to 90-percent capacity before commencing the operation.

**5704.2.9.7.6 Fill pipe connections.** The fill pipe shall be provided with a means for making a direct connection to the tank vehicle's fuel delivery hose so that the delivery of fuel is not exposed to the open air during the filling operation. Where any portion of the fill pipe exterior to the tank extends below the level of the top of the tank, a check valve shall be installed in the fill pipe not more than 12 inches (305 mm) from the fill hose connection.

❖ The filling operation could create a vapor-air mixture above the LFL. The fill hose is to be tight fitting to reduce the potential for the flammable or combustible liquid to be exposed to air.

**5704.2.9.7.7 Spill containers.** A spill container having a capacity of not less than 5 gallons (19 L) shall be provided for each fill connection. For tanks with a top fill connection, spill containers shall be noncombustible and shall be fixed to the tank and equipped with a manual drain valve that drains into the primary tank. For tanks with a remote fill connection, a portable spill container shall be allowed.

❖ To control spillage during filling, a spill container is to be provided for each above-ground tank. The spill container must have a top fill connection, be noncombustible and be permanently fixed to the tank. This spill container is to drain directly into the above-ground tank. A remote fill connection can use a portable spill container.

**5704.2.9.7.8 Tank openings.** Tank openings in protected above-ground tanks shall be through the top only.

❖ Above-ground tanks can have an opening only through the tank top.

**5704.2.9.7.9 Antisiphon devices.** *Approved* antisiphon devices shall be installed in each external pipe connected to the protected above-ground tank where the pipe extends below the level of the top of the tank.

❖ To prevent spillage by siphoning through the fill connection, an approved antisiphon device must be installed on the fill connection. An antisiphon valve is a normally closed valve used on above-ground storage tanks to help prevent a drain off of tank contents if a rupture in a line occurs below the liquid level in the tank.

**5704.2.10 Drainage and diking.** The area surrounding a tank or group of tanks shall be provided with drainage control or shall be diked to prevent accidental discharge of liquid from endangering adjacent tanks, adjoining property or reaching waterways.

### Exceptions:

1. The *fire code official* is authorized to alter or waive these requirements based on a technical report that demonstrates that such tank or group of tanks does not constitute a hazard to other tanks, waterways or adjoining property, after consideration of special features such as topographical conditions, nature of occupancy and proximity to buildings on the same or adjacent property, capacity, and construction of proposed tanks and character of liquids to be stored, and nature and quantity of private and public fire protection provided.
2. Drainage control and diking is not required for *listed* secondary containment tanks.

❖ Leaks and spills of flammable and combustible liquids must be controlled by dikes and drainage. The flammable and combustible liquids are to be collected in a manner that will not endanger other tanks, properties or waterways.

Exception 1 gives the fire code official the authority to consider installations where the use of drainage and dikes may not be necessary if technical documentation exists to show that this is practical.

Exception 2 states that listed secondary containment tanks do not require drainage control or dikes in the surrounding area. The secondary containment system in these tanks is considered equivalent to drainage and diking.

**5704.2.10.1 Volumetric capacity.** The volumetric capacity of the diked area shall be not less than the greatest amount of liquid that can be released from the largest tank within the diked area. The capacity of the diked area enclosing more than one tank shall be calculated by deducting the volume of

the tanks other than the largest tank below the height of the dike.

- ❖ The diked area must have sufficient capacity to contain the spillage of flammable and combustible liquids. The volume of flammable and combustible liquid to be held in the diked area is the greatest amount that can be released from the largest tank. This is the volume of the largest tank that is above the lowest elevation of the dike. For diked areas containing more than one tank, the volume is determined using the volume of the largest tank. This determination is based on the assumption that major leakage from more than one tank at any given time is very unlikely.

Because dike storage capacity is critical to spill control, designers must make certain they design their impoundment based on tank capacity. The fire code official, the plan reviewers and the inspectors responsible for approving the design must also be able to determine whether the design is adequate. Below are two examples to aid in understanding the calculations.

**Example 1:**

Determine the dike storage volume for a single tank.

Tank:

- Diameter = 100 feet (30 480 mm)
- Height = 30 feet (9144 mm)

Dike:

- Length = 140 feet (42 672 mm)
- Width = 140 feet (42 672 mm)
- Height = 5 feet (1524 mm)

Maximum dike storage volume:

$$(140 \text{ feet}) (140 \text{ feet}) (5 \text{ feet}) = 98,000 \text{ ft}^3 (2775 \text{ m}^3)$$

Maximum potential volume of spill:

$$(100 \text{ feet}/2)^2 (\pi) (30 \text{ feet} - 5 \text{ feet}) = 196,350 \text{ ft}^3 (5560 \text{ m}^3)$$

Tank volume below dike height:

$$(100 \text{ feet}/2)^2 (\pi) (5 \text{ feet}) = 39,270 \text{ ft}^3 (1112 \text{ m}^3)$$

Available dike storage volume for spill containment:

$$98,000 \text{ ft}^3 - 39,270 \text{ ft}^3 = 58,730 \text{ ft}^3 (1663 \text{ m}^3)$$

Available dike storage volume for spill containment is not sufficient to contain for the maximum potential spill.

$$58,730 \text{ ft}^3 (1663 \text{ m}^3) < 196,350 \text{ ft}^3 (5560 \text{ m}^3)$$

Determine the minimum size dike based on a square dike area.

$$L = \sqrt{\frac{100(\text{ feet}/2)^2(30 \text{ feet})}{5}} = 218 \text{ feet (66 446 mm)}$$

Maximum dike storage volume:

$$(218 \text{ feet}) (218 \text{ feet}) (5 \text{ feet}) = 237,620 \text{ ft}^3 (6729 \text{ m}^3)$$

Available dike storage volume for spill containment:  
 $237,620 \text{ ft}^3 - 39,270 \text{ ft}^3 = 198,350 \text{ ft}^3 (5617 \text{ m}^3)$

Available dike storage volume for spill containment is sufficient to contain for the maximum potential spill.  
 $198,350 \text{ ft}^3 (5617 \text{ m}^3) > 196,350 \text{ ft}^3 (5560 \text{ m}^3)$

**Example 2:**

Determine the dike storage volume for a dike with three tanks.

Tank 1:

- Diameter = 100 feet (30 480 mm)
- Height = 30 feet (9144 mm)

Tank 2:

- Diameter = 50 feet (15 240 mm)
- Height = 20 feet (6096 mm)

Tank 3:

- Diameter = 50 feet (15 240 mm)
- Height = 20 feet (6096 mm)

Dike:

- Length = 300 feet (91 440 mm)
- Width = 150 feet (45 720 mm)
- Height = 5 feet (1524 mm)

Maximum dike storage volume:

$$300 \text{ feet (150 feet) (5 feet)} = 225,000 \text{ ft}^3 (6371 \text{ m}^3)$$

Maximum potential volume of spill:

Tank 1:

$$(100 \text{ feet}/2)^2 (\pi) (30 \text{ feet} - 5 \text{ feet}) = 196,350 \text{ ft}^3 (5560 \text{ m}^3)$$

Tank 1 volume below dike height:

$$(100 \text{ feet}/2)^2 (\pi) (5 \text{ feet}) = 39,270 \text{ ft}^3 (1112 \text{ m}^3)$$

Tank 2 volume below dike height:

$$(50 \text{ feet}/2)^2 (\pi) (5 \text{ feet}) = 9,817 \text{ ft}^3 (278 \text{ m}^3)$$

Tank 3 volume below dike height:

$$(50 \text{ feet}/2)^2 (\pi) (5 \text{ feet}) = 9,817 \text{ ft}^3 (278 \text{ m}^3)$$

Available dike storage volume for spill containment:

$$225,000 \text{ ft}^3 - 39,270 \text{ ft}^3 - 9,817 \text{ ft}^3 - 9,817 \text{ ft}^3 = 166,095 \text{ ft}^3 (4703 \text{ m}^3)$$

Available dike storage volume for spill containment is not sufficient to contain for the maximum potential spill.  $166,095 \text{ ft}^3 (4703 \text{ m}^3) < 196,350 \text{ ft}^3 (5560 \text{ m}^3)$

Revise the dike design by increasing the dike height to 6 feet (1829 mm).

Maximum dike storage volume:

$$300 \text{ feet (150 feet) (6 feet)} = 270,000 \text{ ft}^3 (7646 \text{ m}^3)$$

Maximum potential volume of spill:

Tank 1:

$$(100 \text{ feet}/2)^2 (\pi) (30 \text{ feet} - 6 \text{ feet}) = 188,496 \text{ ft}^3 (5338 \text{ m}^3)$$

Tank 1 volume below dike height:  
 $(100 \text{ feet}/2)^2 (\pi) (6 \text{ feet}) = 47,124 \text{ ft}^3 (1334 \text{ m}^3)$

Tank 2 volume below dike height:  
 $(50 \text{ feet}/2)^2 (\pi) (6 \text{ feet}) = 11,781 \text{ ft}^3 (334 \text{ m}^3)$

Tank 3 volume below dike height:  
 $(50 \text{ feet}/2)^2 (\pi) (6 \text{ feet}) = 11,781 \text{ ft}^3 (334 \text{ m}^3)$

Available dike storage volume for spill containment:  
 $270,000 \text{ ft}^3 - 47,124 \text{ ft}^3 - 11,781 \text{ ft}^3 - 11,781 \text{ ft}^3 = 199,314 \text{ ft}^3 (5644 \text{ m}^3)$

Available dike storage volume for spill containment is sufficient to contain for the maximum potential spill.  
 $199,314 \text{ ft}^3 (5644 \text{ m}^3) > 188,496 \text{ ft}^3 (5338 \text{ m}^3)$

**5704.2.10.2 Diked areas containing two or more tanks.** Diked areas containing two or more tanks shall be subdivided in accordance with NFPA 30.

❖ Diked areas are to be subdivided according to NFPA 30 to control the flow of flammable and combustible liquids.

**5704.2.10.3 Protection of piping from exposure fires.** Piping shall not pass through adjacent diked areas or impounding basins, unless provided with a sealed sleeve or otherwise protected from exposure to fire.

❖ Piping can be damaged and fail as a result of fire exposure. A failed pipe could add fuel to a fire. To prevent a pipe from an adjacent diked area or impoundment basin from providing additional fuel, the pipe is to be protected with a sealed sleeve or otherwise protected from exposure to fire. The best method is to install piping so that it does not enter an adjacent diked area or impoundment basin whenever possible. The sealed pipe sleeve provides some protection from direct fire exposure and is also a secondary containment system.

**5704.2.10.4 Combustible materials in diked areas.** Diked areas shall be kept free from combustible materials, drums and barrels.

❖ Good housekeeping must be practiced around flammable and combustible materials, whether they are solid or liquid. Combustible materials that accumulate in diked areas are a source of ignition and fuel. These materials must be removed.

**5704.2.10.5 Equipment, controls and piping in diked areas.** Pumps, manifolds and fire protection equipment or controls shall not be located within diked areas or drainage basins or in a location where such equipment and controls would be endangered by fire in the diked area or drainage basin. Piping above ground shall be minimized and located as close as practical to the shell of the tank in diked areas or drainage basins.

**Exceptions:**

1. Pumps, manifolds and piping integral to the tanks or equipment being served, which is protected by inter-

mediate diking, berms, drainage or fire protection such as water spray, monitors or resistive coating.

2. Fire protection equipment or controls that are appurtenances to the tanks or equipment being protected, such as foam chambers or foam piping and water or foam monitors and hydrants, or hand and wheeled extinguishers.

❖ Equipment and controls must be located outside of the diked areas for fire protection. Piping must be in the diked areas to operate the facility, but the piping must be underground except at the tank. This provides as much fire protection for the piping as is practical while still allowing the facility to function.

Exception 1 allows locating equipment that is integral to the tank inside the diked area. Other service equipment that is provided with fire protection may also be in diked areas. Separation (immediate diking), water spray or coatings can accomplish this fire protection.

Exception 2 allows fire protection equipment that is part of the tank system to be in the diked area.

**5704.2.11 Underground tanks.** Underground storage of flammable and *combustible liquids* in tanks shall comply with Section 5704.2 and Sections 5704.2.11.1 through 5704.2.11.4.2.

❖ Underground tanks are exposed to conditions not associated with above-ground tanks. Leakage of flammable and combustible liquids is harder to detect. Protection from loads being placed on top of or adjacent to the underground tank is needed to prevent damage to the underground tank. The underground tank must be protected from flooding and from floating in areas having a groundwater table that may be above the bottom of the underground tank.

**5704.2.11.1 Location.** Flammable and *combustible liquid* storage tanks located underground, either outside or under buildings, shall be in accordance with all of the following:

1. Tanks shall be located with respect to existing foundations and supports such that the loads carried by the latter cannot be transmitted to the tank.
2. The distance from any part of a tank storing liquids to the nearest wall of a *basement*, pit, cellar or *lot line* shall be not less than 3 feet (914 mm).
3. A minimum distance of 1 foot (305 mm), shell to shell, shall be maintained between underground tanks.

❖ Underground tanks must be located away from a building or structure so that the tank does not support the building or structure. The loads from a building or structure can cause the underground tank to rupture.

Underground tanks are to be a minimum of 3 feet (914 mm) from the nearest below-grade wall or property line. Any leakage from an underground tank may migrate through the soil and enter a basement, cellar or pit. The accumulation of flammable and combustible liquids in this location could develop into a hazard-

ous condition. Because the owner of the underground tank does not own the adjacent property, the location of the underground tank should not affect the adjacent property or the use of this property.

To ensure that underground tanks are independent of each other, a minimum clearance of 1 foot (305 mm) is required between the shells of adjacent underground tanks.

**5704.2.11.2 Depth and cover.** Excavation for underground storage tanks shall be made with due care to avoid undermining of foundations of existing structures. Underground tanks shall be set on firm foundations and surrounded with not less than 6 inches (152 mm) of noncorrosive inert material, such as clean sand.

❖ Excavation for underground tanks must not damage existing structures and must provide a sound foundation for the underground tank. The use of 6 inches (152 mm) of a noncorrosive material (sand) around an underground tank prevents concentrated loads from being applied to the tank. These concentrated loads can be caused during backfilling when a hard solid object, such as a rock, comes in contact with the underground tank. Soil pressures on the rock can be concentrated into a small contact area with the underground tank.

**5704.2.11.3 Overfill protection and prevention systems.** Fill pipes shall be equipped with a spill container and an overfill prevention system in accordance with NFPA 30.

❖ To control spillage during filling of underground tanks, each tank must have a spill container that is noncombustible and permanently fixed to the tank. This spill container is to drain directly into the underground tank.

**5704.2.11.4 Leak prevention.** Leak prevention for underground tanks shall comply with Sections 5704.2.11.4.1 and 5704.2.11.4.2.

❖ Leakage from underground tanks is to be detected by either monitoring or an approved leak detection system.

**5704.2.11.4.1 Inventory control.** Daily inventory records for underground storage tank systems shall be maintained.

❖ Leakage detection by inventory control requires accurate records of the volume of flammable and combustible liquid dispensed into and removed from the underground tank. A discrepancy between these two volumes is used to identify a leak.

**5704.2.11.4.2 Leak detection.** Underground storage tank systems shall be provided with an *approved* method of leak detection from any component of the system that is designed and installed in accordance with NFPA 30.

❖ Leakage detection systems must comply with NFPA 30.

**5704.2.12 Testing.** Tank testing shall comply with Sections 5704.2.12.1 and 5704.2.12.2.

❖ Tanks must be tested before being placed in service.

**5704.2.12.1 Acceptance testing.** Prior to being placed into service, tanks shall be tested in accordance with Section 21.5 of NFPA 30.

❖ The acceptance test for tanks is described in Section 21.5 of NFPA 30.

**5704.2.12.2 Testing of underground tanks.** Before being covered or placed in use, tanks and piping connected to underground tanks shall be tested for tightness in the presence of the *fire code official*. Piping shall be tested in accordance with Section 5703.6.3. The system shall not be covered until it has been *approved*.

❖ The fire code official is to be present for testing of underground tanks. The tank, connections and piping are to be tested for tightness. Piping is to be tested under Section 5703.6.3.

**5704.2.13 Abandonment and status of tanks.** Tanks taken out of service shall be removed in accordance with Section 5704.2.14, or safeguarded in accordance with Sections 5704.2.13.1 through 5704.2.13.2.3 and API 1604.

❖ Tanks that are no longer in service are to be removed or secured. Abandoned tanks can develop leaks or be damaged when new construction occurs near the tank. In addition to the referenced standard, API 1604, further guidance on this subject is available in NFPA 30, Annex C.

**5704.2.13.1 Underground tanks.** Underground tanks taken out of service shall comply with Sections 5704.2.13.1.1 through 5704.2.13.1.5.

❖ The procedure for safeguarding an underground tank will depend on the period that the tank is to be out of service.

**5704.2.13.1.1 Temporarily out of service.** Underground tanks temporarily out of service shall have the fill line, gauge opening, vapor return and pump connection secure against tampering. Vent lines shall remain open and be maintained in accordance with Sections 5704.2.7.3 and 5704.2.7.4.

❖ An underground tank that will be temporarily out of service for a period of less than 90 days is to be secured from tampering. The vents are to remain in operation and are to be maintained to allow for continuous venting of the tank. The flammable or combustible liquids may remain in the underground tank.

**5704.2.13.1.2 Out of service for 90 days.** Underground tanks not used for a period of 90 days shall be safeguarded in accordance with all the following or be removed in accordance with Section 5704.2.14:

1. Flammable or *combustible liquids* shall be removed from the tank.
2. All piping, including fill line, gauge opening, vapor return and pump connection, shall be capped or plugged and secured from tampering.
3. Vent lines shall remain open and be maintained in accordance with Sections 5704.2.7.3 and 5704.2.7.4.

❖ Flammable or combustible liquid must be removed from underground tanks that are out of service for 90

days but less than a year. The tank is to be secured and vents are to be opened and maintained as required by Section 5704.2.13.1.1.

The owner also has the option to remove the underground tank according to Section 5704.2.14. The code does not provide the option for abandoning the underground tank in place because the tank could not be returned to service.

**5704.2.13.1.3 Out of service for one year.** Underground tanks that have been out of service for a period of one year shall be removed from the ground in accordance with Section 5704.2.14 or abandoned in place in accordance with Section 5704.2.13.1.4.

❖ An underground tank that is out of service for one year is to be removed or abandoned in place.

**5704.2.13.1.4 Tanks abandoned in place.** Tanks abandoned in place shall be as follows:

1. Flammable and *combustible liquids* shall be removed from the tank and connected piping.
2. The suction, inlet, gauge, vapor return and vapor lines shall be disconnected.
3. The tank shall be filled completely with an *approved* inert solid material.
4. Remaining underground piping shall be capped or plugged.
5. A record of tank size, location and date of abandonment shall be retained.
6. All exterior above-grade fill piping shall be permanently removed when tanks are abandoned or removed.

❖ An underground tank that is abandoned in place is to have the flammable or combustible liquid removed. The tank is to be stripped of any appurtenances and filled with an inert material. Piping from the underground tank is to be capped or plugged and the owner is to retain a record of the tank. This action should remove the flammable or combustible liquid from the underground tank and prevent any residue from readily mixing with air. Annex C of NFPA 30 provides additional guidance on this topic.

Note that these provisions apply to all tanks without exception, such as the one that existed in previous editions of the code for 1,100-gallon (4163 L) capacity residential heating oil tanks. The majority of those tanks were installed in the 1950s and 1960s and the estimated useful life of such unprotected, single wall, steel underground fuel oil tanks is 35 to 40 years. This raises the question of who becomes responsible when someone drives or falls into one of the empty voids left by these tanks when the steel finally corrodes away. In order to improve the safeguarding of the public's health and safety, the exception has been removed and all underground tanks abandoned in place must be filled with an approved, inert solid material.

**5704.2.13.1.5 Reinstallation of underground tanks.** Tanks that are to be reinstalled for flammable or *combustible liquid*

service shall be in accordance with this chapter, ASME *Boiler and Pressure Vessel Code* (Section VIII), API 12-P, API 1615, UL 58 and UL 1316.

❖ An underground tank that is reinstalled for flammable or combustible liquids has to comply as a new installation.

**5704.2.13.2 Above-ground tanks.** Above-ground tanks taken out of service shall comply with Sections 5704.2.13.2.1 through 5704.2.13.2.3.

❖ The procedure for safeguarding an above-ground tank will depend on the period that the tank is to be out of service.

**5704.2.13.2.1 Temporarily out of service.** Above-ground tanks temporarily out of service shall have all connecting lines isolated from the tank and be secured against tampering.

**Exception:** In-place fire protection (foam) system lines.

❖ An above-ground tank that is temporarily out of service for a period of less than 90 days is to be secured from tampering, and all lines to the tank are to be disconnected. The flammable or combustible liquids may remain in the above-ground tank.

The exception requires keeping fire protection lines intact. Disconnecting the fire protection lines would reduce the fire safety of the above-ground tank.

**5704.2.13.2.2 Out of service for 90 days.** Above-ground tanks not used for a period of 90 days shall be safeguarded in accordance with Section 5704.2.13.1.2 or removed in accordance with Section 5704.2.14.

**Exceptions:**

1. Tanks and containers connected to oil burners that are not in use during the warm season of the year or are used as a backup heating system to gas.
2. In-place, active fire protection (foam) system lines.

❖ Flammable or combustible liquid must be removed from an above-ground tank that is out of service for at least 90 days but less than one year. The tank is to be secured and vents are to be opened and maintained as required by Section 5704.2.13.1.1.

The owner has the option to remove the above-ground tank according to Section 5704.2.14.

Exception 1 exempts an above-ground tank used for seasonal heating or as a backup for a gas heater from being considered out of service.

Exception 2 requires fire protection lines to remain intact. To disconnect the fire protection lines would reduce the fire safety of the above-ground tank.

**5704.2.13.2.3 Out of service for one year.** Above-ground tanks that have been out of service for a period of one year shall be removed in accordance with Section 5704.2.14.

**Exception:** Tanks within operating facilities.

❖ Tanks that have held hazardous materials must be properly decommissioned in order to abate the residual hazards that they can present. An above-ground tank that is out of service for one year is assumed by the code to be at the end of its useful life and must be

properly removed and disposed. The exception recognizes that operating facilities such as refineries, tank farms, etc. may hold a tank in reserve out of service for more than one year. The status of tanks should be monitored through the operating permit required by Section 105.6.17(7).

**5704.2.14 Removal and disposal of tanks.** Removal and disposal of tanks shall comply with Sections 5704.2.14.1 and 5704.2.14.2.

❖ Removal and disposal of above-ground and underground tanks requires care because the vapors in the tank may be above the LFL for the flammable or combustible liquid. Operations to remove equipment or piping may involve heat that could ignite the vapor-air mixture or force the vapor-air mixture out of the tank where it may be ignited.

**5704.2.14.1 Removal.** Removal of above-ground and underground tanks shall be in accordance with all of the following:

1. Flammable and *combustible liquids* shall be removed from the tank and connected piping.
2. Piping at tank openings that is not to be used further shall be disconnected.
3. Piping shall be removed from the ground.

**Exception:** Piping is allowed to be abandoned in place where the *fire code official* determines that removal is not practical. Abandoned piping shall be capped and safeguarded as required by the *fire code official*.

4. Tank openings shall be capped or plugged, leaving a  $\frac{1}{8}$ -inch to  $\frac{1}{4}$ -inch-diameter (3.2 mm to 6.4 mm) opening for pressure equalization.
5. Tanks shall be purged of vapor and inerted prior to removal.
6. All exterior above-grade fill and vent piping shall be permanently removed.

**Exception:** Piping associated with bulk plants, terminal facilities and refineries.

❖ For tanks that will be removed and disposed, the flammable or combustible liquid is to be removed from the tank and piping and the tank must be purged. An inert gas, such as nitrogen or carbon dioxide, should be used to purge the tank, not air. Tank openings are to be capped or plugged. Vent openings are to be provided in capped tank openings as a vent for equalization of internal and atmospheric pressure. Abandoned piping above ground or in the ground is to be removed to the maximum practical extent to avoid being mistaken for active piping. Any piping approved by the fire code official to remain in the ground is to be capped.

**5704.2.14.2 Disposal.** Tanks shall be disposed of in accordance with federal, state and local regulations.

❖ Other federal, state and local regulations address the disposal of above-ground and underground tanks.

**5704.2.15 Maintenance.** Above-ground tanks, connected piping and ancillary equipment shall be maintained in a safe operating condition. Tanks shall be maintained in accordance with their listings. Damage to above-ground tanks, connected piping or ancillary equipment shall be repaired using materials having equal or greater strength and *fire resistance* or the equipment shall be replaced or taken out of service.

❖ This section addresses the general maintenance of above-ground flammable and combustible liquid tanks and associated equipment. Similar text appears in Section 5003.2.6 for general maintenance of equipment associated with hazardous materials. However, it is useful and appropriate to also have specific text to address the maintenance of above-ground flammable and combustible liquid tank systems available in Chapter 57 (see also commentary, Section 5003.2.6).

**5704.3 Container and portable tank storage.** Storage of flammable and *combustible liquids* in closed containers that do not exceed 60 gallons (227 L) in individual capacity and portable tanks that do not exceed 660 gallons (2498 L) in individual capacity, and limited transfers incidental thereto, shall comply with Sections 5704.3.1 through 5704.3.8.5.

❖ Storage containers not exceeding 60 gallons (227 L) and portable tanks not exceeding 660 gallons (2798 L) are regulated by this section. The use of these containers and portable tanks is limited to incidental transfers of flammable or combustible liquids.

**5704.3.1 Design, construction and capacity of containers and portable tanks.** The design, construction and capacity of containers for the storage of Class I, II and IIIA liquids shall be in accordance with this section and Section 9.4 of NFPA 30.

❖ Design, construction and capacity of containers and portable tanks are addressed in Section 9.4 of NFPA 30.

**5704.3.1.1 Approved containers.** Only *approved* containers and portable tanks shall be used.

❖ It is difficult at best to determine by examination that a container or portable tank complies with Section 9.4 of NFPA 30. One practical approval method is to require listed containers or portable tanks.

**5704.3.2 Liquid storage cabinets.** Where other sections of this code require that liquid containers be stored in storage cabinets, such cabinets and storage shall be in accordance with Sections 5704.3.2.1 through 5704.3.2.2.

❖ Containers and portable storage tanks are to be stored in liquid storage cabinets.

**5704.3.2.1 Design and construction of storage cabinets.** Design and construction of liquid storage cabinets shall be in accordance with Sections 5704.3.2.1.1 through 5704.3.2.1.4.

❖ Liquid storage cabinets are designed to protect containers and portable storage tanks and their contents from damage and ignition sources.

Liquid storage cabinets can be constructed of

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metal or wood. Cabinets listed under UL 1275 and cabinets constructed according to this section are approved.

**5704.3.2.1.1 Materials.** Cabinets shall be *listed* in accordance with UL 1275, or constructed of *approved* wood or metal in accordance with the following:

1. Unlisted metal cabinets shall be constructed of steel having a thickness of not less than 0.044 inch (1.12 mm) (18 gage). The cabinet, including the door, shall be double walled with 1½-inch (38 mm) airspace between the walls. Joints shall be riveted or welded and shall be tight fitting.
  2. Unlisted wooden cabinets, including doors, shall be constructed of not less than 1-inch (25 mm) exterior grade plywood. Joints shall be rabbeted and shall be fastened in two directions with wood screws. Door hinges shall be of steel or brass. Cabinets shall be painted with an intumescent-type paint.
- ❖ Unlisted liquid storage cabinets and cabinet doors made of steel are to be double-wall cabinets with tight-fitting joints. Minimum steel thickness is 18 gage [0.044 inch (1.12 mm)].

Unlisted liquid storage cabinets and cabinet doors made of wood are to use rabbet joints fastened with wood screws in two directions to develop a tight joint. The minimum wood is to be 1-inch (25 mm) exterior-grade plywood. The cabinet is to be painted with an intumescent-type paint. The plywood grade will increase the cabinet's durability and the intumescent-type paint will reduce the ignition properties of the plywood.

**5704.3.2.1.2 Labeling.** Cabinets shall be provided with a conspicuous label in red letters on contrasting background that reads: FLAMMABLE—KEEP FIRE AWAY.

❖ Label the liquid storage cabinet to restrict ignition sources from the immediate area.

**5704.3.2.1.3 Doors.** Doors shall be well fitted, self-closing and equipped with a three-point latch.

❖ The door is to be self-closing and tight fitting. This prevents flammable or combustible liquid that has leaked or spilled in the storage cabinet from easily escaping the storage cabinet.

**5704.3.2.1.4 Bottom.** The bottom of the cabinet shall be liquid tight to a height of not less than 2 inches (51 mm).

❖ To control the flow of any spills, the cabinet is to be liquid tight for at least 2 inches (51 mm) from the bottom. This prevents flammable or combustible liquid that has leaked or spilled in the storage cabinet from easily escaping the storage cabinet.

**5704.3.2.2 Capacity.** The combined total quantity of liquids in a cabinet shall not exceed 120 gallons (454 L).

❖ The quantity of flammable and combustible liquids in a cabinet is not to exceed 120 gallons (454 L). Controlling the quantity of flammable and combustible liq-

uids in a liquid storage cabinet controls the fire hazard by limiting the amount of liquid that can be involved in a single incident.

**5704.3.3 Indoor storage.** Storage of flammable and *combustible liquids* inside buildings in containers and portable tanks shall be in accordance with Sections 5704.3.3.1 through 5704.3.3.10.

### Exceptions:

1. Liquids in the fuel tanks of motor vehicles, aircraft, boats or portable or stationary engines.
2. The storage of distilled spirits and wines in wooden barrels or casks.

❖ Indoor storage in containers or portable tanks is governed by this section with two exceptions.

The requirements of this section are not applicable to fuel in vehicles and portable engines. The small quantity of fuel and the protection provided by the fuel containers provide sufficient safety for these uses to be indoors.

Distilled spirits and wines in wooden barrels or casks are allowed indoors. This exception is covered in Section 5701.1.

**5704.3.3.1 Portable fire extinguishers.** *Approved* portable fire extinguishers shall be provided in accordance with specific sections of this chapter and Section 906.

❖ Portable fire extinguishers are useful for controlling small fires. Section 906 contains the size and spacing for portable fire extinguishers to be used on a fire involving flammable or combustible liquids that have a liquid depth of 0.25 inch (6.4 mm) or less.

**5704.3.3.2 Incompatible materials.** Materials that will react with water or other liquids to produce a hazard shall not be stored in the same room with flammable and combustible liquids except where stored in accordance with Section 5003.9.8.

❖ Materials that generate heat or become combustible when exposed to water or other liquids are not to be in the same room as flammable or combustible liquids. The exception is when one of the four methods of material separation from Section 5003.9.8 of the code is used. This is to remove a potential ignition reaction.

**5704.3.3.3 Clear means of egress.** Storage of any liquids, including stock for sale, shall not be stored near or be allowed to obstruct physically the route of egress.

❖ The means of egress must be usable to be effective. The placement of flammable or combustible liquids near or in the route used to exit the room or building produces a risk that is not acceptable.

**5704.3.3.4 Empty containers or portable tank storage.** The storage of empty tanks and containers previously used for the storage of flammable or *combustible liquids*, unless free from explosive vapors, shall be stored as required for filled containers and portable tanks. Portable tanks and containers,

when emptied, shall have the covers or plugs immediately replaced in openings.

- ❖ An empty container or portable tank is as dangerous and possibly more dangerous than a full container or portable storage tank. There is a possibility that the vapor-air mixture in the container or portable storage tank could reach the LFL. This potential danger requires that empty containers and portable tanks be handled and stored as if full of flammable or combustible liquid.

**5704.3.3.5 Shelf storage.** Shelving shall be of *approved* construction, adequately braced and anchored. Seismic requirements shall be in accordance with the *International Building Code*.

- ❖ Shelving for containers and portable tanks is to be adequate to support the container and portable tank under normal loads and seismic loads. Failure of shelving could cause damage to containers and portable tanks or leakage.

**5704.3.3.5.1 Use of wood.** Wood of not less than 1 inch (25 mm) nominal thickness is allowed to be used as shelving, racks, dunnage, scuffboards, floor overlay and similar installations.

- ❖ The minimum thickness of wood is to be 1 inch (25 mm).

**5704.3.3.5.2 Displacement protection.** Shelves shall be of sufficient depth and provided with a lip or guard to prevent individual containers from being displaced.

**Exception:** Shelves in storage cabinets or on laboratory furniture specifically designed for such use.

- ❖ Shelving must be designed and constructed to prevent containers or portable tanks from sliding off the shelving. A container or portable tank that falls from a shelf is subject to damage or leakage.

The exception covers shelving in storage cabinets, which may have locked doors or doors fitting snugly against the front of shelves to prevent containers from falling. Shelving that is part of laboratory furniture is not required to have a lip or guard because typically this kind of shelving would hold only small containers. Large containers or tanks would be floor mounted in nearly all laboratory settings. These kinds of shelves may also have other features to prevent containers or portable tanks from sliding or being knocked off the shelf.

**5704.3.3.5.3 Orderly storage.** Shelf storage of flammable and *combustible liquids* shall be maintained in an orderly manner.

- ❖ The handling of containers and portable tanks increases the possibility that an accident can occur. Containers and portable tanks arranged on shelves in an orderly manner make moving one container or portable tank to get to another unnecessary.

**5704.3.3.6 Rack storage.** Where storage on racks is allowed elsewhere in this code, a minimum 4-foot-wide (1219 mm) aisle shall be provided between adjacent rack sections and

any adjacent storage of liquids. Main aisles shall be not less than 8 feet (2438 mm) wide.

- ❖ Rack storage indicates that a larger quantity of flammable and combustible liquids is available for use. Requiring a minimum aisle width of 4 feet (1219 mm) between racks and a minimum main aisle width of 8 feet (2438 mm) provides room to access the flammable and combustible liquids while reducing interference with other racks or other containers and portable tanks. In case of a fire, these aisles are wide enough to give emergency response personnel ready access to the fire and also serve as fire breaks that help prevent fire spread from rack to rack.

**5704.3.3.7 Pile or palletized storage.** Solid pile and palletized storage in liquid warehouses shall be arranged so that piles are separated from each other by not less than 4 feet (1219 mm). Aisles shall be provided and arranged so that no container or portable tank is more than 20 feet (6096 mm) from an aisle. Main *aisles* shall be not less than 8 feet (2438 mm) wide.

- ❖ The rationale for aisle widths is similar to that for rack storage. The 20-foot (6069 mm) restriction is intended to place containers and portable tanks within easy range of on-site fire-fighting equipment as well as minimize the number of items that must be moved to get to the desired container or portable tank.

**5704.3.3.8 Limited combustible storage.** Limited quantities of combustible commodities are allowed to be stored in liquid storage areas where the ordinary combustibles, other than those used for packaging the liquids, are separated from the liquids in storage by not less than 8 feet (2438 mm) horizontally, either by open aisles or by open racks, and where protection is provided in accordance with Chapter 9.

- ❖ Combustible products may be stored in a storage facility with flammable or combustible liquids because having a separate storage facility for these combustible materials may be impractical. The storage of these combustible materials with flammable and combustible liquids results in a source of ignition that must be regulated. The code recognizes a clearance of 8 feet (2438 mm) between the combustible materials and the flammable and combustible liquids, with the building fire protection systems required by Chapter 9, as being acceptable.

**5704.3.3.9 Idle combustible pallets.** Storage of empty or idle combustible pallets inside an unprotected liquid storage area shall be limited to a maximum pile size of 2,500 square feet (232 m<sup>2</sup>) and to a maximum storage height of 6 feet (1829 mm). Storage of empty or idle combustible pallets inside a protected liquid storage area shall comply with NFPA 13. Pallet storage shall be separated from liquid storage by aisles that are not less than 8 feet (2438 mm) wide.

- ❖ The construction of combustible pallets with their large air spaces and volume of wood or plastic boards is a recipe for rapid consumption by fire. Though they present a substantial fuel load, combus-

tible pallets are often necessary for the stable storage of flammable and combustible liquids in containers. Ideally, idle combustible pallets should be stored outdoors; however, that is not always feasible and they may accumulate inside the building.

When stored indoors in unprotected (nonsprinklered) liquid storage areas, the volume of idle combustible pallets stored is regulated to limit the fire load. Note that the maximum volume of combustible pallets that are allowed to be stored is 15,000 cubic feet [2,500 square feet (232 m<sup>2</sup>) in area by 6 feet (1829 mm) (425 m<sup>3</sup>) high].

Conversely, in protected (sprinklered) liquid storage areas, when combustible pallets are no longer in use, the quantity is not controlled in light of the enhanced fire protection provided in accordance with Section 12.12 of NFPA 13.

The required separation aisles are intended to reduce the likelihood of fire spread from the pallet storage pile to rack- or pallet-stored flammable or combustible liquid containers.

**5704.3.3.10 Containers in piles.** Containers in piles shall be stacked in such a manner as to provide stability and to prevent excessive stress on container walls. Portable tanks stored more than one tier high shall be designed to nest securely, without dunnage. Material-handling equipment shall be suitable to handle containers and tanks safely at the upper tier level.

❖ The requirements in this section for stacking containers reduce the possibility of damaging the containers. Piling containers can damage them by placing loading on sides that were not intended to be loaded. Piles are subject to collapse if stress loads on containers become excessive. Collapse could cause the containers to rupture or rub against one another and bump one another, resulting in liquid spills and possibly sparking that could cause ignition. By controlling container stacks, this potential for damage is reduced.

Unless tanks are specifically designed to allow stacking, they must all be stored at ground level.

Requiring material-handling equipment to be designed specifically to handle the stored items is intended to increase safety and reduce the potential for serious accidents.

**5704.3.4 Quantity limits for storage.** Liquid storage quantity limitations shall comply with Sections 5704.3.4.1 through 5704.3.4.4.

❖ The quantity of flammable and combustible liquids in an area is limited to reduce the potential fire hazard.

**5704.3.4.1 Maximum allowable quantity per control area.** For occupancies other than Group M wholesale and retail sales uses, indoor storage of flammable and *combustible liquids* shall not exceed the *maximum allowable quantities per control area* indicated in Table 5003.1.1(1) and shall not exceed the additional limitations set forth in this section.

For Group M occupancy wholesale and retail sales uses, indoor storage of flammable and *combustible liquids* shall not

exceed the *maximum allowable quantities per control area* indicated in Table 5704.3.4.1.

Storage of hazardous production material flammable and *combustible liquids* in Group H-5 occupancies shall be in accordance with Chapter 27.

❖ Whereas Table 5003.1.1(1) lists the MAQs for occupancies other than Group M, Table 5704.3.4.1 lists the flammable and combustible liquid MAQ for Group M occupancies. The term “wholesale” is intended to eliminate the question as to whether Group M provisions apply to stores where goods are displayed and sold in bulk packaging or where bulk-packaged merchandise is kept above customer displays, such as in the popular “big box” home-improvement centers and “club” stores. Conversely, these provisions would not apply to a storage warehouse with a customer service counter or similar arrangement. Such facilities should be regulated using standard MAQs for occupancies other than Group M and would not qualify for the special MAQs of this section. It is very important to note that any time the special MAQs for Group M wholesale and retail-sale uses are applied, the limitations on container types, capacities, fire protection and storage arrangements in Section 5704.3.6 must be applied.

**TABLE 5704.3.4.1.** See page 57-35.

❖ Group M (mercantile) occupancies used for wholesale and retail sales of flammable and combustible liquids are not designed and constructed for flammable and combustible liquids. Business establishments classified in Group M must be able to display flammable and combustible liquids for sale to the public. To control the potential hazard, the quantities of flammable and combustible liquids are limited in a control area. The limitations are based on the type of flammable and combustible liquid in the control area, the type of storage of the flammable and combustible liquids and the automatic sprinkler system installed in the mercantile occupancy.

The easier the flammable or combustible liquid is to ignite, the smaller the quantity of the liquid allowed. This table shows that the quantity of Class IA liquids is smaller than any of the flammable and combustible liquids, and Class III liquids are unlimited in a building with an automatic sprinkler system.

The automatic sprinkler system must be one complying with NFPA 13. Flammable and combustible liquids displayed on shelves of 6 feet (1829 mm) or less are treated as Ordinary Hazard Group 2, which would require a minimum sprinkler density of 0.19 gpm per square foot (7.7 L/min/m<sup>2</sup>) over the most remote 1,500-square-foot (139 m<sup>2</sup>) area.

Because the flammable and combustible liquid is more exposed in individual packaging, the sprinkler system can provide better fire control. If the flammable and combustible liquids are displayed or stored in cartons, pallets or racks, the minimum sprinkler density is 0.21 gpm per square foot (8.6 L/min/m<sup>2</sup>) over

the most remote 1,500-square-foot (139 m<sup>2</sup>) area. This type of display or storage is limited to a maximum height of 4 feet, 6 inches (1372 mm). This type of packaging is more difficult for the automatic sprinkler system to handle so a greater density is required. To allow a larger quantity of flammable and combustible liquids, the mercantile occupancy can use an automatic sprinkler system that complies with Table 5704.3.6.3(4), 5704.3.6.3(5) or 5704.3.7.5.1. These tables require the automatic sprinkler system to have a greater capacity for fire fighting.

**5704.3.4.2 Occupancy quantity limits.** The following limits for quantities of stored flammable or *combustible liquids* shall not be exceeded:

1. Group A occupancies: Quantities in Group A occupancies shall not exceed that necessary for demonstration, treatment, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
2. Group B occupancies: Quantities in drinking, dining, office and school uses within Group B occupancies shall not exceed that necessary for demonstration, treatment, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
3. Group E occupancies: Quantities in Group E occupancies shall not exceed that necessary for demonstration, treatment, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
4. Group F occupancies: Quantities in dining, office, and school uses within Group F occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).

5. Group I occupancies: Quantities in Group I occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
6. Group M occupancies: Quantities in dining, office, and school uses within Group M occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1). The maximum allowable quantities for storage in wholesale and retail sales areas shall be in accordance with Section 5704.3.4.1.
7. Group R occupancies: Quantities in Group R occupancies shall not exceed that necessary for maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
8. Group S occupancies: Quantities in dining and office uses within Group S occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).

❖ Flammable and combustible liquids may be used in occupancies other than Group H. These other occupancies are not designed specifically for flammable and combustible liquids, so there are limitations on the quantities that can be in use or stored in these occupancies. The use of flammable and combustible liquids must be consistent with the function of the occupancy. This prevents these other occupancies from becoming Group H occupancies. The quantities of flammable and combustible liquid are listed in Table 5003.1.1(1). The occupancies covered by these limitations are Groups A, B, E, F, I, M, R and S.

**5704.3.4.3 Quantities exceeding limits for control areas.** Quantities exceeding those allowed in *control areas* set forth

**TABLE 5704.3.4.1  
MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF  
FLAMMABLE AND COMBUSTIBLE LIQUIDS IN WHOLESALE AND RETAIL SALES OCCUPANCIES<sup>a</sup>**

TYPE OF LIQUID	MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA (gallons)		
	Sprinklered <sup>b</sup> in accordance with foot-note densities and arrangements	Sprinklered in accordance with Tables 5704.3.6.3(4) through 5704.3.6.3(8) and Table 5704.3.7.5.1	Nonsprinklered
Class IA	60	60	30
Class IB, IC, II and IIIA	7,500 <sup>c</sup>	15,000 <sup>c</sup>	1,600
Class IIIB	Unlimited	Unlimited	13,200

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 gallon = 3.785 L, 1 gallon per minute per square foot = 40.75 L/min/m<sup>2</sup>.

- a. Control areas shall be separated from each other by not less than a 1-hour *fire barrier*.
- b. To be considered as sprinklered, a building shall be equipped throughout with an approved automatic sprinkler system with a design providing minimum densities as follows:
  1. For uncartoned commodities on shelves 6 feet or less in height where the ceiling height does not exceed 18 feet, quantities are those allowed with a minimum sprinkler design density of Ordinary Hazard Group 2.
  2. For cartoned, palletized or racked commodities where storage is 4 feet 6 inches or less in height and where the ceiling height does not exceed 18 feet, quantities are those allowed with a minimum sprinkler design density of 0.21 gallon per minute per square foot over the most remote 1,500-square-foot area.
- c. Where wholesale and retail sales or storage areas exceed 50,000 square feet in area, the maximum allowable quantities are allowed to be increased by 2 percent for each 1,000 square feet of area in excess of 50,000 square feet, up to not more than 100 percent of the table amounts. A control area separation is not required. The cumulative amounts, including amounts attained by having an additional control area, shall not exceed 30,000 gallons.

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in Section 5704.3.4.1 shall be in liquid storage rooms or liquid storage warehouses in accordance with Sections 5704.3.7 and 5704.3.8.

- ❖ It is possible to have a quantity of flammable and combustible liquids greater than allowed in Section 5704.3.4.1. To control the potential hazard, these quantities must be given additional protection by being in specifically designed liquid storage rooms.

**5704.3.4.4 Liquids for maintenance and operation of equipment.** In all occupancies, quantities of flammable and combustible liquids in excess of 10 gallons (38 L) used for maintenance purposes and the operation of equipment shall be stored in liquid storage cabinets in accordance with Section 5704.3.2. Quantities not exceeding 10 gallons (38 L) are allowed to be stored outside of a cabinet where in *approved* containers located in private garages or other *approved* locations.

- ❖ The operation of a building will require the use of flammable and combustible liquids for maintenance. A quantity of 10 gallons (38 L) or less of flammable and combustible liquids is recognized as practical to allow the use of such liquids for maintenance without requiring fire protection. See also Section 313.1 and its commentary for additional regulations on this topic.

**5704.3.5 Storage in control areas.** Storage of flammable and combustible liquids in control areas shall be in accordance with Sections 5704.3.5.1 through 5704.3.5.4.

- ❖ The location of flammable and combustible liquids in a control area can increase the fire hazard.

**5704.3.5.1 Basement storage.** Class I liquids shall be allowed to be stored in basements in amounts not exceeding the *maximum allowable quantity per control area* for use-open systems in Table 5003.1.1(1), provided that automatic suppression and other fire protection are provided in accordance with Chapter 9. Class II and IIIA liquids shall also be allowed to be stored in basements, provided that automatic suppression and other fire protection are provided in accordance with Chapter 9.

- ❖ The storage of Class I liquids in basements in amounts not exceeding the MAQ in Table 5003.1.1(1) (including the increases allowed by the table notes) is allowed by this section. Since storage is typically thought to be a safer condition than any use condition (no transport, no transfer, etc.), storage in a basement of amounts at least equal to what is allowed for use-open system MAQs in a basement (Section 5705.3.7.2) is allowed. This reflects actual practice in the field with no known loss experience indicating that it has been a problem. Compliance with control area requirements must still be achieved, the MAQ limitations must still apply and the basement must be provided with a fire suppression system and other required protection called for in Chapter 9. It also enhances the level of safety by eliminating the

need to transport Class I liquids vertically in buildings (out of the basement) after use is complete.

Class II and IIIA liquids are also permitted in a basement provided with a fire suppression system and other required protection called for in Chapter 9.

**5704.3.5.2 Storage pile heights.** Containers having less than a 30-gallon (114 L) capacity that contain Class I or II liquids shall not be stacked more than 3 feet (914.4 mm) or two containers high, whichever is greater, unless stacked on fixed shelving or otherwise satisfactorily secured. Containers of Class I or II liquids having a capacity of 30 gallons (114 L) or more shall not be stored more than one container high. Containers shall be stored in an upright position.

- ❖ The storage height of containers of flammable and combustible liquids increases the risk by having a larger quantity per floor area and possible damage to the container. The stacking operation and the weight of containers can damage the containers, creating leaks.

**5704.3.5.3 Storage distance from ceilings and roofs.** Piles of containers or portable tanks shall not be stored closer than 3 feet (914 mm) to the nearest beam, chord, girder or other obstruction, and shall be 3 feet (914 mm) below sprinkler deflectors or discharge orifices of water spray or other overhead fire protection system.

- ❖ The storage of containers or portable tanks near a ceiling or roof can create several problems. The high fire load that close to a structural member could overpower the fire protection of the structure or membrane, allowing the fire to spread to another level or cause a collapse. The height could reduce the effectiveness of the automatic sprinkler system. If the flammable and combustible liquid containers and portable tanks are stacked too high, the sprinkler heads may not be able to effectively apply water to the fire. The containers and portable tanks may be above the sprinkler spray or the containers and portable tanks may shield areas from the spray. Note that the general storage clearances contained in Section 315.3.1 are superceded by these specific requirements as provided in Section 102.9.

**5704.3.5.4 Combustible materials.** In areas that are inaccessible to the public, Class I, II and IIIA liquids shall not be stored in the same pile or rack section as ordinary combustible commodities unless such materials are packaged together as kits.

- ❖ The mixing of flammable and combustible liquid containers and portable tanks with other combustibles can place the flammable and combustible liquid in the vicinity of a possible ignition source and a fuel source.

**5704.3.6 Wholesale and retail sales uses.** Flammable and combustible liquids in Group M occupancy wholesale and retail sales uses shall be in accordance with Sections 5704.3.6.1 through 5704.3.6.5, or Sections 10.10.2, 12.3.8,

16.4.1 through 16.4.3, 16.5.1 through 16.5.2.12, Tables 16.5.2.1 through 16.5.2.12, and Figures 16.4.1(a) through 16.14.1(c) of NFPA 30.

- ❖ A mercantile (Group M) occupancy is not designed to address the fire hazards associated with flammable and combustible liquids, so the limited quantities, specific packing requirements and handling are used to control the fire hazard.

**5704.3.6.1 Container type.** Containers for Class I liquids shall be metal.

**Exception:** In sprinklered buildings, an aggregate quantity of 120 gallons (454 L) of water-miscible Class IB and Class IC liquids is allowed in nonmetallic containers, each having a capacity of 16 ounces (0.473 L) or less.

- ❖ Metal containers are required for Class I liquids. Class II and III liquids may be stored in any container designed for that specific liquid.

The exception recognizes that the additional fire protection provided by an automatic sprinkler system will allow an aggregate quantity of 120 gallons (454 L) of Class IB and IC liquids to be in individual non-combustible containers of 16 ounces (0.473 L) or less. The lower flash point of these Class I liquids, combined with the individual packaging in an automatic sprinkler building, is the rationale for this exception.

**5704.3.6.2 Container capacity.** Containers for Class I liquids shall not exceed a capacity of 5 gallons (19 L).

**Exception:** Metal containers not exceeding 55 gallons (208 L) are allowed to store up to 240 gallons (908 L) of the *maximum allowable quantity per control area* of Class IB and IC liquids in a control area. The building shall be equipped throughout with an *approved* automatic sprinkler system in accordance with Table 5704.3.4.1. The containers shall be provided with plastic caps without cap seals and shall be stored upright. Containers shall not be stacked or stored in racks and shall not be located in areas accessible to the public.

- ❖ Limiting the capacity of containers in a wholesale or retail establishment reduces the size of a potential spill or fire.

The lengthy and detailed exception recognizes that sprinklers provide additional protection so that a greater quantity of flammable and combustible liquids can be placed in the wholesale or retail establishment. Even with this greater fire protection, the flammable and combustible liquids must have the physical property that would allow them to be mixed with water. This ability will allow the sprinkler system to dilute the flammable and combustible liquid. Restrictions on the size of individual containers control the volume of Class IB and IC liquids that can be exposed at one time.

**5704.3.6.3 Fire protection and storage arrangements.** Fire protection and container storage arrangements shall be in accordance with Table 5704.3.6.3(1) or the following:

1. Storage on shelves shall not exceed 6 feet (1829 mm) in height, and shelving shall be metal.
2. Storage on pallets or in piles greater than 4 feet 6 inches (1372 mm) in height, or where the ceiling exceeds 18 feet (5486 mm) in height, shall be protected in accordance with Table 5704.3.6.3(4), and the storage heights and arrangements shall be limited to those specified in Table 5704.3.6.3(2).
3. Storage on racks greater than 4 feet 6 inches (1372 mm) in height, or where the ceiling exceeds 18 feet (5486 mm) in height shall be protected in accordance with Tables 5704.3.6.3(5), 5704.3.6.3(6), and 5704.3.6.3(7) as appropriate, and the storage heights and arrangements shall be limited to those specified in Table 5704.3.6.3(3).

Combustible commodities shall not be stored above flammable and *combustible liquids*.

- ❖ The methods and the maximum height of storage are intended to control the flammable and combustible liquids so that damage to containers is limited and fire protection equipment adequately protects flammable and combustible liquids and controls fire.

**TABLE 5704.3.6.3(1).** See page 57-41.

- ❖ The storage height of flammable and combustible liquids has an effect on the ability of the automatic sprinkler system to control a fire. The first to be considered is storage: the higher the storage, the greater the quantity. By limiting the height of storage, the code limits the volume of flammable and combustible liquids under a sprinkler head. Because the automatic sprinkler system is designed to deliver a minimum density of water per square foot of area, the less flammable and combustible the liquid is, the easier it will be for the automatic sprinkler system to control the fire.

The second function of limiting the height of storage is to make certain the automatic sprinkler system will cover the flammable and combustible liquids. The upper containers of flammable and combustible liquids could act as a shield for lower containers. This shielding could divert the water spray from the sprinkler head away from the fire. With the automatic sprinkler system shielded during early development of the fire, the fire could develop to a stage that the automatic sprinkler system would not be effective.

Note a helps to ensure that storage heights will not exceed the capabilities of the level of sprinkler protection provided. It also clarifies that protection schemes demonstrated with metallic containers and portable tanks are not suitable for nonmetallic containers and

portable tanks, which present a much more significant fire challenge. Without this clarification, which correlates with NFPA 30, the height limits established by the tables place sprinklered buildings at risk of having the sprinkler system fail to control a fire because the protection scheme might not be properly matched with stored commodities.

**TABLE 5704.3.6.3(2).** See page 57-42.

❖ The palletized or solid-pile storage of flammable and combustible liquids in liquid storage rooms and warehouses is regulated by floor, type of container, maximum storage height, maximum quantity per pile and maximum quantity per room. The table restricts the storage by floor to require that the basement not be used for the storage of Class I liquids. The accumulation of vapors from Class I liquids in a basement with a low ignition point for these vapors is not an acceptable situation.

The type of container is regulated to control the problem of leakage and damage to the container caused by handling.

The storage height is used to control the quantity of flammable and combustible liquids and to provide access to the flammable and combustible liquids for water spray from the automatic sprinkler system.

The maximum quantity per pile is to limit the volume of flammable and combustible liquids so that the automatic sprinkler system can control a fire based on the design density of the automatic sprinkler system.

The maximum quantity per room of flammable and combustible liquids is to control the volume of flammable and combustible liquids with the automatic sprinkler system.

The sprinkler system is designed for a minimum flow rate. If the volume of flammable and combustible liquids in a room is not regulated, the room could contain more flammable and combustible liquids than the design flow rate of the automatic sprinkler system could handle.

Note a recognizes that since liquid storage warehouses are dedicated to storage of those materials only, unlimited quantities are acceptable based on Section 5704.3.8.1. See the commentary to Section 5704.3.8.1 for further discussion. This is consistent with Table 5704.3.6.3(3), Note a.

Note b helps to ensure that storage heights will not exceed the capabilities of the level of sprinkler protection provided. It also clarifies that protection schemes demonstrated with metallic containers and portable tanks are not suitable for nonmetallic containers and portable tanks, which present a much more significant fire challenge. Without this clarification, which correlates with NFPA 30, the height limits established by the tables place sprinklered buildings at risk of having the sprinkler system fail to control a fire because the protection scheme might not be properly matched with stored commodities.

Note c recognizes the enhanced level of safety provided by smaller containers.

Note d recognizes that low-flash point, unsaturated polyester resins (UPRs) have a fire behavior more closely resembling that of Class IIIB liquids than Class I liquids, and that sprinkler protection schemes more closely associated with protection of Class III liquids can satisfactorily protect UPRs packaged in relieving-style metal drums. The American Composites Manufacturing Association recently completed a full-scale, two-phase fire test series to demonstrate the safety of UPR storage when protected in that manner.

Phase I of the test program, which included three tests, was conducted at Omega Point Laboratories in San Antonio, Texas. These tests involved totally engulfing single 55-gallon (208 L) relieving-style drums containing a representative UPR in a UPR liquid pool fire to determine the behavior of the commodity in extreme fire conditions. The results of the Phase I tests were considered successful in demonstrating that UPRs are a unique commodity that do not behave like “typical” flammable or combustible liquids in a fire condition because of their high viscosity and density. During the Phase I tests, no significant increases in internal drum pressure were observed in any case even though drum contents completely polymerized during the tests, changing from a liquid to a dense jelly-like consistency.

Phase II tests were conducted at Southwest Research Institute in San Antonio, Texas, in a simulated warehouse environment, and included arrangements ranging in size from a single pallet load to a three-high pallet array. These tests successfully demonstrated that UPRs respond better to the application of sprinkler water than “typical” low-flash point flammable liquids. The unique fire behavior, which resembled that of a Class IIIB liquid as opposed to a Class IC liquid (which is the true classification based on the flash point), can be attributed to at least two factors. First, UPRs are more viscous than typical fluids, which tends to limit the size of associated pool fires, and second, UPRs are heavier than water, which allows sprinkler discharge to cool the surface of a burning pool fire more efficiently than with typical liquids.

Given that the testing conducted clearly demonstrated that a 10-foot-high (3048 mm) array of UPR can be satisfactorily protected with a water-only sprinkler system discharging at a rate of 0.45 gpm per square foot (18 L/min/m<sup>2</sup>); and the testing clearly demonstrated that pile length and width and the associated liquid volume were not factors in determining the effectiveness of sprinkler protection, it is appropriate to allow limits on storage arrays of UPRs to parallel the code requirements for Class III liquids, rather than Class I liquids. Accordingly, the pile quantity limits for UPRs in containers are those currently listed in this table for Class III liquids. However, the recom-

mended height limit is restricted to 10 feet (3048 mm) because that was the height limit utilized in the referenced fire tests.

It is also important to note that there is a code-based precedence for UPRs to be uniquely regulated as a Class IIIB liquid, even though the actual flash point-based classification is ordinarily Class IC. Under NFPA 30, UPRs were generally regarded as “viscous” liquids, which allowed them to be protected as Class IIIB liquids even though the actual designation was Class IC.

**TABLE 5704.3.6.3(3).** See page 57-42.

❖ The storage of flammable and combustible liquids in liquid storage rooms and warehouses is regulated by floor, type of rack, maximum storage height and maximum quantity per room. The table restricts the storage by floor to ensure that the basement is not used for the storage of Class I liquids. The accumulation of vapors from Class I liquids in a basement with a low ignition point for these vapors is not an acceptable situation.

The storage height is used to control the quantity of flammable and combustible liquids and to provide access to the flammable and combustible liquids for water spray from the automatic sprinkler system.

The maximum quantity per room of flammable and combustible liquids is to control the volume of flammable and combustible liquids with the automatic sprinkler system.

The automatic sprinkler system is designed for a minimum flow rate. If the volume of flammable and combustible liquids in a room is not regulated, the room could contain more flammable and combustible liquids than the design flow rate of the automatic sprinkler system could handle.

Note a recognizes that since liquid storage warehouses are dedicated to storage of those materials only, unlimited quantities are acceptable based on Section 5704.3.8.1. See the commentary to Section 5704.3.8.1 for further discussion. This is consistent with Table 5704.3.6.3(2), Note a.

Note b helps to ensure that storage heights will not exceed the capabilities of the level of sprinkler protection provided. It also clarifies that protection schemes demonstrated with metallic containers and portable tanks are not suitable for nonmetallic containers and portable tanks, which present a much more significant fire challenge. Without this clarification, which correlates with NFPA 30, the height limits established by the tables place sprinklered buildings at risk of having the sprinkler system fail to control a fire because the protection scheme might not be properly matched with stored commodities.

**TABLE 5704.3.6.3(4).** See page 57-43.

❖ The quantity of flammable and combustible liquids can be increased if they are in containers and arranged as described in this table and the sprinkler system criteria are increased to comply with this

table. The containers and arrangements control the quantity of flammable and combustible liquid that is exposed. The sprinkler system criteria have been increased to provide a higher density, larger water demand and longer duration than normally required under NFPA 13. These additional sprinkler requirements permit an increase in quantity of flammable and combustible liquids that are permitted per control area in wholesale and retail uses.

Note that the provisions in this table are based on fire tests or historic protection schemes that were based on protection of metal containers and portable tanks. The schemes are inadequate for protection of liquids in containers and portable tanks constructed of other materials, such as plastic. NFPA 30 includes a limited number of protection schemes for nonmetal containers, and those schemes, which require far more protection than the code prescribes in Tables 5704.3.6.3(4) through (8), can still be recognized through the application of Section 5704.3.7.5.1 or 5704.3.8.4. Storage configurations that do not have demonstrated or code-recognized protection schemes, such as putting plastic containers into an area protected for metallic containers, should not be permitted.

**TABLE 5704.3.6.3(5).** See page 57-44.

❖ Rack storage is designed for easy access by personnel and to contain huge quantities of goods that are stored to great heights. The rack storage arrangement maximizes the fuel surface area accessible to flames. Fire can rapidly spread up between containers. Heat from flames burning on one surface augments the heat transfer from the flames burning on the opposing surface. Rack storage geometry can be the most hazardous of all fire geometries. High-rack storage is often protected with in-rack sprinklers inside or on the face of the high-rack storage. The storage of flammable and combustible liquids can be as high as 25 feet (7620 mm) because the containers have been limited in size to control volume in individual containers, and the sprinkler system requirements have been increased to provide more fire protection.

Note that the provisions in this table are based on fire tests or historic protection schemes that were based on protection of metal containers and portable tanks. The schemes are inadequate for protection of liquids in containers and portable tanks constructed of other materials, such as plastic. NFPA 30 includes a limited number of protection schemes for nonmetal containers, and those schemes, which require far more protection than the code prescribes in Tables 5704.3.6.3(4) through (8), can still be recognized through the application of Section 5704.3.7.5.1 or 5704.3.8.4. Storage configurations that do not have demonstrated or code-recognized protection schemes, such as putting plastic containers into an area protected for metallic containers, should not be permitted.

**TABLE 5704.3.6.3(6).** See page 57-45.

❖ Rack storage is designed for easy access by personnel and to contain huge quantities of goods that are stored to great heights. The rack storage arrangement maximizes the fuel surface area accessible to flames. Fire can rapidly spread up between containers. Heat from flames burning on one surface augments the heat transfer from the flames burning on the opposing surface. Rack storage geometry can be the most hazardous of all fire geometries. High-rack storage is often protected with in-rack sprinklers inside or on the face of the high-rack storage. The storage of Class I and II liquids up to 25 feet (7620 mm) and for Class III liquids up to 40 feet (12 192 mm) in containers larger than 5-gallon (19 L) capacity is similar to Table 5704.3.6.3(5), except the sprinkler system requirements have been increased to provide more fire protection.

Note that the provisions in this table are based on fire tests or historic protection schemes that were based on protection of metal containers and portable tanks. The schemes are inadequate for protection of liquids in containers and portable tanks constructed of other materials, such as plastic. NFPA 30 includes a limited number of protection schemes for nonmetal containers, and those schemes, which require far more protection than the code prescribes in Tables 5704.3.6.3(4) through (8), can still be recognized through the application of Section 5704.3.7.5.1 or 5704.3.8.4. Storage configurations that do not have demonstrated or code-recognized protection schemes, such as putting plastic containers into an area protected for metallic containers, should not be permitted.

**TABLE 5704.3.6.3(7).** See page 57-46.

❖ Rack storage is designed for easy access by personnel and to contain huge quantities of goods that are stored to great heights. The rack storage arrangement maximizes the fuel surface area accessible to flames. Fire can rapidly spread up between containers. Heat from flames burning on one surface augments the heat transfer from the flames burning on the opposing surface. Rack storage geometry can be the most hazardous of all fire geometries. High-rack storage (see also Chapter 23) is often protected with in-rack sprinklers inside or on the face of the high-rack storage. Aqueous film-forming foam (AFFF) is effective because the film forms a barrier that starves the fire for oxygen, cools the hydrocarbon and suppresses the release of flammable vapors. The increased fire protection provided by the additional requirements on the AFFF above that required under NFPA 13 allows the storage of flammable and combustible liquids with in-rack storage.

Note that the provisions in this table are based on fire tests or historic protection schemes that were based on protection of metal containers and portable tanks. The schemes are inadequate for protection of

liquids in containers and portable tanks constructed of other materials, such as plastic. NFPA 30 includes a limited number of protection schemes for nonmetal containers, and those schemes, which require far more protection than the code prescribes in Tables 5704.3.6.3(4) through (8), can still be recognized through the application of Section 5704.3.7.5.1 or 5704.3.8.4. Storage configurations that do not have demonstrated or code-recognized protection schemes, such as putting plastic containers into an area protected for metallic containers, should not be permitted.

**TABLE 5704.3.6.3(8).** See page 57-46.

❖ Group M (mercantile) occupancies used for wholesale and retail sales of flammable and combustible liquids are not designed and constructed for flammable and combustible liquids. Table 5704.3.4.1 permits the display and storage of Class I liquid if the automatic fire protection system complies with this table. The limited container size, the limited volume under Table 5704.3.4.1 and the sprinkler protection provided under this table permit display and storage in racks up to 6 feet, 6 inches (1981 mm) high.

Rack storage is designed for easy access by personnel and to contain huge quantities of goods that are stored to great heights. The rack storage arrangement maximizes the fuel surface area accessible to flames. Fire can rapidly spread up between containers. Heat from flames burning on one surface augments the heat transfer from the flames burning on the opposing surface. Rack storage geometry can be the most hazardous of all fire geometries. High-rack storage is often protected with in-rack sprinklers inside or on the face of the high-rack storage. Double-row racks are rack storage that has two racks placed back to back. The double-row rack storage requires additional sprinkler heads to control fire between containers within the rack storage. This table provides the requirements for the additional sprinkler heads and increases the sprinkler density.

Note that the provisions in this table are based on fire tests or historic protection schemes that were based on protection of metal containers and portable tanks. The schemes are inadequate for protection of liquids in containers and portable tanks constructed of other materials, such as plastic. NFPA 30 includes a limited number of protection schemes for nonmetal containers, and those schemes, which require far more protection than the code prescribes in Tables 5704.3.6.3(4) through (8), can still be recognized through the application of Sections 5704.3.7.5.1 or 5704.3.8.4. Storage configurations that do not have demonstrated or code-recognized protection schemes, such as putting plastic containers into an area protected for metallic containers, should not be permitted.

**5704.3.6.4 Warning for containers.** Cans, containers and vessels containing flammable liquids or flammable liquid

compounds or mixtures offered for sale shall be provided with a warning indicator, painted or printed on the container and stating that the liquid is flammable, and shall be kept away from heat and an open flame.

- ❖ Individual containers and their packaging must bear labels warning handling personnel and the public of flammable and combustible liquids. This warning is to prevent the containers from being accidentally or deliberately exposed to heat or open flame.

**5704.3.6.5 Storage plan.** Where required by fire the code official, *aisle* and storage plans shall be submitted in accordance with Chapter 50.

- ❖ The storage plan would be needed if there are conditions that the fire code official believes would lead to the mishandling of flammable and combustible liquids. Such conditions include, but are not limited to, quantity of flammable and combustible liquids, the turnover rate of flammable and combustible liquids and the turnover rate of personnel.

**5704.3.7 Liquid storage rooms.** Liquid storage rooms shall comply with Sections 5704.3.7.1 through 5704.3.7.5.2.

- ❖ Liquid storage rooms are protected locations for the storage of flammable and combustible liquids in occupancies normally not associated with the use and storage of flammable and combustible liquids. Liquid storage rooms are intended to store flammable and combustible liquids that exceed the quantities permitted in a control area.

**5704.3.7.1 General.** Quantities of liquids exceeding those set forth in Section 5704.3.4.1 for storage in *control areas* shall be stored in a liquid storage room complying with this section and constructed and separated as required by the *International Building Code*.

- ❖ Liquid storage rooms are intended to store flammable and combustible liquids that exceed the quantities permitted in a control area.

**5704.3.7.2 Quantities and arrangement of storage.** The quantity limits and storage arrangements in liquid storage rooms shall be in accordance with Tables 5704.3.6.3(2) and

5704.3.6.3(3) and Sections 5704.3.7.2.1 through 5704.3.7.2.3.

- ❖ Liquid storage rooms are limited in the quantity of flammable and combustible liquids and the method of storage of flammable and combustible liquids. The maximum height and maximum volume per pile are limited by Tables 5704.3.6.3(2) and 5704.3.6.3(3).

**5704.3.7.2.1 Mixed storage.** Where two or more classes of liquids are stored in a pile or rack section, both of the following shall apply:

1. The quantity in that pile or rack shall not exceed the smallest of the maximum quantities for the classes of liquids stored in accordance with Table 5704.3.6.3(2) or 5704.3.6.3(3).
2. The height of storage in that pile or rack shall not exceed the smallest of the maximum heights for the classes of liquids stored in accordance with Table 5704.3.6.3(2) or 5704.3.6.3(3).

- ❖ A liquid storage room is intended for the storage of a maximum quantity of flammable and combustible liquid. When more than one class of flammable and combustible liquid is stored in the same room, the aggregate quantity of flammable and combustible liquids cannot exceed the smallest quantity allowed in Table 5704.3.6.3(2) or 5704.3.6.3(3) for the flammable and combustible liquids being stored:

1. Because the liquid storage room is adequate for a maximum volume of a flammable or combustible liquid, the liquid storage room will be adequate for the aggregate quantity based on the allowable volume of the most hazardous flammable and combustible liquid being stored.
2. Because the liquid storage room is adequate for a maximum height of a flammable or combustible liquid, the liquid storage room will be adequate for the height based on the allowable height of the most hazardous flammable and combustible liquid being stored.

TABLE 5704.3.6.3(1)  
MAXIMUM STORAGE HEIGHT IN CONTROL AREA

TYPE OF LIQUID	NONSPRINKLERED AREA (feet)	SPRINKLERED AREA <sup>a</sup> (feet)	SPRINKLERED WITH IN-RACK PROTECTION <sup>a, b</sup> (feet)
Flammable liquids:			
Class IA	4	4	4
Class IB	4	8	12
Class IC	4	8	12
Combustible liquids:			
Class II	6	8	12
Class IIIA	8	12	16
Class IIIB	8	12	20

For SI: 1 foot = 304.8 mm.

- a In buildings protected by an automatic sprinkler system, the storage height for containers and portable tanks shall not exceed the maximum storage height permitted for the fire protection scheme set forth in NFPA 30 or the maximum storage height demonstrated in a full-scale fire test, whichever is greater. NFPA 30 criteria and fire test results for metallic containers and portable tanks shall not be applied to nonmetallic containers and portable tanks.
- b In-rack protection shall be in accordance with Table 5704.3.6.3(5), 5704.3.6.3(6) or 5704.3.6.3(7).

**TABLE 5704.3.6.3(2)**  
**STORAGE ARRANGEMENTS FOR PALLETIZED OR SOLID-PILE STORAGE IN LIQUID STORAGE ROOMS AND WAREHOUSES**

CLASS	STORAGE LEVEL	MAXIMUM STORAGE HEIGHT			MAXIMUM QUANTITY PER PILE (gallons)		MAXIMUM QUANTITY PER ROOM <sup>a</sup> (gallons)	
		Drums	Containers <sup>b</sup> (feet)	Portable tanks <sup>b</sup> (feet)	Containers	Portable tanks	Containers	Portable tanks
IA	Ground floor	1	5	Not Allowed	3,000	Not Allowed	12,000	Not Allowed
	Upper floors	1	5	Not Allowed	2,000	Not Allowed	8,000	Not Allowed
	Basements	0	Not Allowed	Not Allowed	Not Allowed	Not Allowed	Not Allowed	Not Allowed
IB	Ground floor	1	6.5	7	5,000	20,000	15,000	40,000
	Upper floors	1	6.5	7	3,000	10,000	12,000	20,000
	Basements	0	Not Allowed	Not Allowed	Not Allowed	Not Allowed	Not Allowed	Not Allowed
IC	Ground floor <sup>d</sup>	1	6.5 <sup>c</sup>	7	5,000	20,000	15,000	40,000
	Upper floors	1	6.5 <sup>c</sup>	7	3,000	10,000	12,000	20,000
	Basements	0	Not Allowed	Not Allowed	Not Allowed	Not Allowed	Not Allowed	Not Allowed
II	Ground floor <sup>d</sup>	3	10	14	10,000	40,000	25,000	80,000
	Upper floors	3	10	14	10,000	40,000	25,000	80,000
	Basements	1	5	7	7,500	20,000	7,500	20,000
III	Ground floor	5	20	14	15,000	60,000	50,000	100,000
	Upper floors	5	20	14	15,000	60,000	50,000	100,000
	Basements	3	10	7	10,000	20,000	25,000	40,000

For SI: 1 foot = 304.8 mm, 1 gallon = 3.785 L.

- a. See Section 5704.3.8.1 for unlimited quantities in liquid storage warehouses.
- b. In buildings protected by an automatic sprinkler system, the storage height for containers and portable tanks shall not exceed the maximum storage height permitted for the fire protection scheme set forth in NFPA 30 or the maximum storage height demonstrated in a full-scale fire test, whichever is greater. NFPA 30 criteria and fire test results for metallic containers and portable tanks shall not be applied to nonmetallic containers and portable tanks.
- c. These height limitations are allowed to be increased to 10 feet for containers having a capacity of 5 gallons or less.
- d. For palletized storage of unsaturated polyester resins (UPR) in relieving-style metal containers with 50 percent or less by weight Class IC or II liquid and no Class IA or IB liquid, height and pile quantity limits shall be permitted to be 10 feet and 15,000 gallons, respectively, provided that such storage is protected by sprinklers in accordance with NFPA 30 and that the UPR storage area is not located in the same containment area or drainage path for other Class I or II liquids.

**TABLE 5704.3.6.3(3)**  
**STORAGE ARRANGEMENTS FOR RACK STORAGE IN LIQUID STORAGE ROOMS AND WAREHOUSES**

CLASS	TYPE RACK	STORAGE LEVEL	MAXIMUM STORAGE HEIGHT <sup>b</sup> (feet)	MAXIMUM QUANTITY PER ROOM <sup>a</sup> (gallons)
			Containers	Containers
IA	Double row or Single row	Ground floor	25	7,500
		Upper floors	15	4,500
		Basements	Not Allowed	Not Allowed
IB IC	Double row or Single row	Ground floor	25	15,000
		Upper floors	15	9,000
		Basements	Not Allowed	Not Allowed
II	Double row or Single row	Ground floor	25	24,000
		Upper floors	25	24,000
		Basements	15	9,000
III	Multirow Double row Single row	Ground floor	40	48,000
		Upper floors	20	48,000
		Basements	20	24,000

For SI: 1 foot = 304.8 mm, 1 gallon = 3.785 L.

- a. See Section 5704.3.8.1 for unlimited quantities in liquid storage warehouses.
- b. In buildings protected by an automatic sprinkler system, the storage height for containers and portable tanks shall not exceed the maximum storage height permitted for the fire protection scheme set forth in NFPA 30 or the maximum storage height demonstrated in a full-scale fire test, whichever is greater. NFPA 30 criteria and fire test results for metallic containers and portable tanks shall not be applied to nonmetallic containers and portable tanks.

TABLE 5704.3.6.3(4) AUTOMATIC SPRINKLER PROTECTION FOR SOLID-PILE AND PALLETIZED STORAGE OF LIQUIDS IN METAL CONTAINERS AND PORTABLE TANKS<sup>a</sup>

STORAGE CONDITIONS		CEILING SPRINKLER DESIGN AND DEMAND				MINIMUM HOSE STREAM DEMAND (gpm)	MINIMUM DURATION SPRINKLERS AND HOSE STREAMS (hours)
Class liquid	Container size and arrangement	Density (gpm/ft <sup>2</sup> )	Area (square feet)		Maximum spacing (square feet)		
			High temperature sprinklers	Ordinary temperature sprinklers			
IA	5 gallons or less, with or without cartons, palletized or solid pile <sup>b</sup>	0.30	3,000	5,000	100	750	2
	Containers greater than 5 gallons, on end or side, palletized or solid pile	0.60	5,000	8,000	80	750	
IB, IC and II	5 gallons or less, with or without cartons, palletized or solid pile <sup>b</sup>	0.30	3,000	5,000	100	500	2
	Containers greater than 5 gallons on pallets or solid pile, one high	0.25	5,000	8,000	100		
II	Containers greater than 5 gallons on pallets or solid pile, more than one high, on end or side	0.60	5,000	8,000	80	750	2
	Portable tanks, one high	0.30	3,000	5,000	100	500	2
III	Portable tanks, two high	0.60	5,000	8,000	80	750	2
	5 gallons or less, with or without cartons, palletized or solid pile	0.25	3,000	5,000	120	500	1
III	Containers greater than 5 gallons on pallets or solid pile, on end or sides, up to three high	0.25	3,000	5,000	120	500	1
	Containers greater than 5 gallons, on pallets or solid pile, on end or sides, up to 18 feet high	0.35	3,000	5,000	100	750	2
III	Portable tanks, one high	0.25	3,000	5,000	120	500	1
	Portable tanks, two high	0.50	3,000	5,000	80	750	2

For SI: 1 foot = 304.8 mm, 1 gallon = 3.785 L, 1 square foot = 0.0929 m<sup>2</sup>, 1 gallon per minute = 3.785 L/m, 1 gallon per minute per square foot = 40.75 L/min/m<sup>2</sup>.  
 a. The design area contemplates the use of Class II standpipe systems. Where Class I standpipe systems are used, the area of application shall be increased by 30 percent without revising density.  
 b. For storage heights above 4 feet or ceiling heights greater than 18 feet, an approved engineering design shall be provided in accordance with Section 104.7.2.

TABLE 5704.3.6.3(5)  
**AUTOMATIC SPRINKLER PROTECTION REQUIREMENTS FOR RACK STORAGE OF LIQUIDS IN METAL CONTAINERS OF 5-GALLON CAPACITY OR LESS WITH OR WITHOUT CARTONS ON CONVENTIONAL WOOD PALLETS<sup>a</sup>**

CLASS LIQUID	CEILING SPRINKLER DESIGN AND DEMAND			IN-RACK SPRINKLER ARRANGEMENT AND DEMAND				MINIMUM HOSE STREAM DEMAND (gpm)	MINIMUM DURATION SPRINKLER AND HOSE STREAM (hours)	
	Density (gpm/ft <sup>2</sup> )	Area (square feet)		Racks up to 9 feet deep	Racks more than 9 feet to 12 feet deep	30 psi (standard orifice)				
		High-temperature sprinklers	Ordinary temperature sprinklers			14 psi (large orifice)	Number of sprinklers operating			
I (maximum 25-foot height) Option 1	0.40	3,000	5,000	80 ft <sup>2</sup> /head	1. Ordinary temperature, quick-response sprinklers, maximum 8 feet 3 inches horizontal spacing 2. One line sprinklers above each level of storage 3. Locate in longitudinal flue space, staggered vertical 4. Shields required where multilevel	1. Ordinary temperature, quick-response sprinklers, maximum 8 feet 3 inches horizontal spacing 2. See 2 above 3. See 3 above 4. See 4 above	1. Ordinary temperature, quick-response sprinklers, maximum 8 feet 3 inches horizontal spacing 2. See 2 above 3. See 3 above 4. See 4 above	1. Eight sprinklers if only one level 2. Six sprinklers each on two levels if only two levels 3. Six sprinklers each on top three levels, if three or more levels 4. Hydraulically most remote	750	2
I (maximum 25-foot height) Option 2	0.55	2,000 <sup>b</sup>	Not Applicable	100 ft <sup>2</sup> /head	1. Ordinary temperature, quick-response sprinklers, maximum 8 feet 3 inches horizontal spacing 2. See 2 above 3. See 3 above 4. See 4 above	1. Ordinary temperature, quick-response sprinklers, maximum 8 feet 3 inches horizontal spacing 2. See 2 above 3. See 3 above 4. See 4 above	1. Ordinary temperature, quick-response sprinklers, maximum 8 feet 3 inches horizontal spacing 2. See 2 above 3. See 3 above 4. See 4 above	See 1 through 4 above	500	2
I and II (maximum 14-foot storage height) (maximum three tiers)	0.55 <sup>c</sup>	2,000 <sup>d</sup>	Not Applicable	100 ft <sup>2</sup> /head	Not Applicable None for maximum 6-foot-deep racks	Not Applicable	Not Applicable	Not Applicable	500	2
II (maximum 25-foot height)	0.30	3,000	5,000	100 ft <sup>2</sup> /head	1. Ordinary temperature sprinklers 8 feet apart horizontally 2. One line sprinklers between levels at nearest 10-foot vertical intervals 3. Locate in longitudinal flue space, staggered vertical 4. Shields required where multilevel	1. Ordinary temperature, quick-response sprinklers, maximum 8 feet 3 inches horizontal spacing 2. See 2 above 3. See 3 above 4. See 4 above	1. Ordinary temperature, quick-response sprinklers, maximum 8 feet 3 inches horizontal spacing 2. See 2 above 3. See 3 above 4. See 4 above	Hydraulically most remote—six sprinklers at each level, up to a maximum of three levels	750	2
III (40-foot height)	0.25	3,000	5,000	120 ft <sup>2</sup> /head	Same as for Class II liquids	Same as for Class II liquids	Same as for Class II liquids	Same as for Class II liquids	500	2

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square inch = 6.895 kPa, 1 gallon = 3.785 L, 1 gallon per minute = 3.785 L/m, 1 gallon per minute per square foot = 40.75 L/min·m<sup>2</sup>.

a. The design area contemplates the use of Class II standpipe systems. Where Class I standpipe systems are used, the area of application shall be increased by 30 percent without revising density.

b. Using listed or approved extra-large orifices, high-temperature quick-response or standard element sprinklers under a maximum 30-foot ceiling with minimum 7.5-foot aisles.

c. For friction lid cans and other metal containers equipped with plastic nozzles or caps, the density shall be increased to 0.65 gpm per square foot using listed or approved extra-large orifice, high-temperature quick-response sprinklers.

d. Using listed or approved extra-large orifice, high-temperature quick-response or standard element sprinklers under a maximum 18-foot ceiling with minimum 7.5-foot aisles and metal containers.

TABLE 5704.3.6.3(6) AUTOMATIC SPRINKLER PROTECTION REQUIREMENTS OR RACK STORAGE OF LIQUIDS IN METAL CONTAINERS GREATER THAN 5-GALLON CAPACITY<sup>a</sup>

CLASS LIQUID	CEILING SPRINKLER DESIGN AND DEMAND			IN-RACK SPRINKLER ARRANGEMENT AND DEMAND					MINIMUM HOSE STREAM DEMAND (gpm)	MINIMUM DURATION SPRINKLER AND HOSE STREAM (hours)
	Density (gpm/ft <sup>2</sup> )	Area (square feet)		Maximum spacing	On-side storage racks up to 9-foot-deep racks	On-end storage (on pallets) up to 9-foot-deep racks	Minimum nozzle pressure	Number of sprinklers operating		
		High-temperature sprinklers	Ordinary temperature sprinklers							
IA (maximum 25-foot height)	0.60	3,000	5,000	80 ft <sup>2</sup> /head	1. Ordinary temperature sprinklers 8 feet apart horizontally 2. One line sprinklers above each tier of storage 3. Locate in longitudinal flue space, staggered vertical 4. Shields required where multilevel	1. Ordinary temperature sprinklers 8 feet apart horizontally 2. One line sprinklers above each tier of storage 3. Locate in longitudinal flue space, staggered vertical 4. Shields required where multilevel	30 psi	Hydraulically most remote—six sprinklers at each level	1,000	2
IB, IC and II (maximum 25-foot height)	0.60	3,000	5,000	100 ft <sup>2</sup> /head	1. See 1 above 2. One line sprinklers every three tiers of storage 3. See 3 above 4. See 4 above	1. See 1 above 2. See 2 above 3. See 3 above 4. See 4 above	30 psi	Hydraulically most remote—six sprinklers at each level	750	2
III (maximum 40-foot height)	0.25	3,000	5,000	120 ft <sup>2</sup> /head	1. See 1 above 2. One line sprinklers every sixth level (maximum) 3. See 3 above 4. See 4 above	1. See 1 above 2. One line sprinklers every third level (maximum) 3. See 3 above 4. See 4 above	15 psi	Hydraulically most remote—six sprinklers at each level	500	1

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square inch = 6.895 kPa, 1 gallon = 3.785 L, 1 gallon per minute = 3.785 L/m, 1 gallon per minute per square foot = 40.75 L/min/m<sup>2</sup>.  
 a. The design assumes the use of Class II standpipe systems. Where a Class I standpipe system is used, the area of application shall be increased by 30 percent without revising density.

TABLE 5704.3.6.3(7) AUTOMATIC AFF WATER PROTECTION REQUIREMENTS FOR RACK STORAGE OF LIQUIDS IN METAL CONTAINERS GREATER THAN 5-GALLON CAPACITY<sup>a,b</sup>

CLASS LIQUID	CEILING SPRINKLER DESIGN AND DEMAND		IN-RACK SPRINKLER ARRANGEMENT AND DEMAND <sup>c</sup>				DURATION AFF SUPPLY (minimum)	DURATION WATER SUPPLY (hours)	
	Density (gpm/ft <sup>2</sup> )	Area (square feet)		Minimum nozzle pressure (psi)	Number of sprinklers operating	Hose stream demand <sup>d</sup> (gpm)			
		High-temperature sprinklers	Ordinary temperature sprinklers						
IA, IB, IC and II	0.30	1,500	2,500	On-end storage of drums on pallets, up to 25 feet	30	Three sprinklers per level	500	15	2

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square inch = 6.895 kPa, 1 gallon = 3.785 L, 1 gallon per minute = 3.785 L/m, 1 gallon per square foot = 40.75 L/min/m<sup>2</sup>.

a. System shall be a closed-head wet system with *approved* devices for proportioning aqueous film-forming foam.

b. Except as modified herein, in-rack sprinklers shall be installed in accordance with NFPA 13.

c. The height of storage shall not exceed 25 feet.

d. Hose stream demand includes 1½-inch inside hose connections, where required.

TABLE 5704.3.6.3(8) AUTOMATIC SPRINKLER PROTECTION REQUIREMENTS FOR CLASS I LIQUID STORAGE IN METAL CONTAINERS OF 1-GALLON CAPACITY OR LESS WITH UNCARTONED OR CASE-CUT SHELF DISPLAY UP TO 6.5 FEET, AND PALLETIZED STORAGE ABOVE IN A DOUBLE-ROW RACK ARRAY<sup>a</sup>

STORAGE HEIGHT	CEILING SPRINKLER DESIGN AND DEMAND			IN-RACK SPRINKLER ARRANGEMENT AND DEMAND				MINIMUM HOSE STREAM DEMAND (gpm)	MINIMUM DURATION SPRINKLERS AND HOSE STREAM (hours)	
	Density (gpm/ft <sup>2</sup> )	Area (square feet)		Racks 9 to 12 feet	Racks up to 9 feet deep	Minimum nozzle pressure	Number of sprinklers operating			
		High temperature	Ordinary temperature							
Maximum 20-foot storage height	0.60	2,000 <sup>b</sup>	Not Applicable	100 ft <sup>2</sup> /head	1. Ordinary temperature, quick-response sprinklers, maximum 8 feet 3 inches horizontal spacing 2. One line of sprinklers at the 6-foot level and the 11.5-foot level of storage 3. Locate in longitudinal flue space, staggered vertical space, staggered vertical 4. Shields required where multilevel	Not Applicable	30 psi (standard orifice) or 14 psi (large remote 12 sprinklers)	1. Six sprinklers each on two levels 2. Hydraulically most remote 12 sprinklers	500	2

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square inch = 6.895 kPa, 1 gallon = 3.785 L, 1 gallon per minute = 3.785 L/m, 1 gallon per square foot = 40.75 L/min/m<sup>2</sup>.

a. This table shall not apply to racks with solid shelves.

b. Using extra-large orifice sprinklers under a ceiling 30 feet or less in height. Minimum aisle width is 7.5 feet.

**5704.3.7.2.2 Separation and aisles.** Piles shall be separated from each other by not less than 4-foot (1219 mm) aisles. Aisles shall be provided so that all containers are 20 feet (6096 mm) or less from an aisle. Where the storage of liquids is on racks, a minimum 4-foot-wide (1219 mm) aisle shall be provided between adjacent rows of racks and adjacent storage of liquids. Main aisles shall be not less than 8 feet (2438 mm) wide.

Additional aisles shall be provided for access to doors, required windows and ventilation openings, standpipe connections, mechanical equipment and switches. Such aisles shall be not less than 3 feet (914 mm) in width, unless greater widths are required for separation of piles or racks, in which case the greater width shall be provided.

❖ Aisles in a liquid storage room are designed to the same aisle criteria as for rack storage. A minimum aisle width of 4 feet (1219 mm) between piles and a minimum main aisle of 8 feet (2438 mm) is to provide clearance for personnel to access the flammable and combustible liquids without interference with other piles.

Egress from the room for evacuation and access to fire protection and other facilities within the room must be maintained.

**5704.3.7.2.3 Stabilizing and supports.** Containers and piles shall be separated by pallets or dunnage to provide stability and to prevent excessive stress to container walls. Portable tanks stored over one tier shall be designed to nest securely without dunnage.

Requirements for portable tank design shall be in accordance with Chapters 9 and 12 of NFPA 30. Shelving, racks, dunnage, scuffboards, floor overlay and similar installations shall be of noncombustible construction or of wood not less than a 1-inch (25 mm) nominal thickness. Adequate material-handling equipment shall be available to handle tanks safely at upper tier levels.

❖ The requirements of this section are intended to prevent piles from collapsing and causing container damage or liquid spills. Requiring pallets or dunnage spreads stress loads over broad surfaces, reducing stresses in container walls that could lead to damage or leakage.

Requirements for portable tank design are intended to result in stability that will prevent tanks from toppling. Having materials-handling equipment that is designed to handle the tanks also helps to ensure safe storage and handling.

**5704.3.7.3 Spill control and secondary containment.** Liquid storage rooms shall be provided with spill control and secondary containment in accordance with Section 5004.2.

❖ Spills must be contained and controlled to prevent the spread of the liquid and the vapors. Section 5004.2 discusses the use of liquid-tight floors, curbs, dikes and drainage systems to divert the liquid to a location where it can be contained and safely handled. Storage rooms shall be ventilated in accordance with

Section 5004.3, which discusses mechanical and natural exhaust systems. The exhaust system is to remove the vapors to prevent them from accumulating in concentrations in the flammable range of the vapor.

**5704.3.7.4 Ventilation.** Liquid storage rooms shall be ventilated in accordance with Section 5004.3.

❖ See the commentary to Section 5004.3 for discussions of ventilation requirements.

**5704.3.7.5 Fire protection.** Fire protection for liquid storage rooms shall comply with Sections 5704.3.7.5.1 and 5704.3.7.5.2.

❖ This section introduces the fire protection requirements for liquid storage rooms.

**5704.3.7.5.1 Fire-extinguishing systems.** Liquid storage rooms shall be protected by *automatic sprinkler systems* installed in accordance with Chapter 9 and Tables 5704.3.6.3(4) through 5704.3.6.3(7) and Table 5704.3.7.5.1. In-rack sprinklers shall also comply with NFPA 13.

Automatic foam-water systems and automatic aqueous film-forming foam (AFFF) water sprinkler systems shall not be used except where *approved*.

Protection criteria developed from fire modeling or full-scale fire testing conducted at an *approved* testing laboratory are allowed in lieu of the protection as shown in Tables 5704.3.6.3(2) through 5704.3.6.3(7) and Table 5704.3.7.5.1 where *approved*.

❖ The fire protection system must be designed to handle anticipated fires. For a liquid storage room that contains a variety of flammable and combustible liquids, the fire protection needs to be selected from Tables 5704.3.6.3(4) through 5704.3.6.3(7) and Table 5704.3.7.5.1. These tables address the classification of flammable and combustible liquids, container size and the method of storing the liquids. The installation of this fire protection is to comply with Chapter 9. For liquid storage rooms that use rack storage not covered in the tables, use NFPA 13 for the fire protection requirements.

Automatic foam-water systems and AFFF are to be used if approved by the fire code official. These fire protection systems starve the fire for oxygen by forming a barrier between the hydrocarbon and the air, by cooling the hydrocarbon and by suppressing the release of flammable vapors.

These fire protection systems, however, can be harmful to the environment. Containment of the foam solution should be considered when using these systems.

The code is designed to reflect that there may be other methods available for meeting code requirements. The fire code official is responsible for reviewing proposed alternative methods and has the authority to approve them when they have been demonstrated or documented to comply with the code.

**TABLE 5704.3.7.5.1.** See below.

❖ Solid-pile or palletized storage of flammable and combustible liquids, except for Class IA liquids, in metal containers is allowed when AFFF is installed. The storage system permits these flammable and combustible liquids to either be in cartons or uncartoned. Flammable and combustible liquids in carton packaging can be piled 11 feet (3353 mm) high while uncartoned containers can be piled 12 feet (3658 mm) high. The higher storage is allowed for containers out of cartons because the combustible cartons have been removed, reducing the fire load.

AFFF is effective fire protection for this storage because it forms a barrier that starves the fire for oxygen, cools the hydrocarbon and suppresses the release of flammable vapors. The 5-gallon (19 L) metal containers provide some protection from ignition as well as limit the quantity of flammable and combustible liquids that can be exposed. The cartons and pallets are a source of combustibles.

The AFFF provides fire prevention and fire protection in case of a liquid spill or pool fire. The AFFF will also provide protection for the metal containers if the cartons or pallets become involved in a fire. The increased fire protection provided by using 5-gallon (19 L) containers or less with the additional requirements on the AFFF above that required under NFPA 13 permit the storage of flammable and combustible liquids in solid-piled and palletized storage.

**5704.3.7.5.2 Portable fire extinguishers.** Not less than one approved portable fire extinguisher complying with Section 906 and having a rating of not less than 20-B shall be located not less than 10 feet (3048 mm) or more than 50 feet (15 240 mm) from any Class I or II liquid storage area located outside of a liquid storage room.

Not less than one portable fire extinguisher having a rating of not less than 20-B shall be located outside of, but not more than 10 feet (3048 mm) from, the door opening into a liquid storage room.

❖ Portable fire extinguishers are to be available outside of the liquid storage room because a fire in the liquid storage room could prevent personnel from getting to portable fire extinguishers in the room. The 20-B por-

table fire extinguisher is for the control of small flammable liquid fires.

**5704.3.8 Liquid storage warehouses.** Buildings used for storage of flammable or combustible liquids in quantities exceeding those set forth in Section 5704.3.4 for control areas and Section 5704.3.7 for liquid storage rooms shall comply with Sections 5704.3.8.1 through 5704.3.8.5 and shall be constructed and separated as required by the *International Building Code*.

❖ Liquid storage warehouses, as defined in Section 5702.1, are buildings that are designed to store flammable and combustible liquids in quantities that exceed the quantities allowed in a control area or a liquid storage room. A liquid storage warehouse is classified in Group H-2 or H-3 depending on whether the liquid is (H-2) or is not (H-3) under pressure. It can be a separate, detached building or it can be an attached building separated from other parts of the structure by a fire wall complying with IBC Section 706. This section establishes the applicability of Sections 5704.3.8.1 through 5704.3.8.5 to these unique buildings. See the commentary to Section 5702.1 and definition of “Liquid storage warehouse” for further information.

**5704.3.8.1 Quantities and storage arrangement.** The total quantities of liquids in a liquid storage warehouse shall not be limited. The arrangement of storage shall be in accordance with Table 5704.3.6.3(2) or 5704.3.6.3(3).

❖ Liquid storage warehouses are not restricted in the quantity of flammable and combustible liquids that may be stored; however, the maximum height and maximum volume per pile is limited by Tables 5704.3.6.3(2) and 5704.3.6.3(3), which effectively limit the quantity of flammable or combustible liquids that can be stored in a given space. Aisle width requirements further restrict quantities.

**5704.3.8.1.1 Mixed storage.** Mixed storage shall be in accordance with Section 5704.3.7.2.1.

❖ Liquid storage warehouses have to meet the same criteria as a liquid storage room. Liquid storage warehouses are intended for the storage of a maximum quantity of flammable and combustible liquid. When

**TABLE 5704.3.7.5.1**  
**AUTOMATIC AFFF-WATER PROTECTION REQUIREMENTS FOR SOLID-PILE AND**  
**PALLETIZED STORAGE OF LIQUIDS IN METAL CONTAINERS OF 5-GALLON CAPACITY OR LESS<sup>a, b</sup>**

PACKAGE TYPE	CLASS LIQUID	CEILING SPRINKLER DESIGN AND DEMAND					STORAGE HEIGHT (feet)	HOSE DEMAND (gpm) <sup>c</sup>	DURATION AFFF SUPPLY (minimum)	DURATION WATER SUPPLY (hours)
		Density (gpm/ft <sup>2</sup> )	Area (square feet)	Temperature rating	Maximum spacing	Orifice size (inch)				
Cartoned	IB, IC, II and III	0.40	2,000	286°F	100 ft <sup>2</sup> /head	0.531	11	500	15	2
Uncartoned	IB, IC, II and III	0.30	2,000	286°F	100 ft <sup>2</sup> /head	0.5 or 0.531	12	500	15	2

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 gallon per minute = 3.785 L/m, 1 gallon per minute per square foot = 40.75 L/min/m<sup>2</sup>, °C = [(°F)-32]/1.8.

a. System shall be a closed-head wet system with approved devices for proportioning aqueous film-forming foam.

b. Maximum ceiling height of 30 feet.

c. Hose stream demand includes 1½-inch inside hose connections, where required.

more than one class of flammable and combustible liquid is stored in the same liquid storage warehouse, the aggregate quantity of flammable and combustible liquids cannot exceed the smallest quantity allowed in Table 5704.3.6.3(2) or 5704.3.6.3(3) for the flammable and combustible liquids being stored.

Because the liquid storage warehouse is adequate for a maximum volume of a flammable or combustible liquid, the liquid storage warehouse will be adequate for the aggregate quantity based on the allowable volume of the most hazardous flammable and combustible liquid being stored.

Because the liquid storage warehouse is adequate for a maximum height of a flammable or combustible liquid, the liquid storage warehouse will be adequate for the height based on the allowable height of the most hazardous flammable and combustible liquid being stored.

**5704.3.8.1.2 Separation and aisles.** Separation and *aisles* shall be in accordance with Section 5704.3.7.2.2.

❖ Liquid storage warehouses must meet the same criteria as a liquid storage room. A liquid storage warehouse is designed to the same aisle criteria as rack storage. A minimum aisle width of 4 feet (1219 mm) between piles and a minimum main aisle of 8 feet (2438 mm) provide clearance for personnel and materials-handling equipment to access the flammable and combustible liquids without interference with other piles. The aisles are also intended for ready access by emergency responders.

Egress from the warehouse for evacuation and access to fire protection and other facilities within the warehouse need to be maintained.

**5704.3.8.2 Spill control and secondary containment.** Liquid storage warehouses shall be provided with spill control and secondary containment as set forth in Section 5004.2.

❖ The spill must be controlled to prevent the spread of liquid. Section 5004.2 discusses the use of liquid-tight floors, curbs, dikes and drainage systems to divert the liquid to a location where it can be contained and safely handled.

**5704.3.8.3 Ventilation.** Liquid storage warehouses storing containers greater than 5 gallons (19 L) in capacity shall be ventilated at a rate of not less than 0.25 cfm per square foot (0.075 m<sup>3</sup>/s · m<sup>2</sup>) of floor area over the storage area.

❖ This section specifies the ventilation rate for liquid warehouses storing containers whose capacity exceeds 5 gallons (19 L). Note that the provisions of Section 5004.3 do not apply. The exhaust system is to remove the vapors to prevent them from accumulating in concentrations in the flammable range of the vapor.

**5704.3.8.4 Automatic sprinkler systems.** Liquid storage warehouses shall be protected by *automatic sprinkler systems* installed in accordance with Chapter 9 and Tables 5704.3.6.3(4) through 5704.3.6.3(7) and Table 5704.3.7.5.1, or Sections 16.4.1 through 16.4.3, 16.5.1 through 16.5.2.12,

and Tables 16.5.2.1 through 16.5.2.12 and Figures 16.4.1(a) through 16.4.1(c) of NFPA 30. In-rack sprinklers shall also comply with NFPA 13.

Automatic foam-water systems and automatic AFFF water sprinkler systems shall not be used except where *approved*.

Protection criteria developed from fire modeling or full-scale fire testing conducted at an *approved* testing laboratory are allowed in lieu of the protection as shown in Tables 5704.3.6.3(2) through 5704.3.6.3(7) and Table 5704.3.7.5.1 where *approved*.

❖ The fire protection system must be designed to cope with anticipated fires. For a liquid storage warehouse that contains a variety of flammable and combustible liquids, the fire protection needs to be selected from Tables 5704.3.6.3(4) through 5704.3.6.3(7) and Table 5704.3.7.5.1. These tables address the classification of flammable and combustible liquids, container size and the method of storing the liquids. The installation of this fire protection is to comply with Chapter 9. For liquid storage warehouses that use rack storage not covered in the tables, use NFPA 13 for the fire protection requirements.

Automatic foam-water systems and AFFF are to be used if approved by the fire code official. These fire protection systems starve the fire for oxygen by forming a barrier between the hydrocarbon and the air, by cooling the hydrocarbon and by suppressing the release of flammable vapors.

These fire protection systems, however, can be harmful to the environment. Containment of the foam solution should be considered when using these systems.

The code always recognizes that there may be other methods available for accomplishing its intent. The fire code official is responsible for reviewing these alternative methods and has the authority to approve them if they have been demonstrated or documented to comply with the intent of the code requirement.

**5704.3.8.5 Warehouse hose lines.** In liquid storage warehouses, either 1<sup>1</sup>/<sub>2</sub>-inch (38 mm) lined or 1-inch (25 mm) hard rubber hose lines shall be provided in sufficient number to reach all liquid storage areas and shall be in accordance with Section 903 or 905.

❖ The requirements for hose lines stated in this section are consistent with the requirements of Chapter 9. They may be supplied by either the automatic sprinkler system in accordance with Section 903 or a standpipe system in accordance with Section 905.

**5704.4 Outdoor storage of containers and portable tanks.** Storage of flammable and *combustible liquids* in closed containers and portable tanks outside of buildings shall be in accordance with Section 5703 and Sections 5704.4.1 through 5704.4.8. Capacity limits for containers and portable tanks shall be in accordance with Section 5704.3.

❖ Outdoor storage in containers and portable tanks is regulated to prevent ignition sources from coming in

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contact with containers and portable tanks, to prevent damage to containers and portable tanks and to protect property and buildings.

**5704.4.1 Plans.** Storage shall be in accordance with *approved* plans.

❖ The fire code official must approve the layout of the outdoor storage. The clearances between tanks, buildings and property lines are to ensure that ignition sources are not in the immediate vicinity of the outdoor storage area.

**5704.4.2 Location on property.** Outdoor storage of liquids in containers and portable tanks shall be in accordance with Table 5704.4.2. Storage of liquids near buildings located on the same lot shall be in accordance with this section.

❖ Restrictions on pile size, required pile separation distances and required distances from lot lines, structures and public thoroughways are intended to result in improved fire safety. Limiting quantities that can be stored in a single pile limits the potential fuel load in any fire. Keeping piles away from structures, lot lines and public ways protects the piles from stray ignition sources as well as keeping buildings, personnel and the general public safe from the hazards of a possible fire.

**TABLE 5704.4.2.** See below.

❖ The outdoor storage of flammable and combustible liquids in containers and portable tanks is limited to control the size and location of a fire. The volume of flammable and combustible liquids is limited based on the type of liquid. The lower the ignition point of the liquid, the smaller the volume of the liquid permitted in a pile. The same approach is taken in determining the maximum height of a pile. These two features control the size of a fire.

Separation is used to control the spread of fire from pile to pile and from a pile to a structure or other property. The distance between piles is the same for all classes of flammable and combustible liquids. The

distance between a pile and a structure or property line serves several functions. The clearance is greater for flammable or combustible liquids with a lower ignition point to protect the flammable and combustible liquid from an ignition source as well as protecting the surrounding area from a pool fire of flammable or combustible liquid.

**5704.4.2.1 Mixed liquid piles.** Where two or more classes of liquids are stored in a single pile, the quantity in the pile shall not exceed the smallest of maximum quantities for the classes of material stored.

❖ When more than one class of flammable and combustible liquid is stored in the same pile, the aggregate quantity of flammable and combustible liquids cannot exceed the smallest quantity allowed in Table 5704.4.2.

Because the pile is adequate for a maximum volume of a flammable or combustible liquid, the pile will be adequate for the aggregate quantity based on the allowable volume of the most hazardous flammable and combustible liquid being stored.

Because the pile is adequate for a maximum height of a flammable or combustible liquid, the pile will be adequate for the height based on the allowable height of the most hazardous flammable and combustible liquid being stored.

**5704.4.2.2 Access.** Storage of containers or portable tanks shall be provided with fire apparatus access roads in accordance with Chapter 5.

❖ Access roads for fire department apparatus must be maintained in the outdoor storage so that fire department apparatus can gain access to any pile storage. Access may involve more than one access point. Consideration must be given to the turning radius of fire apparatus, dead-end lanes and entrance through security gates or locked gates.

**5704.4.2.3 Security.** The storage area shall be protected against tampering or trespassers where necessary and shall be

**TABLE 5704.4.2  
OUTDOOR LIQUID STORAGE IN CONTAINERS AND PORTABLE TANKS**

CLASS OF LIQUID	CONTAINER STORAGE— MAXIMUM PER PILE		PORTABLE TANK STORAGE— MAXIMUM PER PILE		MINIMUM DISTANCE BETWEEN PILES OR RACKS (feet)	MINIMUM DISTANCE TO LOT LINE OF PROP- ERTY THAT CAN BE BUILT UPON <sup>c, d</sup> (feet)	MINIMUM DISTANCE TO PUBLIC STREET, PUB- LIC ALLEY OR PUBLIC WAY <sup>d</sup> (feet)
	Quantity <sup>a, b</sup> (gallons)	Height (feet)	Quantity <sup>a, b</sup> (gallons)	Height (feet)			
IA	1,100	10	2,200	7	5	50	10
IB	2,200	12	4,400	14	5	50	10
IC	4,400	12	8,800	14	5	50	10
II	8,800	12	17,600	14	5	25	5
III	22,000	18	44,000	14	5	10	5

For SI: 1 foot = 304.8 mm, 1 gallon 3.785 L.

a. For mixed class storage, see Section 5704.4.2.

b. For storage in racks, the quantity limits per pile do not apply, but the rack arrangement shall be limited to not more than 50 feet in length and two rows or 9 feet in depth.

c. If protection by a public fire department or private fire brigade capable of providing cooling water streams is not available, the distance shall be doubled.

d. When the total quantity stored does not exceed 50 percent of the maximum allowed per pile, the distances are allowed to be reduced 50 percent, but not less than 3 feet.

kept free from weeds, debris and other combustible materials not necessary to the storage.

- ❖ Unauthorized personnel may not know the potential dangers associated with flammable and combustible liquids. By controlling access to the outdoor storage facility, the owner will be able to monitor sources of heat and open flame. Security will be able to monitor the accumulation of combustibles and take appropriate action to remove these fuel sources.

**5704.4.2.4 Storage adjacent to buildings.** Not more than 1,100 gallons (4163 L) of liquids stored in closed containers and portable tanks is allowed adjacent to a building located on the same premises and under the same management, provided that:

1. The building does not exceed one story in height. Such building shall be of fire-resistance-rated construction with noncombustible exterior surfaces or noncombustible construction and shall be used principally for the storage of liquids; or
2. The exterior building wall adjacent to the storage area shall have a *fire-resistance rating* of not less than 2 hours, having no openings to above-grade areas within 10 feet (3048 mm) horizontally of such storage and no openings to below-grade areas within 50 feet (15 240 mm) horizontally of such storage.

The quantity of liquids stored adjacent to a building protected in accordance with Item 2 is allowed to exceed 1,100 gallons (4163 L), provided that the maximum quantity per pile does not exceed 1,100 gallons (4163 L) and each pile is separated by a 10-foot-minimum (3048 mm) clear space along the common wall.

Where the quantity stored exceeds 1,100 gallons (4163 L) adjacent to a building complying with Item 1, or the provisions of Item 1 cannot be met, a minimum distance in accordance with Table 5704.4.2, column 7 (“Minimum Distance to Lot Line of Property That Can Be Built Upon”) shall be maintained between buildings and the nearest container or portable tank.

- ❖ Storage of flammable and combustible liquid next to a building can expose the flammable and combustible liquid or the building to a fire; however, placing flammable and combustible liquids next to a building may be necessary for the operation of the facility. To control the fire exposure, both the flammable and combustible liquid next to the building and the building itself must be on the same property and under the same management. Two types of buildings may have flammable and combustible liquid stored adjacent to them.

A building of noncombustible construction not more than one story in height used for the storage of flammable and combustible liquid that is of noncombustible construction and not more than one story in height can have outdoor storage next to it. This building has fire protection features installed to protect the building and its contents from an interior fire, but is

not designed for the exterior fire exposure. Limiting the quantity of flammable and combustible liquid to 1,100 gallons (4136 L) in closed containers reduces the exterior fire exposure. If the exterior quantity of flammable and combustible liquid exceeds 1,100 gallons (4136 L) in closed containers, or this building does not meet the criteria for construction, height or use as storage for flammable and combustible liquids, the fire protection must be increased by using the distance between the building and the pile. The clearance required between the class of flammable and combustible liquid and the property line is to be used.

A building can have outdoor storage next to it when the building exterior wall adjacent to the storage of flammable and combustible liquid has a minimum 2-hour fire-resistance rating and protected openings. The restriction on openings above grade is to prevent an interior or exterior fire from bypassing the 2-hour fire-resistance-rated wall construction. The restriction on an opening below grade is to prevent flammable or combustible liquid or vapors from entering the building. The maximum quantity of flammable and combustible liquid is limited to 1,100 gallons (4136 L) in closed containers per pile. More than one pile can be located adjacent to this fire-resistant construction if the piles are located a minimum of 10 feet (3480 mm) from the building.

**5704.4.3 Spill control and secondary containment.** Storage areas shall be provided with spill control and secondary containment in accordance with Section 5703.4.

**Exception:** Containers stored on *approved* containment pallets in accordance with Section 5004.2.3 and containers stored in cabinets and lockers with integral spill containment.

- ❖ Outdoor storage of flammable or Class II combustible liquids must be controlled to prevent the spread of liquid. Section 5004.2 discusses the use of liquid-tight floors, curbs, dikes and drainage systems to divert the liquid to a location where it can be contained and safely handled.

The exception allows use of approved containment pallets as an acceptable alternative to an integral spill containment for containers. Section 5004.2.3 requires containment pallets to have a liquid-tight sump that is accessible for visible inspection with a minimum capacity of 66 gallons (250 L). The containment pallet must be designed to prevent the collection of rainwater in the sump.

**5704.4.4 Security.** Storage areas shall be protected against tampering or trespassers by fencing or other *approved* control measures.

- ❖ Unauthorized personnel may not know the potential dangers associated with flammable and combustible liquids. By controlling access to the outdoor storage facility, the owner will be able to monitor sources of heat and open flame.

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**5704.4.5 Protection from vehicles.** Guard posts or other means shall be provided to protect exterior storage tanks from vehicular damage. Where guard posts are installed, the posts shall be installed in accordance with Section 312.

- ❖ Protection from vehicle impact is provided by guard posts or other approved barriers. Section 312 contains the specifications for guard posts or the design forces required for an approved barrier to comply with the code.

**5704.4.6 Clearance from combustibles.** The storage area shall be kept free from weeds, debris and combustible materials not necessary to the storage. The area surrounding an exterior storage area shall be kept clear of such materials for a minimum distance of 15 feet (4572 mm).

- ❖ This is the same requirement as in Section 5704.4.2.3, with the additional focus that combustible materials be cleared for a minimum of 15 feet (4572 mm) around the storage area. Keeping combustibles a minimum of 15 feet (4572 mm) from each pile removes a fuel source from the immediate area.

**5704.4.7 Weather protection.** Weather protection for outdoor storage shall be in accordance with Section 5004.13.

- ❖ Weather protection is not required for outdoor storage; however, where an overhead structure is erected, it must conform to the requirements of Section 5004.13, which refers to the requirements of the IBC. The code reference notes that an open structure consisting of only a noncombustible roof structure does not change the storage facility to indoor storage. Natural airflow through a structure with no walls and only a noncombustible roof has sufficient ventilation for the storage area to be treated as outdoor storage for flammable and combustible liquids.

**5704.4.8 Empty containers and tank storage.** The storage of empty tanks and containers previously used for the storage of flammable or *combustible liquids*, unless free from explosive vapors, shall be stored as required for filled containers and tanks. Tanks and containers when emptied shall have the covers or plugs immediately replaced in openings.

- ❖ An empty container or portable tank is at least as dangerous as and possibly more dangerous than a full container or portable storage tank. There is a possibility that a vapor-air mixture in the container or portable storage tank could reach the LFL. This potential danger requires that empty containers and portable tanks be handled and stored as if full of flammable or combustible liquid.

## SECTION 5705

### DISPENSING, USE, MIXING AND HANDLING

**5705.1 Scope.** Dispensing, use, mixing and handling of flammable liquids shall be in accordance with Section 5703 and this section. Tank vehicle and tank car loading and unloading

and other special operations shall be in accordance with Section 5706.

**Exception:** Containers of organic coatings having no fire point and which are opened for pigmentation are not required to comply with this section.

- ❖ The dispensing, use, mixing and handling of flammable and combustible liquids provide opportunities for flammable and combustible liquids to become mixed with air. These operations can create a vapor-air mixture between the LFL and the UFL.

This section does not cover organic coating with no fire point used for pigmentation. This exception is also covered in Section 5701.1.

**5705.2 Liquid transfer.** Liquid transfer equipment and methods for transfer of Class I, II and IIIA liquids shall be *approved* and be in accordance with Sections 5705.2.1 through 5705.2.6.

- ❖ The low flash points for Class I, II and IIIA liquids require restrictions on transferring flammable and combustible liquids.

**5705.2.1 Pumps.** Positive-displacement pumps shall be provided with pressure relief discharging back to the tank, pump suction or other *approved* location, or shall be provided with interlocks to prevent over-pressure.

- ❖ Positive-displacement pumps are used because the pumping action is forward only and is a good pump for viscous fluids. The positive-displacement pump will create pressure waves in the fluid. A buildup of pressure can damage the pump and the piping system. This pressure buildup must be relieved by discharging the excess pressure into the tank or the pump suction (intake) or other approved location.

**5705.2.2 Pressured systems.** Where gases are introduced to provide for transfer of Class I liquids, or Class II and III liquids transferred at temperatures at or above their *flash points* by pressure, only inert gases shall be used. Controls, including pressure relief devices, shall be provided to limit the pressure so that the maximum working pressure of tanks, containers and piping systems cannot be exceeded. Where devices operating through pressure within a tank or container are used, the tank or container shall be a pressure vessel *approved* for the intended use. Air or oxygen shall not be used for pressurization.

**Exception:** Air transfer of Class II and III liquids at temperatures below their *flash points*.

- ❖ Compressed inert gas can be used to transfer flammable and combustible liquids. The inert gas prevents a vapor-air mixture from entering the LFL. The pressure system must be designed to prevent overloading any component of the system. An overload could create a leak or failure in the system.

The use of air as the compressed gas is permitted for Class II and III liquids under limited conditions. If the Class II and III liquids are to be dispensed at a

temperature below their flash points, there is no ignition source.

**5705.2.3 Piping, hoses and valves.** Piping, hoses and valves used in liquid transfer operations shall be *approved* or *listed* for the intended use.

❖ Piping, hoses and valves must be designed to function with the flammable or combustible liquid being transferred and at the temperatures and pressures of the dispensing system.

**5705.2.4 Class I, II and III liquids.** Class I liquids or, when heated to or above their flash points, Class II and Class III liquids, shall be transferred by one of the following methods:

1. From safety cans complying with UL 30.
2. Through an *approved* closed piping system.
3. From containers or tanks by an *approved* pump taking suction through an opening in the top of the container or tank.
4. For Class IB, IC, II and III liquids, from containers or tanks by gravity through an *approved* self-closing or automatic-closing valve where the container or tank and dispensing operations are provided with spill control and secondary containment in accordance with Section 5703.4. Class IA liquids shall not be dispensed by gravity from tanks.
5. *Approved* engineered liquid transfer systems.

**Exception:** Liquids in original shipping containers not exceeding a 5.3-gallon (20 L) capacity.

❖ This section correlates with Section 5701.5 and similar provisions in Section 18.4.2 of NFPA 30. The lower flash points for Class I liquids require that dispensing be done by an approved procedure to avoid the development of a vapor-air mixture above the LFL. Class II and III liquids, when they are heated up to or above their flash point, become as readily ignitable as Class I liquids.

The exception exempts original shipping containers no larger than 5.3 gallons (20 L) from the limitations of this section with the intent of preventing the use of temporary, single-use containers.

**5705.2.5 Manual container filling operations.** Class I liquids or Class II and Class III liquids that are heated up to or above their *flash points* shall not be transferred into containers unless the nozzle and containers are electrically interconnected. Acceptable methods of electrical interconnection include either of the following:

1. Metallic floor plates on which containers stand while filling, where such floor plates are electrically connected to the fill stem.
2. Where the fill stem is bonded to the container during filling by means of a bond wire.

❖ Flammable and combustible liquids being transferred near or above their flash points will generate vapors

and are near the point of ignition. Transferring these liquids to a container must be done in a manner to prevent a static spark. Grounding the container and the nozzle will remove the potential for an electrical hazard and the possibility for a spark to jump.

**5705.2.6 Automatic container-filling operations for Class I liquids.** Container-filling operations for Class I liquids involving conveyor belts or other automatic-feeding operations shall be designed to prevent static accumulations.

❖ The conveyor belts and other automatic-feeding equipment can develop a static charge. This static charge must be discharged by grounding the equipment so that no electrical potential can develop.

**5705.3 Use, dispensing and mixing inside of buildings.** Indoor use, dispensing and mixing of flammable and *combustible liquids* shall be in accordance with Section 5705.2 and Sections 5705.3.1 through 5705.3.5.3.

❖ The use, dispensing and mixing of flammable and combustible liquids creates an environment where vapor may accumulate. These vapors must be controlled to keep the vapor-air mixture from reaching the LFL.

**5705.3.1 Closure of mixing or blending vessels.** Vessels used for mixing or blending of Class I liquids and Class II or III liquids heated up to or above their *flash points* shall be provided with self-closing, tight-fitting, noncombustible lids that will control a fire within such vessel.

**Exception:** Where such devices are impractical, *approved* automatic or manually controlled fire-extinguishing devices shall be provided.

❖ Flammable and combustible liquids being mixed or blended near or above their flash points will generate vapors and are near the point of ignition. Using a vessel with a self-closing, tight-fitting, noncombustible lid will allow a fire to be contained within the vessel and for the fire to be cut off from any source of additional air.

The exception covers situations in which the use of a vessel to contain and extinguish the fire may be impractical. These processes can use a fire-extinguishing device that operates automatically or manually.

**5705.3.2 Bonding of vessels.** Where differences of potential could be created, vessels containing Class I liquids or liquids handled at or above their *flash points* shall be electrically connected by bond wires, ground cables, piping or similar means to a static grounding system to maintain equipment at the same electrical potential to prevent sparking.

❖ Static electricity will spark between surfaces with different electrical potential. This spark is an ignition source for Class I liquids. Vessels used to contain Class I liquids near or above their flash points are to be bonded using wires, ground cables, metal piping or other similar means that will carry current.

**5705.3.3 Heating, lighting and cooking appliances.** Heating, lighting and cooking appliances that utilize Class I liquids shall not be operated within a building or structure.

**Exception:** Operation in single-family *dwelling*s.

- ❖ The use of Class I liquids for the operation of heating, lighting and cooking appliances is not permitted inside of a building or structure except for a single-family dwelling.

**5705.3.4 Location of processing vessels.** Processing vessels shall be located with respect to distances to *lot lines* of adjoining property that can be built on, in accordance with Tables 5705.3.4(1) and 5705.3.4(2).

**Exception:** Where the exterior wall facing the adjoining *lot line* is a blank wall having a *fire-resistance rating* of not less than 4 hours, the *fire code official* is authorized to modify the distances. The distance shall be not less than that set forth in the *International Building Code*, and where Class IA or unstable liquids are involved, explosion control shall be provided in accordance with Section 911.

- ❖ Adjacent property is protected from processing vessels by separation. The three factors to be considered in determining the minimum clearance to protect property are the processing vessel operating pressure, the processing vessel capacity and the stability of the flammable or combustible liquid. The larger these factors become, the greater the clearance needed for safety. Processing an unstable flammable or combustible liquid will require a greater clearance than a similar operation using a stable flammable or combustible liquid. Tables 5705.3.4(1) and 5705.3.4(2) are used together to determine the minimum clearance required to protect adjacent property or important buildings on the same property.

The exception allows fire-resistant construction to be substituted for clearance to a property. A 4-hour fire-resistant exterior wall without any openings may be used to reduce the clearance to as little as 30 feet (9144 mm). The fire code official can use the requirements in IBC Section 415.6.1, along with a 4-hour fire-resistance-rated exterior wall without any openings, to approve smaller clearance to a property line. The clearances in IBC Section 415.6.1 establish the minimum clearance.

For process vessels using Class I liquids, this exception requires that the building be designed for explosion control as well as having a 4-hour fire-resistant exterior wall without any openings to take advantage of the smaller clearance.

Here are some sample problems to determine the separation for processing vessels:

**Example 1:**

Processing vessel:  
 Tank capacity = 800 gallons (3028 L)  
 Emergency relief venting = 2 psig (14 kPa)

Flammable liquid is stable.

Factors from Table 5705.3.4(1):  
 Emergency relief venting under 2.5 psig (17 kPa)  
 with stable liquid = 1

Minimum distance from Table 5705.3.4(2):  
 Distance from lot line or opposite side of public way = 15 feet (4572 mm)  
 Distance to nearest side of public way or important building = 5 feet (1524 mm)

Adjustment to the minimum distance resulting from emergency relief venting and stability of flammable liquid:

Distance from lot line or opposite side of public way:  
 1 (15 feet) = 15 feet (4572 mm)  
 Distance to nearest side of public way or important building:  
 1 (5 feet) = 5 feet (1524 mm)

**Example 2:**

Processing vessel:  
 Tank capacity = 800 gallons (3028 L)  
 Emergency relief venting = 3 psig (21 kPa)

Flammable liquid is stable.

Factors from Table 5705.3.4(1):  
 Emergency relief venting over 2.5 psig (17 kPa)  
 with stable liquid = 2.5

Minimum distance from Table 5705.3.4(2):  
 Distance from lot line or opposite side of public way = 15 feet (4572 mm)  
 Distance to nearest side of public way or important building = 5 feet (1524 mm)

Adjustment to the minimum distance resulting from emergency relief venting and stability of flammable liquid:

Distance from lot line or opposite side of public way:  
 2.5 (15 feet) = 37.5 feet (11 430 mm)  
 Distance to nearest side of public way or important building: 2.5 (5 feet) = 12.5 feet (3810 mm)

**Example 3:**

Processing vessel:  
 Tank capacity = 800 gallons (3028 L)  
 Emergency relief venting = 2 psig (14 kPa)

Flammable liquid is stable.

Factors from Table 5705.3.4(1):  
 Emergency relief venting under 2.5 psig (17 kPa)  
 with stable liquid = 1.5

Minimum distance from Table 5705.3.4(2):  
 Distance from lot line or opposite side of public way = 15 feet (4572 mm)  
 Distance to nearest side of public way or important building = 5 feet (1524 mm)

Adjustment to the minimum distance resulting from emergency relief venting and stability of flammable liquid:

Distance from lot line or opposite side of public way:  
1.5 (15 feet) = 22.5 feet (6858 mm)

Distance to nearest side of public way or important building: 1.5 (5 feet) = 7.5 feet (2286 mm)

**Example 4:**

Processing vessel:  
Tank capacity = 800 gallons (3028 L)  
Emergency relief venting = 3 psig (17 kPa)

Flammable liquid is unstable.

Factors from Table 5705.3.4(1):  
Emergency relief venting over 2.5 psig (17 kPa) with unstable liquid = 4

Minimum distance from Table 5705.3.4(2):  
Distance from lot line or opposite side of public way = 15 feet (4572 mm)  
Distance to nearest side of public way or important building = 5 feet (1524 mm)

Adjustment to the minimum distance resulting from emergency relief venting and stability of flammable liquid:

Distance from lot line or opposite side of public way:  
4 (15 feet) = 60 feet (18 288 mm)  
Distance to nearest side of public way or important building: 4 (5 feet) = 20 feet (6096 mm)

**TABLE 5705.3.4(1).** See below.

- ❖ Processing vessels containing flammable and combustible liquids must be located a minimum distance from property lines. The clearance is to protect flammable and combustible liquids from ignition sources that are not under the control of facility operators. This clearance also protects the property adjacent to the facility.

The separation varies depending on the type of flammable and combustible liquid and operating pressure of the processing vessel. The table divides flammable and combustible liquids into two categories: stable and unstable. An unstable liquid can self-react when exposed to heat. This autoignition property requires that the separation distance for an unstable flammable or combustible liquid be several times greater than for a stable flammable or combustible liquid.

The operating pressure of the processing vessel is divided into two categories: 2.5 psig (17 kPa) or less and over 2.5 psig (17 kPa). Pressure can be the cause of damage to the processing system, and this damage could result in a vapor or liquid leak of flammable or combustible liquid. A higher pressure would also force more vapor or liquid out of the system during a leak. To provide protection from a processing vessel with an operating pressure greater than 2.5 psig (17 kPa), the separation distance is several times greater than for a processing vessel with an operating pressure 2.5 psig (17 kPa) or less. These two factors are cumulative. One or both of these factors may increase the separation distance. This table provides the factor to be used to calculate the separation distance listed in Table 5705.3.4(2).

**TABLE 5705.3.4(2).** See page 57-56.

- ❖ The separation distance from the processing vessel is affected by the tank capacity of the processing vessel and the object. The larger the tank capacity, the greater the separation distance. This greater separation distance is to handle the potential pool fire with the tank capacity. The separation distance is greater to a property line to protect the processing vessel from ignition sources that are not under control of the facility operators, as well as to protect the adjacent property from a potential fire. The separation distance to an important building on the property or to a public way is the same or less than for a property line. Because buildings on the property are under the control and operation of the facility operators, these buildings should be maintained and operated to prevent an ignition source. The separation from a public way is handled the same as from an important building on the property. The public way does not have buildings that have ignition sources, so the potential is not as great as from an adjacent property.

**5705.3.5 Quantity limits for use.** Liquid use quantity limitations shall comply with Sections 5705.3.5.1 through 5705.3.5.3.

- ❖ The volume of flammable and combustible liquid is controlled to limit the potential fire. The smaller the quantity, the smaller the potential fire. The dispensing and mixing of flammable and combustible liquids indoors can generate a vapor-air mixture. If this vapor-air mixture is ignited, the size of the fire could increase because of the availability of flammable and combustible liquid in the area. Limiting the volume will help control the overall size of any fire.

**TABLE 5705.3.4(1)**  
**SEPARATION OF PROCESSING VESSELS FROM LOT LINES**

PROCESSING VESSELS WITH EMERGENCY RELIEF VENTING	LOCATION <sup>a</sup>	
	Stable liquids	Unstable liquids
Not in excess of 2.5 psig	Table 5705.3.4(2)	2.5 times Table 5705.3.4(2)
Over 2.5 psig	1.5 times Table 5705.3.4(2)	4 times Table 5705.3.4(2)

For SI: 1 pound per square inch gauge = 6.895 kPa.

a. Where protection of exposures by a public fire department or private fire brigade capable of providing cooling water streams on structures is not provided, distances shall be doubled.

**FLAMMABLE AND COMBUSTIBLE LIQUIDS**

**5705.3.5.1 Maximum allowable quantity per control area.**

Indoor use, dispensing and mixing of flammable and *combustible liquids* shall not exceed the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) and shall not exceed the additional limitations set forth in Section 5705.3.5.

**Exception:** Cleaning with Class I, II and IIIA liquids shall be in accordance with Section 5705.3.6.

Use of hazardous production material flammable and *combustible liquids* in Group H-5 occupancies shall be in accordance with Chapter 27.

❖ The maximum quantity per control area for use, dispensing and mixing of flammable and combustible liquids indoors is identical to that for indoor storage (see Section 5704.3.3) with some additional limits caused by the processing operation. Table 5003.1.1(1) contains the quantity permitted per control area. By limiting the quantity per control area, the flammable and combustible liquid hazard is reduced to a level that the fire protection can handle and that will not interfere with egress requirements, which results in a building that can function and provide a reasonable degree of safety.

Cleaning with Class I, II, and IIIA liquids is covered in Section 5705.3.6.

The use of flammable and combustible liquids in a semiconductor fabrication facility is covered by Chapter 27.

**5705.3.5.2 Occupancy quantity limits.** The following limits for quantities of flammable and *combustible liquids* used, dispensed or mixed based on occupancy classification shall not be exceeded:

**Exception:** Cleaning with Class I, II, or IIIA liquids shall be in accordance with Section 5705.3.6.

1. Group A occupancies: Quantities in Group A occupancies shall not exceed that necessary for demonstration, treatment, laboratory work, maintenance

purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).

2. Group B occupancies: Quantities in drinking, dining, office and school uses within Group B occupancies shall not exceed that necessary for demonstration, treatment, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
3. Group E occupancies: Quantities in Group E occupancies shall not exceed that necessary for demonstration, treatment, laboratory work, maintenance purposes and operation of equipment and shall not exceed quantities set forth in Table 5003.1.1(1).
4. Group F occupancies: Quantities in dining, office and school uses within Group F occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
5. Group I occupancies: Quantities in Group I occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
6. Group M occupancies: Quantities in dining, office and school uses within Group M occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
7. Group R occupancies: Quantities in Group R occupancies shall not exceed that necessary for maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).

**TABLE 5705.3.4(2)  
REFERENCE TABLE FOR USE WITH TABLE 5705.3.4(1)**

TANK CAPACITY (gallons)	MINIMUM DISTANCE FROM LOT LINE OF A LOT WHICH IS OR CAN BE BUILT UPON, INCLUDING THE OPPOSITE SIDE OF A PUBLIC WAY (feet)	MINIMUM DISTANCE FROM NEAREST SIDE OF ANY PUBLIC WAY OR FROM NEAREST IMPORTANT BUILDING ON THE SAME PROPERTY (feet)
275 or less	5	5
276 to 750	10	5
751 to 12,000	15	5
12,001 to 30,000	20	5
30,001 to 50,000	30	10
50,001 to 100,000	50	15
100,001 to 500,000	80	25
500,001 to 1,000,000	100	35
1,000,001 to 2,000,000	135	45
2,000,001 to 3,000,000	165	55
3,000,001 or more	175	60

For SI: 1 foot = 304.8 mm, 1 gallon = 3.785 L.

8. Group S occupancies: Quantities in dining and office uses within Group S occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment and shall not exceed quantities set forth in Table 5003.1.1(1).

❖ Flammable and combustible liquids may be used in occupancies other than Group H. The control of these liquids is based on the quantity in that occupancy.

The limitations for occupancies are based on the quantity limits for the storage of flammable and combustible liquids in containers and portable tanks in other occupancies. These other occupancies are not designed for flammable and combustible liquids so there are limitations on the quantity of flammable and combustible liquids that can be stored or used in these occupancies.

The use of flammable and combustible liquids must be consistent with the function of the occupancy. This prevents these other occupancies from being converted into Group H. The MAQs of flammable and combustible liquids are listed in Table 5003.1.1(1). The occupancies covered by these limitations are Groups A, B, E, F, I, M, R and S.

**5705.3.5.3 Quantities exceeding limits for control areas.**

Quantities exceeding the *maximum allowable quantity per control area* indicated in Sections 5705.3.5.1 and 5705.3.5.2 shall be in accordance with the following:

1. For *open systems*, indoor use, dispensing and mixing of flammable and *combustible liquids* shall be within a room or building complying with the *International Building Code* and Sections 5705.3.7.1 through 5705.3.7.5.
2. For *closed systems*, indoor use, dispensing and mixing of flammable and *combustible liquids* shall be within a room or building complying with the *International Building Code* and Sections 5705.3.7 through 5705.3.7.4 and Section 5705.3.7.6.

❖ It is possible to have a quantity of flammable and combustible liquids greater than allowed in Sections 5704.3.5 and 5705.3.5.2. To use, dispense and mix flammable and combustible liquids indoors in quantities larger than approved in this section, the building or room must be designed and constructed to provide additional protection. The design and construction requirements are based on the potential for the use, dispensing and mixing to generate vapors.

**5705.3.6 Cleaning with flammable and combustible liquids.** Cleaning with Class I, II and IIIA liquids shall be in accordance with Sections 5705.3.6.1 through 5705.3.6.2.7.

**Exceptions:**

1. Dry cleaning shall be in accordance with Chapter 21.
2. Spray-nozzle cleaning shall be in accordance with Section 2403.3.5.

❖ Cleaning machines using flammable or combustible liquids may generate a vapor-air mixture in the flammable range.

The use of cleaning machines using flammable or combustible liquids is regulated to control the vapor-air mixture, ignition sources and quantity of flammable or combustible liquids in the machines and the work area.

The exception directs the reader to other chapters for a detailed discussion of dry cleaning operations and spray nozzle cleaning.

**5705.3.6.1 Cleaning operations.** Class IA liquids shall not be used for cleaning. Cleaning with Class IB, IC or II liquids shall be conducted as follows:

1. In a room or building in accordance with Section 5705.3.7; or
2. In a parts cleaner *listed, labeled* and approved for the purpose in accordance with Section 5705.3.6.2.

**Exception:** Materials used in commercial and industrial process-related cleaning operations in accordance with other provisions of this code and not involving facilities maintenance cleaning operations.

❖ The lower flash point for a Class IA liquid is the reason for prohibiting its use as a cleaning solution. Class IB, IC and II liquids can be used in rooms designed and constructed with adequate fire protection, spillage control and ventilation, or in a machine that is designed to protect and control the liquid. The exception is provided to make it clear that process-related cleaning operations not considered part of facility maintenance cleaning and having a good safety history are not included in the operations regulated by this section.

**5705.3.6.2 Listed and approved machines.** Parts cleaning and degreasing conducted in *listed* and *approved* machines in accordance with Section 5705.3.6.1 shall be in accordance with Sections 5705.3.6.2.1 through 5705.3.6.2.7.

❖ Prior to the development of parts-washing machines, the typical method of washing automotive or other machinery parts was primitive and dangerous and typically consisted of allowing parts to soak in an open bucket of gasoline or low-flash-point solvent. Labeled machines used for the washing of parts are similar to the spray equipment cleaning machines discussed in the commentary to Section 2403.3.5.1. Such machines consist of a sink-like open container set upon a solvent reservoir or connected to it by approved hoses. A noncombustible lid on the sink is typically held in the open position by a fusible element that will melt and allow the lid to close in the event of a fire in the sink [see Commentary Figure 5705.3.6.2(1)].

Some labeled parts washing machines do not include a solvent reservoir but are simply a solvent-filled, sink-like rinsing tank in which parts may be soaked, manually agitated or scrubbed with a brush, but in which circulation of the solvent does not occur [see Commentary Figure 5705.3.6.2(2)]. The manufacturers' installation instructions are evaluated as part of the labeling process and, thus, must be care-

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fully followed when setting up and using these machines.

**5705.3.6.2.1 Solvents.** Solvents shall be classified and shall be compatible with the machines within which they are used.

❖ Manufacturers of labeled parts-washing machines either manufacture and market or recommend specific solvents that may be used in their machines in order to maintain the level of safety contemplated in the design of the machine. The testing and labeling process is based on only the manufacturer-recommended solvents being used in the machines. Typically, these are Class II or III solvents.

**5705.3.6.2.2 Machine capacities.** The quantity of solvent shall not exceed the *listed* design capacity of the machine for the solvent being used with the machine.

❖ The machine listing states the quantity of solvent permitted. The listing agency tests the machine to determine the maximum capacity of flammable or combustible liquid. The listing indicates that the machine is safe for use based on the quantities permitted.

**5705.3.6.2.3 Solvent quantity limits.** Solvent quantities shall be limited as follows:

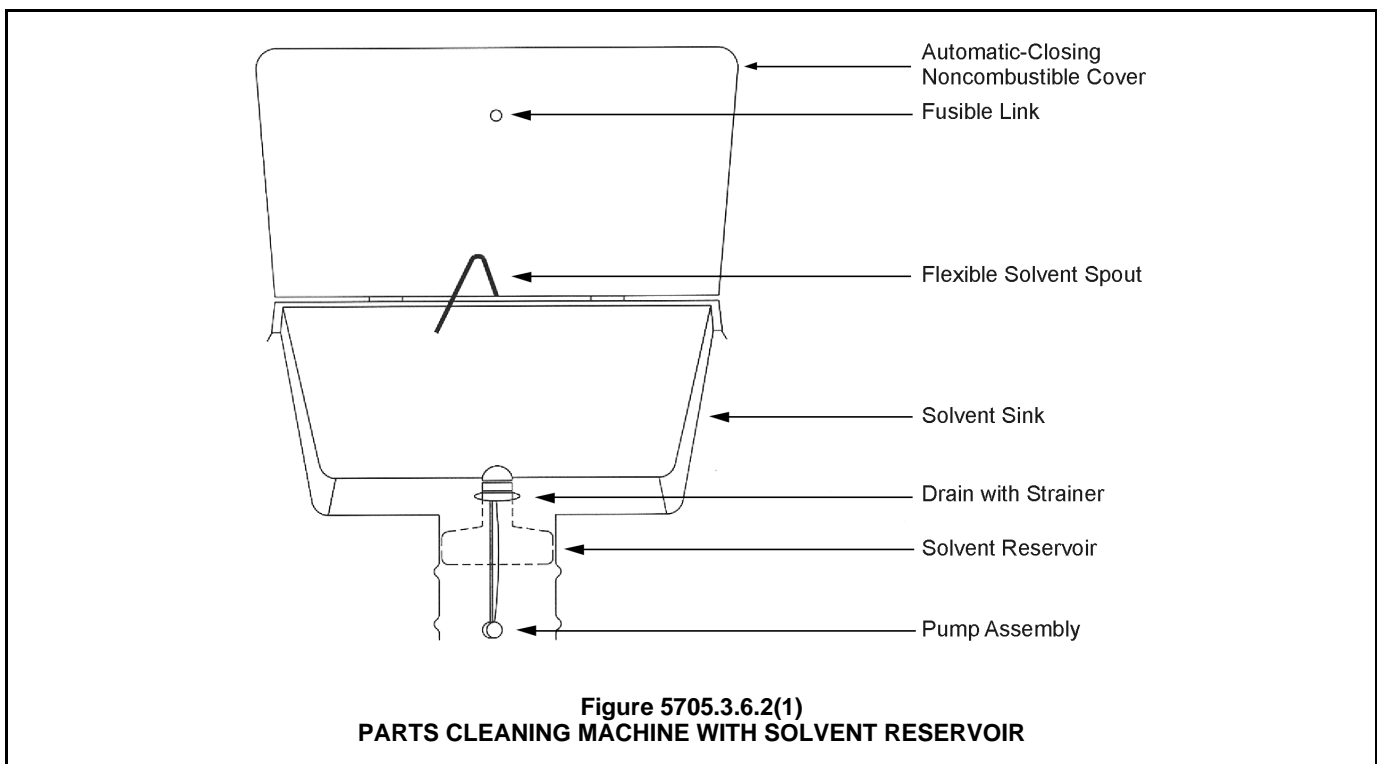
1. Machines without remote solvent reservoirs shall be limited to quantities set forth in Section 5705.3.5.
2. Machines with remote solvent reservoirs using Class I liquids shall be limited to quantities set forth in Section 5705.3.5.
3. Machines with remote solvent reservoirs using Class II liquids shall be limited to 35 gallons (132 L) per machine. The total quantities shall not exceed an aggregate

of 240 gallons (908 L) per *control area* in buildings not equipped throughout with an *approved* automatic sprinkler system and an aggregate of 480 gallons (1817 L) per *control area* in buildings equipped throughout with an *approved* automatic sprinkler system in accordance with Section 903.3.1.1.

4. Machines with remote solvent reservoirs using Class IIIA liquids shall be limited to 80 gallons (303 L) per machine.

❖ This section lists four restrictions on solvent quantities in machines:

1. A machine without a remote solvent reservoir is under the quantity limitations for a control area. The quantity of solvent in the machine and any other flammable and combustible liquids in the control area cannot exceed the maximum quantity permitted under Table 5003.1.1(1). These quantities can be increased by the application of Section 5705.3.5.3.
2. A machine with a remote solvent reservoir using Class IB or IC liquids is treated the same as a machine without a remote solvent reservoir.
3. A machine with a remote solvent reservoir using Class II liquid is permitted to have larger quantities than Table 5003.1.1(1) allows. The allowable quantity is increased even more if the control area has an automatic sprinkler system. The safety features built into the machine permit the increase in Class II solvent quantities for each machine and for the control area.



- 4. A machine with a remote solvent reservoir using Class IIIA liquid is permitted to have 80 gallons (303 L) per machine.

**5705.3.6.2.4 Immersion soaking of parts.** Work areas of machines with remote solvent reservoirs shall not be used for immersion soaking of parts.

- ❖ The action of immersion soaking of parts for a machine with a remote reservoir would have the effect of changing the machine from having a remote reservoir to a machine without a remote reservoir. This function of immersion soaking of parts changes the justification for permitting machines with a remote reservoir to have greater quantities of solvent than machines without a remote reservoir.

**5705.3.6.2.5 Separation.** Multiple machines shall be separated from each other by a distance of not less than 30 feet (9144 mm) or by a *fire barrier* with a minimum 1-hour *fire-resistance rating*.

- ❖ Machines are isolated from one another to reduce the potential of a fire from one machine affecting an adjacent machine. The isolation can be by a clearance of 30 feet (9144 mm) or by a 1-hour fire-resistant barrier.

**5705.3.6.2.6 Ventilation.** Machines shall be located in areas adequately ventilated to prevent accumulation of vapors.

- ❖ The machines are to be located in areas having mechanical or natural ventilation complying with Section 5004.3 to remove the vapors in order to prevent

the vapor-air mixture from accumulating in concentrations above the LFL.

**5705.3.6.2.7 Installation.** Machines shall be installed in accordance with their listings.

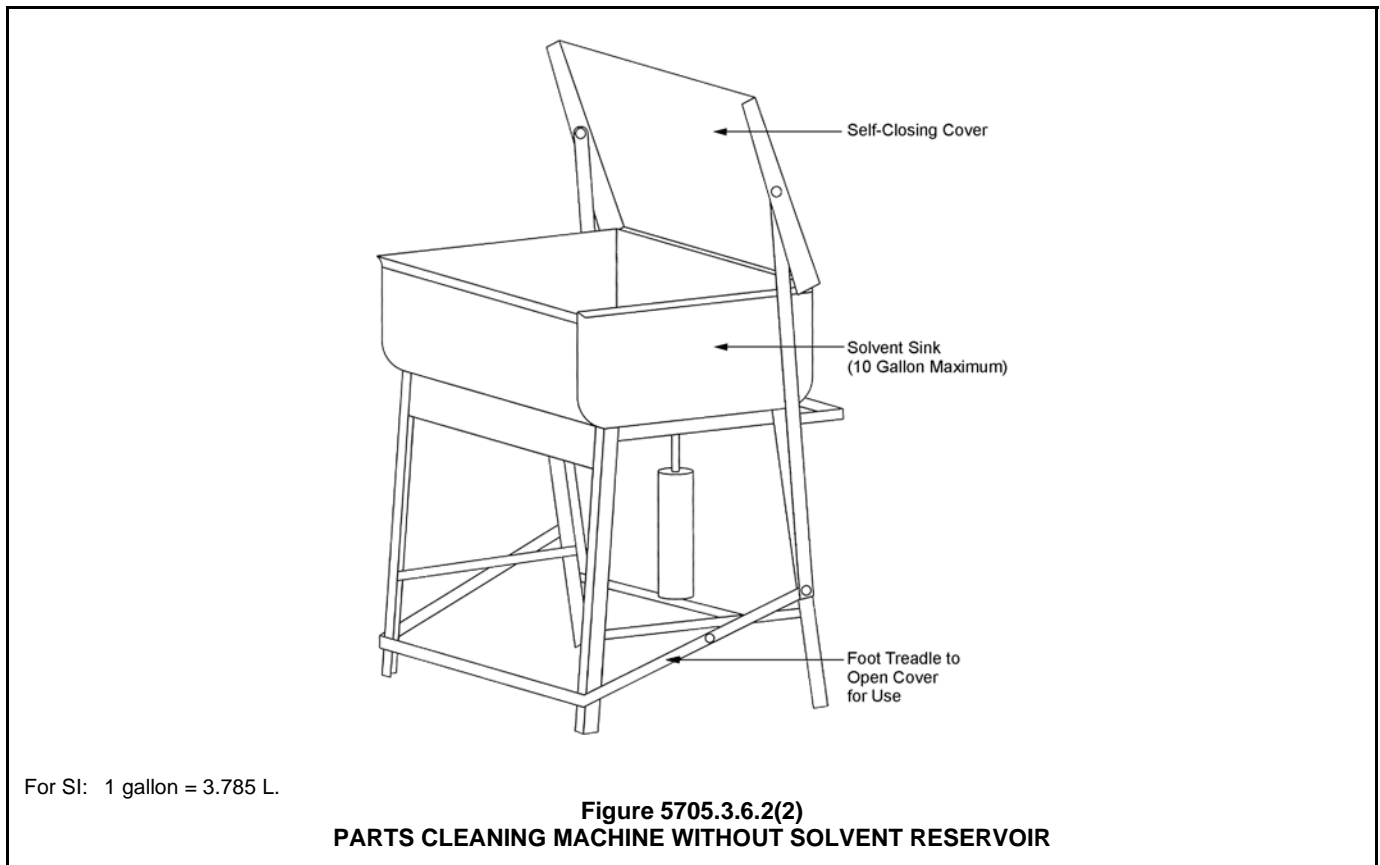
- ❖ Listed machines normally have written installation instructions that must be followed to make certain the machine is installed correctly. A machine installed incorrectly could generate vapors, leaks or sparks.

**5705.3.7 Rooms or buildings for quantities exceeding the maximum allowable quantity per control area.** Where required by Section 5705.3.5.3 or 5705.3.6.1, rooms or buildings used for the use, dispensing or mixing of flammable and *combustible liquids* in quantities exceeding the maximum allowable quantity per control area shall be in accordance with Sections 5705.3.7.1 through 5705.3.7.6.3.

- ❖ Some uses of flammable and combustible liquids may require a quantity that is greater than the MAQ. These sections state requirements for a room or building so that a greater quantity of flammable and combustible liquid may be used.

**5705.3.7.1 Construction, location and fire protection.** Rooms or buildings classified in accordance with the *International Building Code* as Group H-2 or H-3 occupancies based on use, dispensing or mixing of flammable or *combustible liquids* shall be constructed in accordance with the *International Building Code*.

- ❖ Group H-2 occupancy is the classification for a facility that uses or stores Class I, II or III liquids in open con-



tainers and systems, or in closed containers or systems under a pressure greater than 15 psig (103 kPa). Group H-3 occupancy is the classification for a facility that uses or stores Class I, II or III liquids in closed containers or systems under a pressure of 15 psig (103 kPa) or less. IBC Sections 414 and 415 give guidance for determining the construction requirements for these two occupancies.

**5705.3.7.2 Basements.** In rooms or buildings classified in accordance with the *International Building Code* as Group H-2 or H-3, dispensing or mixing of flammable or *combustible liquids* shall not be conducted in *basements*.

❖ The mixing and dispensing of flammable and combustible liquids may generate vapors. The accumulation of flammable and combustible liquids or vapors in a basement could develop into a hazardous condition. These operations are prohibited in a basement of a Group H-2 or H-3 occupancy.

**5705.3.7.3 Fire protection.** Rooms or buildings classified in accordance with the *International Building Code* as Group H-2 or H-3 occupancies shall be equipped with an *approved* automatic fire-extinguishing system in accordance with Chapter 9.

❖ Group H-2 and H-3 occupancies must have an automatic sprinkler system according to Section 903.2.5.1 of the code. Any building that can be classified as a Group H-2 or H-3 occupancy that is not equipped with an automatic sprinkler system is in violation of the code.

**5705.3.7.4 Doors.** Interior doors to rooms or portions of such buildings shall be self-closing fire doors in accordance with the *International Building Code*.

❖ Interior fire-resistance-rated wall construction used to separate or isolate portions of a building must have fire-resistance-rated doors in the openings in the wall. A fire-resistance-rated interior door consists of the door, door frame, latches, locks, hinges, closers and any other hardware that is necessary for the door to function. The door is to be self-closing to ensure that the door is not open during a fire. IBC Section 716 contains the criteria for the fire-resistance-rated door. Any obstruction to the operation of or damage to this door that prevents the door from forming a barrier with the fire-resistance-rated wall must be removed or repaired.

**5705.3.7.5 Open systems.** Use, dispensing and mixing of flammable and *combustible liquids* in *open systems* shall be in accordance with Sections 5705.3.7.5.1 through 5705.3.7.5.3.

❖ Rooms and buildings where flammable and combustible liquids are dispensed, mixed or used in open containers or open systems must be designed and constructed to control the potential fire hazard created by the liquid and its vapor.

**5705.3.7.5.1 Ventilation.** Continuous mechanical ventilation shall be provided at a rate of not less than 1 cfm per square

foot [0.00508 m<sup>3</sup>/(s · m<sup>2</sup>)] of floor area over the design area. Provisions shall be made for introduction of makeup air in such a manner to include all floor areas or pits where vapors can collect. Local or spot ventilation shall be provided where needed to prevent the accumulation of hazardous vapors. Ventilation system design shall comply with the *International Building Code* and *International Mechanical Code*.

**Exception:** Where natural ventilation can be shown to be effective for the materials used, dispensed or mixed.

❖ The requirements of this section for a mechanical ventilation system are identical to those in Section 5004.3. The mechanical ventilation system must remove the vapors to prevent accumulation in concentrations in the flammable range for the flammable and combustible liquids being used.

The exception allows use of natural ventilation complying with Section 5004.3 that can be demonstrated to be effective for the flammable and combustible liquids being used.

**5705.3.7.5.2 Explosion control.** Explosion control shall be provided in accordance with Section 911.

❖ Refer to Section 911 for deflagration venting to direct the force of an explosion out of the structure into an unoccupied area. That section also references NFPA 69, which may require monitoring of gases and other methods to suppress factors affecting an explosion.

**5705.3.7.5.3 Spill control and secondary containment.** Spill control shall be provided in accordance with Section 5703.4 where Class I, II or IIIA liquids are dispensed into containers exceeding a 1.3-gallon (5 L) capacity or mixed or used in open containers or systems exceeding a 5.3-gallon (20 L) capacity. Spill control and secondary containment shall be provided in accordance with Section 5703.4 where the capacity of an individual container exceeds 55 gallons (208 L) or the aggregate capacity of multiple containers or tanks exceeds 100 gallons (378.5 L).

❖ Spill control complying with Section 5703.4 must be built into a room or a building where Class I, II or IIIA liquids are used in open containers or open systems that dispense the liquid into containers greater than 1.3 gallons (5 L), or mixed or used in quantities greater than 5.3 gallons (20 L). In addition, secondary containment must be provided for individual containers greater than 55 gallons or multiple containers with an aggregate capacity greater than 100 gallons. This section references Section 5004.2, which discusses the use of liquid-tight floors, curbs, dikes and drainage systems to divert the liquid to a location where it can be contained and safely handled.

**5705.3.7.6 Closed systems.** Use or mixing of flammable or *combustible liquids* in *closed systems* shall be in accordance with Sections 5705.3.7.6.1 through 5705.3.7.6.3.

❖ Rooms and buildings where flammable and combustible liquids are dispensed, mixed or used in closed systems must be designed and constructed to control the potential fire hazard created by the liquid and its vapor.

**5705.3.7.6.1 Ventilation.** *Closed systems* designed to be opened as part of normal operations shall be provided with ventilation in accordance with Section 5705.3.7.5.1.

❖ The requirements of this section for a mechanical ventilation system are identical to those in Section 5004.3. The mechanical ventilation system must remove the vapors to prevent accumulation in concentrations in the flammable range for the flammable and combustible liquids being used. Natural ventilation complying with Section 5004.3 that can be demonstrated to be effective for the flammable and combustible liquids being used is an acceptable alternative.

**5705.3.7.6.2 Explosion control.** Explosion control shall be provided where an explosive environment can occur as a result of the mixing or use process. Explosion control shall be designed in accordance with Section 911.

**Exception:** Where process vessels are designed to contain fully the worst-case explosion anticipated within the vessel under process conditions considering the most likely failure.

❖ Refer to Section 911 for deflagration venting to direct the force of an explosion out of the structure into an unoccupied area. This section also references NFPA 69, which may require monitoring of gases and other methods to suppress factors affecting an explosion.

The exception recognizes that a closed system can be designed to absorb the forces from an internal explosion. If the closed system is designed to resist the worst-case explosion, the room or building does not have to be designed to comply with Section 911.

**5705.3.7.6.3 Spill control and secondary containment.** Spill control shall be provided in accordance with Section 5703.4 where flammable or *combustible liquids* are dispensed into containers exceeding a 1.3-gallon (5 L) capacity or mixed or used in open containers or systems exceeding a 5.3-gallon (20 L) capacity. Spill control and secondary containment shall be provided in accordance with Section 5703.4 where the capacity of an individual container exceeds 55 gallons (208 L) or the aggregate capacity of multiple containers or tanks exceeds 1,000 gallons (3785 L).

❖ Spill control complying with Section 5703.4 must be designed into a room or a building where flammable or combustible liquids are used in closed systems that dispense the liquid into containers greater than 1.3 gallons (5 L), or mixed or used in quantities greater than 5.3 gallons (20 L). In addition, secondary containment must be provided for individual containers greater than 55 gallons or multiple containers with an aggregate capacity greater than 1,000 gallons. This section references Section 5004.2, which discusses the use of liquid-tight floors, curbs, dikes and drainage systems to divert the liquid to a location where it can be contained and safely handled. This is identical to the requirement for an open system except that the aggregate quantity for a closed sys-

tem is 1,000 gallons (3785 L) and only 100 gallons (379 L) for an open system.

**5705.3.8 Use, dispensing and handling outside of buildings.** Outside use, dispensing and handling shall be in accordance with Sections 5705.3.8.1 through 5705.3.8.4.

Dispensing of liquids into motor vehicle fuel tanks at motor fuel-dispensing facilities shall be in accordance with Chapter 23.

❖ Dispensing and handling of flammable and combustible liquids outside of a building requires that the location be protected from ignition sources by separating it from structures, property lines, streets, etc. Spill control and drainage control must be designed into the outside location to prevent flammable and combustible liquids from affecting other areas. Dispensing into motor vehicle fuel tanks is covered in Chapter 23.

**5705.3.8.1 Spill control.** Outside use, dispensing and handling areas shall be provided with spill control as set forth in Section 5703.4.

❖ Outside use, dispensing and handling areas must have spill control according to Section 5703.4. Section 5004.2 discusses the use of liquid-tight floors, curbs, dikes and drainage systems to divert the liquid to a location where it can be contained and safely handled.

**5705.3.8.2 Location on property.** Dispensing activities that exceed the quantities set forth in Table 5705.3.8.2 shall not be conducted within 15 feet (4572 mm) of buildings or combustible materials or within 25 feet (7620 mm) of building openings, *lot lines*, public streets, public alleys or *public ways*. Dispensing activities that exceed the quantities set forth in Table 5705.3.8.2 shall not be conducted within 15 feet (4572 mm) of storage of Class I, II or III liquids unless such liquids are stored in tanks that are *listed* and *labeled* as 2-hour protected tank assemblies in accordance with UL 2085.

#### Exceptions:

1. The requirements shall not apply to areas where only the following are dispensed: Class III liquids; liquids that are heavier than water; water-miscible liquids; and liquids with viscosities greater than 10,000 centipoise (cp) (10 Pa • s).
  2. Flammable and *combustible liquid* dispensing in refineries, chemical plants, process facilities, gas and crude oil production facilities and oil-blending and packaging facilities, terminals and bulk plants.
- ❖ The dispensing of flammable and combustible liquids can generate vapors. Flammable and combustible liquid exceeding the quantities in Table 5705.3.8.2 must be separated from combustibles, buildings, other property, public property, etc. The separation allows the vapor to disperse to a vapor-air mixture below its LFL. The clearance isolates the dispensing area from ignition sources and other fuel sources. When the quantity of flammable and combustible liquid exceeds the quantity in Table 5705.3.8.2, the

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

storage tank for the flammable or combustible liquid must be protected by separation from the dispensing area. The clearance between the storage tank and the dispensing area can be reduced if the storage tank is a 2-hour protected tank in accordance with UL 2085.

Exception 1 is based on the viscosity of the hazardous liquid. Class III liquids, liquids heavier than water, water-miscible liquids and liquids with a viscosity greater than 10,000 cp need not be isolated. The isolation is not necessary for liquids with higher flash points, liquids that can be mixed with water, liquids that can be covered by a barrier of water or liquids that are slow moving. These liquids can be controlled by other procedures rather than mandate a clearance.

Exception 2 exempts facilities that are designed specifically for processing, manufacturing, storage or transfer of large quantities of flammable and combustible liquids.

**Table 5705.3.8.2.** See below.

- ❖ The quantities of flammable and combustible liquids dispensed outdoors are limited when the dispensing is near a building. This table contains the maximum volume of flammable and combustible liquids that can be dispensed in an outdoor control area. An outdoor control area is defined as the area within 15 feet (4572 mm) of a building, combustible materials or a Class I, II or III liquid storage tank unless the storage tanks have 2-hour fire protection, or within 25 feet (7620 mm) of a building opening, a property line, a street, an alley or a public way. This quantity limit protects the vapor of flammable or combustible liquids from ignition sources. It also protects the building and adjacent property from a fire involving flammable or combustible liquids.

**TABLE 5705.3.8.2**  
**MAXIMUM ALLOWABLE QUANTITIES FOR**  
**DISPENSING OF FLAMMABLE AND COMBUSTIBLE**  
**LIQUIDS IN OUTDOOR CONTROL AREAS<sup>a, b</sup>**

CLASS OF LIQUID	QUANTITY (gallons)
Flammable	
Class IA	10
Class IB	15
Class IC	20
Combination Class IA, IB and IC	30 <sup>c</sup>
Combustible	
Class II	30
Class IIIA	80
Class IIIB	3,300

For SI: 1 gallon = 3.785 L.

- a. For definition of "Outdoor Control Area," see Section 5002.1.
- b. The fire code official is authorized to impose special conditions regarding locations, types of containers, dispensing units, fire control measures and other factors involving fire safety.
- c. Containing not more than the maximum allowable quantity per control area of each individual class.

**5705.3.8.3 Location of processing vessels.** Processing vessels shall be located with respect to distances to *lot lines* that can be built on in accordance with Table 5705.3.4(1).

**Exception:** In refineries and distilleries.

- ❖ Processing vessels outside of a building must be treated the same as a processing vessel inside a building. The exception covers refineries and distilleries, which are designed specifically for the processing of large quantities of hazardous liquids.

**5705.3.8.4 Weather protection.** Weather protection for outdoor use shall be in accordance with Section 5005.3.9.

- ❖ Weather protection is not required for outdoor use; however, where an overhead protective structure is erected, it must conform to the requirements of Section 5004.13. That section also notes that an open structure consisting of only a noncombustible roof structure does not change the storage facility to being considered as indoor storage, provided that the roof structure is constructed in accordance with the construction requirements of IBC Section 414.6.1. Natural airflow through a structure with no walls and only a noncombustible roof is considered sufficient ventilation for the storage area to be treated as outdoor storage for flammable and combustible liquids.

**5705.4 Solvent distillation units.** Solvent distillation units shall comply with Sections 5705.4.1 through 5705.4.9.

- ❖ Distillation units generate vapors by heating the flammable and combustible liquids. This process must be controlled to prevent the vapor-air mixture from reaching the LFL or an ignition source from coming into contact with the mixture.

**5705.4.1 Unit with a capacity of 60 gallons or less.** Solvent distillation units used to recycle Class I, II or IIIA liquids having a distillation chamber capacity of 60 gallons (227 L) or less shall be *listed, labeled* and installed in accordance with Section 5705.4 and UL 2208.

**Exceptions:**

1. Solvent distillation units used in continuous through-put industrial processes where the source of heat is remotely supplied using steam, hot water, oil or other heat transfer fluids, the temperature of which is below the auto-ignition point of the solvent.
  2. *Approved* research, testing and experimental processes.
- ❖ Distillation equipment with a distillation chamber (sometimes called a "still pot") of the stated size can be manufactured so that the design, construction and operation can be tested for safety. These units are tested, listed and labeled according to this section and UL 2208. There are two exceptions to these requirements: Exception 1 exempts solvent distillation units that are in continuous operation, do not use heat from fluid transfer and the heat transfer fluid

temperature is below the autoignition point. Exception 2 exempts solvent distillation units that are approved for research or experimental processes from complying with this section or UL 2208.

**5705.4.2 Units with a capacity exceeding 60 gallons.** Solvent distillation units used to recycle Class I, II or IIIA liquids, having a distillation chamber capacity exceeding 60 gallons (227 L) shall be used in locations that comply with the use and mixing requirements of Section 5705 and other applicable provisions in this chapter.

- ❖ Distillation units with a distillation chamber (sometimes called a “still pot”) of the stated size must be treated as if the unit was for mixing and blending. The operation involves vapor concentrations from flammable or combustible liquid that may be in the flammable range.

**5705.4.3 Prohibited processing.** Class I, II and IIIA liquids that are also classified as unstable (reactive) shall not be processed in solvent distillation units.

**Exception:** Appliances *listed* for the distillation of unstable (reactive) solvents.

- ❖ Flammable and combustible liquids that are also unstable are prohibited from being processed by a solvent distillation unit. An unstable liquid can self-react when exposed to heat. By removing the heat source, the code is reducing the potential danger.

The exception recognizes that some equipment is designed for the safe distillation of unstable flammable and combustible liquids and is listed for that function.

**5705.4.4 Labeling.** A permanent label shall be affixed to the unit by the manufacturer. The label shall indicate the capacity of the distillation chamber, and the distance the unit shall be placed away from sources of ignition. The label shall indicate the products for which the unit has been *listed* for use or refer to the instruction manual for a list of the products.

- ❖ The distillation unit is to be permanently labeled to provide information for its safe operation. At minimum, the label must indicate capacity, clearance from ignition sources and information on products the unit is designed to process.

**5705.4.5 Manufacturer’s instruction manual.** An instruction manual shall be provided. The manual shall be readily available for the user and the *fire code official*. The manual shall include installation, use and servicing instructions. It shall identify the liquids for which the unit has been *listed* for distillation purposes along with each liquid’s *flash point* and auto-ignition temperature. For units with adjustable controls, the manual shall include directions for setting the heater temperature for each liquid to be instilled.

- ❖ Manufacturers of listed and labeled equipment normally prepare an instruction manual for their equipment. The instruction manual is to be available for use by installation personnel and the fire code official. The instruction manual should include not only installation instructions, but also operating procedures and the products the unit can distill.

**5705.4.6 Location.** Solvent distillation units shall be used in locations in accordance with the listing. Solvent distillation units shall not be used in *basements*.

- ❖ The label and instruction manual will include information on acceptable locations, separation from ignition sources, light sources, ventilation, etc. Regardless of the instruction manual, the distillation unit cannot be located in a basement. Vapors that may escape during distillation will normally be heavier than air and settle to the lower levels, making their removal from a basement location difficult.

**5705.4.7 Storage of liquids.** Distilled liquids and liquids awaiting distillation shall be stored in accordance with Section 5704.

- ❖ Distilled liquids governed by this section will always present storage hazards. It is therefore important that all the liquids, both before and after distillation, be handled as prescribed in Section 5704.

**5705.4.8 Storage of residues.** Hazardous residue from the distillation process shall be stored in accordance with Section 5704 and Chapter 50.

- ❖ The residue from the distillation process may be a flammable or combustible material, or some other hazardous material. The instruction manual must include information on the products that the distillation unit is designed to process and identify the residue. If the residue is hazardous, it must be handled according to Section 5704 and Chapter 50.

**5705.4.9 Portable fire extinguishers.** *Approved* portable fire extinguishers shall be provided in accordance with Section 906. Not less than one portable fire extinguisher having a rating of not less than 40-B shall be located not less than 10 feet (3048 mm) or more than 30 feet (9144 mm) from any solvent distillation unit.

- ❖ Portable fire extinguishers must be located in clear view and within 30 feet (9144 mm) of the distillation unit. The 40-B portable fire extinguisher is for the control of small flammable liquid fires.

**5705.5 Alcohol-based hand rubs classified as Class I or II liquids.** The use of wall-mounted dispensers containing alcohol-based hand rubs classified as Class I or II liquids shall be in accordance with all of the following:

1. The maximum capacity of each dispenser shall be 68 ounces (2 L).
2. The minimum separation between dispensers shall be 48 inches (1219 mm).
3. The dispensers shall not be installed above, below, or closer than 1 inch (25 mm) to an electrical receptacle, switch, appliance, device or other ignition source. The wall space between the dispenser and the floor or intervening counter top shall be free of electrical receptacles, switches, appliances, devices or other ignition sources.
4. Dispensers shall be mounted so that the bottom of the dispenser is not less than 42 inches (1067 mm) and not

more than 48 inches (1219 mm) above the finished floor.

5. Dispensers shall not release their contents except when the dispenser is manually activated. Facilities shall be permitted to install and use automatically activated “touch free” alcohol-based hand-rub dispensing devices with the following requirements:

- 5.1. The facility or persons responsible for the dispensers shall test the dispensers each time a new refill is installed in accordance with the manufacturer’s care and use instructions.

- 5.2. Dispensers shall be designed and must operate in a manner that ensures accidental or malicious activations of the dispensing device are minimized. At a minimum, all devices subject to or used in accordance with this section shall have the following safety features:

- 5.2.1. Any activations of the dispenser shall only occur when an object is placed within 4 inches (98 mm) of the sensing device.

- 5.2.2. The dispenser shall not dispense more than the amount required for hand hygiene consistent with label instructions as regulated by the United States Food and Drug Administration (USFDA).

- 5.2.3. An object placed within the activation zone and left in place will cause only one activation.

6. Storage and use of alcohol-based hand rubs shall be in accordance with the applicable provisions of Sections 5704 and 5705.

7. Dispensers installed in occupancies with carpeted floors shall only be allowed in smoke compartments or *fire areas* equipped throughout with an *approved* automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2.

❖ Alcohol-based hand rubs are essential in health care occupancies for controlling the spread of unwanted infectious microorganisms. Numerous studies conducted on their use have found that they provide a vastly improved efficacy against numerous pathogens and are more effective for a longer time period when compared to simple hand-washing with soap and water.

In 2003, the American Hospital Association (AHA) approached the International Code Council® (ICC®) regarding the safety issues related to the use of alcohol-based hand rub products in health care occupancies. Specifically, they were concerned that some code officials had prohibited the installation of alcohol-based hand rub dispensers in corridors. The ICC Board of Directors appointed an ad hoc committee with broad representation to address the issue and develop appropriate code change proposals.

Alcohol-based hand rub solution is typically pack-

aged in pump bottles or soft bladders for insertion into a pump dispenser. They are closed to the atmosphere with no mixing or refilling of containers. The likelihood of ignition is extremely remote. But if, somehow, a dispenser were to ignite, the burn characteristics must be understood to better determine the risks. The American Society of Healthcare Engineering (ASHE) commissioned a fire modeling analysis to study the overall effects of placing dispensers in corridors and suites of rooms. The Fire Dynamics Simulator (FDS) Version 3.1, published by the National Institute of Standards and Technology (NIST), was used for the modeling. The results of the FDS model were used to evaluate the potential hazards and characteristics including:

- Tenability of the space.
- Ignition of adjacent fuel loads/combustibles.
- Sprinkler activation.

Because the modeling was for sick patients incapable of self-preservation, the tenability value (temperature, visibility, and carbon monoxide) was chosen to be conservative (factor of safety of 10).

Several fire scenarios were modeled with variables of dispenser volume, spacing and space configuration. In each scenario, a “worst case” was simulated that consisted of a complete rupture of the dispenser and simultaneous ignition resulting in a pool fire. The results indicated that both ethyl and isopropyl alcohol-based products met the tenability criteria when controlled in volume (1.2-L container in a corridor and 2 L in a room) and in dispenser placement [6-foot wide (1829 mm) corridor]. The results showed that with adequate horizontal spacing [48 inches (1219 mm)], none of the fuel targets put into the models would ignite, indicating that the proposed spacing was reasonable to prevent additional ignition. Sprinkler activation was not predicted for most of the scenarios modeled (activation only occurred with the larger 2-L spills). Additionally, the results indicate the scenario with a carpeted floor is a concern because of visibility problems.

This section and Section 5705.5.1 are the result of the ICC ad hoc committee’s consensus proposals and also reflect the opinion of the *International Fire Code*® (IFC®) Code Development Committee and the ICC membership as to the appropriate level of regulation necessary in allowing the use of alcohol-based hand rubs in buildings. The intent of this section is to provide a means to avoid the code being utilized as a barrier to infection control while maintaining an appropriate level of safety in health care and other environments where alcohol-based hand rubs are an important public health tool. It should be noted that, while the AHA approached the ICC specifically regarding health care occupancies, these provisions are not occupancy-specific because the ad hoc committee recognized that the use of alcohol-based

hand rubs affects more than a single occupancy group. Section 5001.1 also provides the necessary cross reference to these new provisions to prevent the alcohol-based hand rub dispensers from being considered the same as other flammable liquids, thereby exempting them from the MAQs in Table 5003.1.1(1).

This section outlines seven criteria that are necessary, based in large part on fire modeling tests, to safely utilize alcohol-based hand rubs in buildings of any occupancy. These include regulating fuel load by controlling dispenser volume based on established industry practices (Criterion 1), minimizing the potential for ignition of other dispensers by establishing horizontal spacing requirements (Criterion 2), minimizing the potential for ignition of dispensers by establishing clearance requirements to ignition sources (Criterion 3), access to dispensers consistent with accessibility requirements (Criterion 4), control of dripping (Criterion 5), regulation of alcohol-based hand rub storage and use (Criterion 6) and mitigation of concerns over the visibility of leakage on carpeting by requiring sprinkler protection (Criterion 7). When combined, these controls effectively manage and minimize fire risk while allowing personnel ready access to these hand hygiene products.

It should be noted that, originally, Criterion 5 of this section allowed only manual activation of hand-rub dispensers by actual physical contact with the unit, which did not include operation by means of an infrared sensor. Infrared sensor operation has gained in popularity as use of hand rubs has grown, resulting in a revised Criterion 5 that allows “touch-free” operation. Touch-free dispensers have been developed to eliminate the need for persons to touch the dispenser, which creates a potential path for passing of microorganisms. (See Commentary Figure 5705.5) The devices are generally activated by passing hands in front of or under an optical scanner, which dispenses a specified dose of ethanol or isopropanol. In addition to compliance with all seven of the requirements of this section, these particular dispensers are required by Item 5.1 to be tested each time the dispenser is refilled in accordance the manufacturer’s care and use instructions. Item 5.2 requires that dispenser design be such that accidental or malicious activations are minimized. To prevent accidental activation of the device, such as when a cart or gurney is pushed near a touch-free dispenser, Item 5.2.1 only allows dispenser activation to occur when an object is placed within 4 inches (102 mm) of the device. Item 5.2.2 requires the discharged dose to be limited to the amount necessary for hand hygiene. Finally, if a cart or other object is “parked” close enough to activate the dispenser, Item 5.2.3 only allows the device to dispense a single dose, i.e., the dispenser must be designed so that it does not

continue to cycle and dispense additional doses of alcohol.

**5705.5.1 Corridor installations.** In addition to the provisions of Section 5705.5, where wall-mounted dispensers containing alcohol-based hand rubs are installed in *corridors* or rooms and areas open to the corridor, they shall be in accordance with all of the following:

1. Level 2 and 3 aerosol containers shall not be allowed in *corridors*.
2. The maximum capacity of each Class I or II liquid dispenser shall be 41 ounces (1.21 L) and the maximum capacity of each Level 1 aerosol dispenser shall be 18 ounces (0.51 kg).
3. The maximum quantity allowed in a *corridor* within a *control area* shall be 10 gallons (37.85 L) of Class I or II liquids or 1135 ounces (32.2 kg) of Level 1 aerosols, or a combination of Class I or II liquids and Level 1 aerosols not to exceed, in total, the equivalent of 10 gallons (37.85 L) or 1,135 ounces (32.2 kg) such that the sum of the ratios of the liquid and aerosol quantities divided by the allowable quantity of liquids and aerosols, respectively, shall not exceed one.
4. The minimum *corridor* width shall be 72 inches (1829 mm).
5. Projections into a *corridor* shall be in accordance with Section 1003.3.3.

❖ Though these provisions are not occupancy specific, in health care occupancies, hand rub dispensers are often located in the patient room. But due to a variety of clinical issues, including patient population (psychiatric and pediatric patients), care delivery models (teaching hospitals with multiple residents in contact with patients) and patient room space constraints



**Figure 5705.5**  
**TOUCH-FREE ALCOHOL-BASED**  
**HAND RUB DISPENSER**  
 (Credit: Gojo Industries, Akron, OH)

(lack of available space for mounting a dispenser away from constricted traffic flow, electric outlets and electric switches), mounting the dispenser in the patient room may not be possible or may compromise effective patient care. In these instances, dispensers mounted in the corridor best meet the clinical needs.

Because of life safety hazards in health care occupancies, various medical professional associations approached the ASHE to address the challenge of understanding, and if possible, allowing the installation of a number of dispensers containing a small quantity of alcohol-based hand rubs (Class 1B flammable liquid) in egress corridors of health care facilities. Concerned that the introduction of alcohol-based hand rubs may simply be reducing one risk while creating another (fire safety), ASHE responded by investigating the current use of alcohol-based hand rub solutions and analyzing the risks presented by them. The ad hoc committee reviewed the results of the fire modeling in corridors and recommended the five safeguards contained in this section.

Item 1 prohibits the use of Level 2 and 3 aerosol alcohol-based hand rub dispensers in exit access corridors because aerosol containers were not considered in the fire modeling for the original project. This exclusion is appropriate for Level 2 and 3 aerosols but not for Level 1 aerosols, because they are treated as ordinary combustibles by the code. Their alcohol content is equal to that currently permitted in Class I and II liquid or gel hand sanitizers. The aerosol industry was asked to conduct its own study and testing to show that aerosols could also be allowed in the same application. The study determined that the hazard of level 1 aerosols was less than that of the allowed Class I and II liquid or gel hand sanitizers and that the aerosol can would not release its contents before the temperatures in the corridor became untenable.

Item 2 is based on the fact that the fire modeling and aerosol industry test results indicated that both ethyl and isopropyl alcohol-based products and aerosols met the tenability criteria when controlled in volume to 41-ounce (1158 g) liquid and 18-ounce (509 g) aerosol dispenser containers in corridors. For aerosols, the capacity is based on typical industry containers.

In arriving at Item 3, based on usage patterns, primarily in health care occupancies, it was felt that establishing a 10-gallon (38 L) allowable amount or combined liquid and aerosol equivalent allowable amount, which is well below the MAQs for Class I or II liquids in Table 5003.1.1(1), is reasonable and safe for any occupancy. A simple method of calculating the maximum allowable quantity of combined liquids and aerosols is provided and is based on IBC Section 508.4.2. For example, if 4 gallons (15 L) of liquids and 500 ounces (14 175 g) of aerosols were present, 4/10 plus 500/1135 is less than one and, therefore, below the maximum combined allowable quantity.

Item 4 is based on the performance of the dis-

penser containers in the fire modeling scenarios.

Item 5 is intended to prevent dispensers from projecting into areas over walking surfaces as regulated in Section 1003.3.3. See the commentary for Section 1003.3.3 for further discussion of projections into the required width of corridors.

## SECTION 5706 SPECIAL OPERATIONS

**5706.1 General.** This section shall cover the provisions for special operations that include, but are not limited to, storage, use, dispensing, mixing or handling of flammable and *combustible liquids*. The following special operations shall be in accordance with Sections 5701, 5703, 5704 and 5705, except as provided in Section 5706.

1. Storage and dispensing of flammable and *combustible liquids* on farms and construction sites.
2. Well drilling and operating.
3. Bulk plants or terminals.
4. Bulk transfer and process transfer operations utilizing tank vehicles and tank cars.
5. Tank vehicles and tank vehicle operation.
6. Refineries.
7. Vapor recovery and vapor-processing systems.

❖ This section covers uses of flammable and combustible liquids for specific occupancies. The requirements of Sections 5701, 5703, 5704 and 5705 apply to these occupancies except as specifically directed by Section 5706.

**5706.2 Storage and dispensing of flammable and combustible liquids on farms and construction sites.** Permanent and temporary storage and dispensing of Class I and II liquids for private use on farms and rural areas and at construction sites, earth-moving projects, gravel pits or borrow pits shall be in accordance with Sections 5706.2.1 through 5706.2.8.1.

**Exception:** Storage and use of fuel oil and containers connected with oil-burning equipment regulated by Section 603 and the *International Mechanical Code*.

❖ These provisions cover both temporary and permanent storage and dispensing of Class I and II liquids, primarily in outdoor locations.

The exception covers storage and use of fuel oil for building service equipment, which is governed by other sections of the code as well as other codes.

**5706.2.1 Combustibles and open flames near tanks.** Storage areas shall be kept free from weeds and extraneous combustible material. Open flames and smoking are prohibited in flammable or *combustible liquid* storage areas.

❖ The area around storage tanks is to be free of combustibles and ignition sources.

**5706.2.2 Marking of tanks and containers.** Tanks and containers for the storage of liquids above ground shall be conspicuously marked with the name of the product that they

contain and the words: FLAMMABLE—KEEP FIRE AND FLAME AWAY. Tanks shall bear the additional marking: KEEP 50 FEET FROM BUILDINGS.

- ❖ When hazardous liquids are stored in above-ground storage tanks, signs containing safety information and warnings to keep ignition sources from the tanks are to be placed on the tanks.

**5706.2.3 Containers for storage and use.** Metal containers used for storage of Class I or II liquids shall be in accordance with DOTn requirements or shall be of an *approved* design.

Discharge devices shall be of a type that do not develop an internal pressure on the container. Pumping devices or *approved* self-closing faucets used for dispensing liquids shall not leak and shall be well-maintained. Individual containers shall not be interconnected and shall be kept closed when not in use.

Containers stored outside of buildings shall be in accordance with Section 5704 and the *International Building Code*.

- ❖ Individual containers for the storage of Class I and II liquids are to be DOT approved or approved for use with these liquids. To prevent leaks and spills, the discharge devices must be designed for use with Class I and II liquids. The storage of individual containers outside of a building is to be treated as outside storage under Section 5704.

**5706.2.4 Permanent and temporary tanks.** The capacity of permanent above-ground tanks containing Class I or II liquids shall not exceed 1,100 gallons (4164 L). The capacity of temporary above-ground tanks containing Class I or II liquids shall not exceed 10,000 gallons (37 854 L). Tanks shall be of the single-compartment design.

**Exception:** Permanent above-ground tanks of greater capacity that meet the requirements of Section 5704.2.

- ❖ Above-ground, single-compartment storage tanks must be used for permanent or temporary storage of Class I and II liquids. Permanent storage is limited to 1,100 gallons (3785 L) where temporary storage is limited to 10,000 gallons (37 854 L).

The exception covers permanent storage of quantities larger than 1,100 gallons (3785 L). Requirements for permanent storage of larger quantities are contained in Section 5704.2.

**5706.2.4.1 Fill-opening security.** Fill openings shall be equipped with a locking closure device. Fill openings shall be separate from vent openings.

- ❖ Security to prevent the dispensing of flammable and combustible liquids is provided by a locking device on the fill opening. Fill openings are separated from vent openings so that locking does not affect the operation of the vent openings.

**5706.2.4.2 Vents.** Tanks shall be provided with a method of normal and emergency venting. Normal vents shall be in accordance with Section 5704.2.7.3.

Emergency vents shall be in accordance with Section 5704.2.7.4. Emergency vents shall be arranged to discharge

in a manner that prevents localized overheating or flame impingement on any part of the tank in the event that vapors from such vents are ignited.

- ❖ The need for normal venting and emergency venting is no different than required on other storage tanks. The requirements of Sections 5702.7.3 and 5702.7.4 apply to venting the storage tanks.

**5706.2.4.3 Location.** Tanks containing Class I or II liquids shall be kept outside and not less than 50 feet (15 240 mm) from buildings and combustible storage. Additional distance shall be provided where necessary to ensure that vehicles, equipment and containers being filled directly from such tanks will not be less than 50 feet (15 240 mm) from structures, haystacks or other combustible storage.

- ❖ The clearance required between above-ground storage tanks containing Class I and II liquids, combustible storage and other structures is 50 feet (15 240 mm). Vehicles, equipment or containers using the storage tank are to have a clearance of 50 feet (15 240 mm) from these same ignition sources and fuel sources.

**5706.2.4.4 Locations where above-ground tanks are prohibited.** The storage of Class I and II liquids in above-ground tanks is prohibited within the limits established by law as the limits of districts in which such storage is prohibited (see Section 3 of the Sample Legislation for Adoption of the *International Fire Code* on page xxi).

- ❖ This section enables the adopting jurisdiction to prohibit the installation of above-ground tanks in certain geographic areas by enumerating them in the adopting legislation. Page xxi of the code (ix in this volume) shows a sample ordinance containing blank space for the jurisdiction to fill in describing the particular areas where above-ground tank installations are to be prohibited.

**5706.2.5 Type of tank.** Tanks shall be provided with top openings only or shall be elevated for gravity discharge.

- ❖ Above-ground storage tanks are to be top-opening or gravity discharge tanks.

**5706.2.5.1 Tanks with top openings only.** Tanks with top openings shall be mounted in accordance with either of the following:

1. On well-constructed metal legs connected to shoes or runners designed so that the tank is stabilized and the entire tank and its supports can be moved as a unit.
2. For stationary tanks, on a stable base of timbers or blocks approximately 6 inches (152 mm) in height that prevents the tank from contacting the ground.

- ❖ Above-ground storage tanks with top openings must be on stable supports of metal or wood. The above-ground storage tank shell is not to be in contact with the ground. Stability is extremely important because movement of the tank could damage the tank shell or connected piping, creating a leak.

**5706.2.5.1.1 Pumps and fittings.** Tanks with top openings only shall be equipped with a tightly and permanently

attached, *approved* pumping device having an *approved* hose of sufficient length for filling vehicles, equipment or containers to be served from the tank. Either the pump or the hose shall be equipped with a padlock to its hanger to prevent tampering. An effective antisiphoning device shall be included in the pump discharge unless a self-closing nozzle is provided. Siphons or internal pressure discharge devices shall not be used.

❖ Above-ground storage tanks with top openings must be equipped with an approved, permanently attached tight-fitting pump and hose. Pumps must be secured against unauthorized use and designed to prevent siphoning through the pump.

**5706.2.5.2 Tanks for gravity discharge.** Tanks with a connection in the bottom or the end for gravity-dispensing liquids shall be mounted and equipped as follows:

1. Supports to elevate the tank for gravity discharge shall be designed to carry all required loads and provide stability.
2. Bottom or end openings for gravity discharge shall be equipped with a valve located adjacent to the tank shell that will close automatically in the event of fire through the operation of an effective heat-activated releasing device. Where this valve cannot be operated manually, it shall be supplemented by a second, manually operated valve.

The gravity discharge outlet shall be provided with an *approved* hose equipped with a self-closing valve at the discharge end of a type that can be padlocked to its hanger.

❖ Above-ground storage tanks for gravity discharge must be elevated on stable supports capable of supporting all required loads. Valves for bottom and end openings must be located adjacent to the tank shell. These valves are to be heat-activated valves that must close in case of a fire. The valve is to prevent the tank from dispensing its content through one of the tank openings. If the heat-activated valve cannot be manually operated, a second manually operable valve must be installed. The hose must be secured to prevent unauthorized operation.

**5706.2.6 Spill control drainage control and diking.** Indoor storage and dispensing areas shall be provided with spill control and drainage control as set forth in Section 5703.4. Outdoor storage areas shall be provided with drainage control or diking as set forth in Section 5704.2.10.

❖ Indoor above-ground storage tanks must be equipped to control leaks and spills to prevent the spread of liquid and vapors. Section 5004.2 discusses the use of liquid-tight floors, curbs, dikes and drainage systems to divert the liquid to a location where it can be contained and safely handled. Section 5004.3 discusses mechanical and natural exhaust systems. The exhaust system is to remove the vapors to prevent them from accumulating in concentrations in the flammable range of the vapor.

Outdoor above-ground storage tanks must use

dikes and drainage to control leaks or spills from a tank. The flammable and combustible liquids must be collected in a manner that will not endanger other tanks, properties or waterways.

The fire code official has the authority to consider installations where the use of drainage and dikes may not be necessary, such as listed secondary containment tanks in lieu of drainage control or dikes. The secondary containment system in these tanks is considered equivalent to drainage and diking.

**5706.2.7 Portable fire extinguishers.** Portable fire extinguishers with a minimum rating of 20-B:C and complying with Section 906 shall be provided where required by the *fire code official*.

❖ Portable fire extinguishers must be in clear view and within 50 feet (15 240 mm) of the storage tank. The 20-B:C portable fire extinguisher is for the control of small flammable liquid fires and electrical fires.

**5706.2.8 Dispensing from tank vehicles.** Where *approved*, liquids used as fuels are allowed to be transferred from tank vehicles into the tanks of motor vehicles or special equipment, provided:

1. The tank vehicle's specific function is that of supplying fuel to motor vehicle fuel tanks.
2. The dispensing hose does not exceed 100 feet (30 480 mm) in length.
3. The dispensing nozzle is an *approved* type.
4. The dispensing hose is properly placed on an *approved* reel or in a compartment provided before the tank vehicle is moved.
5. Signs prohibiting smoking or open flames within 25 feet (7620 mm) of the vehicle or the point of refueling are prominently posted on the tank vehicle.
6. Electrical devices and wiring in areas where fuel dispensing is conducted are in accordance with NFPA 70.
7. Tank vehicle-dispensing equipment is operated only by designated personnel who are trained to handle and dispense motor fuels.
8. Provisions are made for controlling and mitigating unauthorized discharges.

❖ The dispensing of fuel at a farm or construction site may be from a tanker to a vehicle or equipment. Dispensing fuel using a tanker requires the tanker to be designed and equipped specifically for fueling other vehicles and equipment. The dispensing line cannot exceed 100 feet (30 480 mm). The tanker operator is responsible for the dispensing line and the tanker, so these two items need to be in the same area. The dispensing cannot be done around an ignition source, such as smoking, or electrical equipment that is not classified for use in hazardous locations. Note that these provisions apply to all classes of liquid fuel, not Class II and III only, as in Section 5706.5.4.5.

**5706.2.8.1 Location.** Dispensing from tank vehicles shall be conducted not less than 50 feet (15 240 mm) from structures or combustible storage.

- ❖ Fuel must be dispensed at least 50 feet (15 240 mm) from a structure or combustible storage to prevent the accumulation of vapor-air mixtures, control ignition sources and to minimize the potential loss of property.

**5706.3 Well drilling and operating.** Wells for oil and natural gas shall be drilled and operated in accordance with Sections 5706.3.1 through 5706.3.8.

- ❖ The drilling and operation of a well may allow the escape of vapors from petroleum products. Well drilling and operation are essential for the extraction of petroleum products. The requirements are to prevent the vapor-air mixture from reaching the LFL, to prevent ignition sources from being in the immediate vicinity and other functions to control the hazard.

**5706.3.1 Location.** The location of wells shall comply with Sections 5706.3.1.1 through 5706.3.1.3.2.

- ❖ The location of wells is regulated to permit the dilution of any vapor-air mixtures that may escape the well head or facilities, prevent ignition sources from being in close proximity and other safety and security to control the hazards created by the well drilling and production operation.

**5706.3.1.1 Storage tanks and sources of ignition.** Storage tanks or boilers, fired heaters, open-flame devices or other sources of ignition shall not be located within 25 feet (7620 mm) of well heads. Smoking is prohibited at wells or tank locations except as designated and in *approved* posted areas.

**Exception:** Engines used in the drilling, production and serving of wells.

- ❖ Sources of ignition from equipment and open flame must be kept a minimum of 25 feet (7620 mm) from a well head. The distance provides an area for any vapors leaking from the well head to dilute to a vapor-air mixture below the LFL.

Only equipment necessary for the drilling, installation and production of the well is permitted. These engines are designed for this use.

**5706.3.1.2 Streets and railways.** Wells shall not be drilled within 75 feet (22 860 mm) of any dedicated public street, highway or nearest rail of an operating railway.

- ❖ Sources of ignition from vehicle and rail traffic are to be kept a minimum of 75 feet (22 860 mm) from a well head. Vehicle traffic can produce sources of ignition from either the vehicle or the passengers. The rail traffic can produce sources of ignition by engine, brakes or personnel. The distance provides an area for any vapors leaking from the well head to dilute to a vapor-air mixture below the LFL.

**5706.3.1.3 Buildings.** Wells shall not be drilled within 100 feet (30 480 mm) of buildings not necessary to the operation of the well.

- ❖ Sources of ignition from buildings are to be kept a minimum of 100 feet (30 480 mm) from a well head. Building equipment and occupancy can become sources of ignition. The building also represents a potential for loss of life and property. The distance provides an area for any vapors leaking from the well head to dilute to a vapor-air mixture below the LFL.

The separation distance also protects buildings and their occupants from hazards associated with the well and its operation.

A building necessary for operation of a well need not be remote from the well head, but it should be constructed and maintained to prevent it from becoming an ignition source.

**5706.3.1.3.1 Group A, E or I buildings.** Wells shall not be drilled within 300 feet (91 440 mm) of buildings with an occupancy in Group A, E or I.

- ❖ Sources of ignition from a Group A, E, or I occupancy must be kept a minimum of 300 feet (91 440 mm) from a well head. Building equipment and occupancy can become sources of ignition. Because these occupancies also represent a potential for loss of life and property, the clearance has been increased over that required for other occupancies. The distance provides an area for any vapors leaking from the well head to dilute to a vapor-air mixture below the LFL.

**5706.3.1.3.2 Existing wells.** Where wells are existing, buildings shall not be constructed within the distances set forth in Section 5706.3.1 for separation of wells or buildings.

- ❖ The same problems exist regardless of whether the well head is installed first or the building is constructed first. The code regulates whichever is built second. The well head clearance to the building is to be maintained.

**5706.3.2 Waste control.** Control of waste materials associated with wells shall comply with Sections 5706.3.2.1 and 5706.3.2.2.

- ❖ Liquids containing petroleum or its products are to be disposed of according to federal and state laws and any local ordinances.

**5706.3.2.1 Discharge on a street or water channel.** Liquids containing crude petroleum or its products shall not be discharged into or on streets, highways, drainage canals or ditches, storm drains or flood control channels.

- ❖ The discharge of liquids containing petroleum or its products is prohibited. The unregulated discharge of liquids containing petroleum or its products can place flammable or combustible liquids and gases into contact with ignition sources. The liquids and their vapors also can become environmental problems and can cause health concerns.

**5706.3.2.2 Discharge and combustible materials on ground.** The surface of the ground under, around or near wells, pumps, boilers, oil storage tanks or buildings shall be kept free from oil, waste oil, refuse or waste material.

❖ The discharge of liquids containing petroleum or its products is prohibited. The unregulated discharge of liquids containing petroleum or its products can place flammable or combustible liquids and gases into contact with ignition sources and become a source of environmental contamination and health hazards.

**5706.3.3 Sumps.** Sumps associated with wells shall comply with Sections 5706.3.3.1 through 5706.3.3.3.

❖ Sumps and basins may be necessary to temporarily store drilling materials that may contain petroleum products. The use of sumps and basins is regulated to control their size, service life and security.

**5706.3.3.1 Maximum width.** Sumps or other basins for the retention of oil or petroleum products shall not exceed 12 feet (3658 mm) in width.

❖ The maximum width of 12 feet (3658 mm) for a sump or basin keeps the surface area of the sump or basin at a size that will help in diluting the vapor-air mixture to below the LFL and that is readily accessible to fire-fighting equipment. The narrow width allows the vapors of the petroleum products to diffuse with a greater volume of air than if the sump or basin were allowed to be larger.

**5706.3.3.2 Backfilling.** Sumps or other basins for the retention of oil or petroleum products larger than 6 feet by 6 feet by 6 feet (1829 mm by 1829 mm by 1829 mm) shall not be maintained longer than 60 days after the cessation of drilling operations.

❖ The temporary storage of oil or petroleum products in sumps or basins larger than 6 feet by 6 feet by 6 feet (1829 mm by 1829 mm by 1829 mm) is restricted to no more than 60 days. Drilling operations may require that materials containing petroleum products be stored in a sump or basin. This open storage may allow the vapors from the petroleum products to mix with air, creating a hazard. To control the hazard, the use of a sump or basin is restricted to a maximum of 60 days. The storage of oil or petroleum products in volumes greater than the capacity of these sumps or basins needs to be equipped with safety features to control the hazard.

**5706.3.3.3 Security.** Sumps, diversion ditches and depressions used as sumps shall be securely fenced or covered.

❖ Security for the open storage of oil or petroleum products in sumps, basins and ditches is needed to prevent unauthorized access. Individuals may not realize the hazard presented by this open storage and accidentally introduce ignition sources.

**5706.3.4 Prevention of blowouts.** Protection shall be provided to control and prevent the blowout of a well. Protection

equipment shall meet federal, state and other applicable jurisdiction requirements.

❖ A blowout is the uncontrolled release of oil, gas or water from a well. Pressure relief equipment must be installed and maintained on a drilling apparatus to reduce the likelihood of an uncontrolled release of oil, gas or water. Oil vapor or gas escaping in an uncontrolled manner poses an extreme hazard and can generate enough energy to ignite during its release, which can lead to the destruction of the drilling apparatus or the site itself with a corresponding potential for loss of life. Federal and state regulations govern the protective equipment required to prevent blowouts.

**5706.3.5 Storage tanks.** Storage of flammable or *combustible liquids* in tanks shall be in accordance with Section 5704. Oil storage tanks or groups of tanks shall have posted in a conspicuous place, on or near such tank or tanks, an *approved* sign with the name of the *owner* or operator, or the lease number and the telephone number where a responsible person can be reached at any time.

❖ The storage requirements for flammable and combustible liquids at a well head are identical to those for any other storage of flammable and combustible liquids. Clearances, security, corrosion protection, drainage, diking, signing, etc., are to control ignition sources, combustibles, leaks, spills, etc.

**5706.3.6 Soundproofing.** Where soundproofing material is required during oil field operations, such material shall be noncombustible.

❖ The operation of drilling, pumping and dispensing equipment may create noise that needs to be reduced. Soundproofing material must not add a fuel source around the flammable or combustible liquids. Combustible soundproofing is to be used only at locations that are beyond the distances for the clearance between flammable and combustible liquids and combustibles.

**5706.3.7 Signs.** Well locations shall have posted in a conspicuous place on or near such tank or tanks an *approved* sign with the name of the *owner* or operator, name of the leasee or the lease number, the well number and the telephone number where a responsible person can be reached at any time. Such signs shall be maintained on the premises from the time materials are delivered for drilling purposes until the well is abandoned.

❖ Well heads may or may not have personnel on site, so it may be necessary to contact the operator/owner. The signs need to provide sufficient information so the operator/owner can be notified of any problems with the site.

**5706.3.8 Field-loading racks.** Field-loading racks shall be in accordance with Section 5706.5.

❖ See the commentary to Section 5706.5.

**5706.4 Bulk plants or terminals.** Portions of properties where flammable and *combustible liquids* are received by tank vessels, pipelines, tank cars or tank vehicles and stored or blended in bulk for the purpose of distribution by tank vessels, pipelines, tanks cars, tank vehicles or containers shall be in accordance with Sections 5706.4.1 through 5706.4.10.4.

❖ Bulk plants and terminals are used for the blending or transferring of large volumes of flammable and combustible liquids. Besides normally involving large quantities of flammable and combustible liquids, these facilities can create numerous opportunities for leaks, spills and the escape of vapors.

**5706.4.1 Building construction.** Buildings shall be constructed in accordance with the *International Building Code*.

❖ These facilities are hazardous occupancies divided into Group H-2 or H-3. Sections 414 and 415 of the IBC contain guidance for determining the construction requirements for these two occupancies.

**5706.4.2 Means of egress.** Rooms in which liquids are stored, used or transferred by pumps shall have *means of egress* arranged to prevent occupants from being trapped in the event of fire.

❖ The means of egress from rooms where flammable or combustible liquids are present must be an escape route for personnel that cannot be blocked in case of a fire. This may require having more than one independent escape route or having a short travel distance to a door exiting the room. Doors exiting rooms should swing in the direction of exit travel.

**5706.4.3 Heating.** Rooms in which Class I liquids are stored or used shall be heated only by means not constituting a source of ignition, such as steam or hot water. Rooms containing heating appliances involving sources of ignition shall be located and arranged to prevent entry of flammable vapors.

❖ Heating units that use open flames and other ignition sources must be separated from areas where flammable or combustible liquids are present or where vapors from these liquids can migrate. The low flash point for Class I liquids requires that where Class I liquid is present, either steam or hot water must be used as the heat source.

**5706.4.4 Ventilation.** Ventilation shall be provided for rooms, buildings and enclosures in which Class I liquids are pumped, used or transferred. Design of ventilation systems shall consider the relatively high specific gravity of the vapors. Where natural ventilation is used, adequate openings in outside walls at floor level, unobstructed except by louvers or coarse screens, shall be provided. Where natural ventilation is inadequate, mechanical ventilation shall be provided in accordance with the *International Mechanical Code*.

❖ The low flash point for Class I liquids requires that where Class I liquid is present the area be ventilated to prevent the accumulation of a vapor-air mixture above the LFL. Ventilation can be either mechanical

or natural. Because the vapors from Class I liquids are heavier than air, the ventilation must remove the air at the floor level. Natural ventilation must be to the outdoors.

**5706.4.4.1 Basements and pits.** Class I liquids shall not be stored or used within a building having a *basement* or pit into which flammable vapors can travel, unless such area is provided with ventilation designed to prevent the accumulation of flammable vapors therein.

❖ The vapors from Class I liquids are heavier than air, so these vapors can settle from the upper floors and accumulate in a basement or pit. In a building with a basement or pit that has any connection between the basement or pit and upper floors, the basement or pit is not to be used for the storage or mixing of Class I liquids. The vapors from Class I liquids may settle in the basement or pit through openings for mechanical systems or that are part of an egress path, creating a hazard. Unless there is a mechanical or natural ventilation system that is adequate for removing accumulated vapors from the basement or pit, the building cannot be used for the storage or mixing of Class I liquids.

**5706.4.4.2 Dispensing of Class I liquids.** Containers of Class I liquids shall not be drawn from or filled within buildings unless a provision is made to prevent the accumulation of flammable vapors in hazardous concentrations. Where mechanical ventilation is required, it shall be kept in operation while flammable vapors could be present.

❖ Containers of Class I liquids cannot be dispensed or filled in a building unless ventilation is installed to remove accumulated vapors. To make certain that vapors do not accumulate, any mechanical ventilation system must operate continuously or whenever containers of Class I liquids are open.

**5706.4.5 Storage.** Storage of Class I, II and IIIA liquids in bulk plants shall be in accordance with the applicable provisions of Section 5704.

❖ The potential hazards of storing Class I, II and IIIA liquids are the same for bulk plants and terminals as for any other facility. The requirements for storage are covered in Section 5704.

**5706.4.6 Overfill protection of Class I and II liquids.** Manual and automatic systems shall be provided to prevent overfill during the transfer of Class I and II liquids from mainline pipelines and marine vessels in accordance with API 2350.

❖ Overfill protection must comply with API 2350. This standard is limited to above-ground tanks that receive liquids from main pipelines or marine vessels. The standard accomplishes overfill protection by awareness of available tank capacity and inventory and careful monitoring and control of product movement.

**5706.4.7 Wharves.** This section shall apply to all wharves, piers, bulkheads and other structures over or contiguous to navigable water having a primary function of transferring liq-

uid cargo in bulk between shore installations and tank vessels, ships, barges, lighter boats or other mobile floating craft.

**Exception:** Marine motor fuel-dispensing facilities in accordance with Chapter 23.

❖ This section regulates the transfer of flammable and combustible liquids in bulk quantities between a shore installation and any marine vessel or other floating craft, except for marine motor fuel-dispensing facilities, which are covered in Chapter 23.

**5706.4.7.1 Transferring approvals.** Handling packaged cargo of liquids, including full and empty drums, bulk fuel and stores, over a wharf during cargo transfer shall be subject to the approval of the wharf supervisor and the senior deck officer on duty.

❖ The handling and transferring of flammable and combustible liquids, including any container that contains or has contained these liquids, must be approved by the personnel responsible for the wharf. This will usually be the wharf supervisor or senior deck officer. Because these materials represent a potential hazard if mishandled, the person in authority must be aware of the potential hazard and approve the process being used.

**5706.4.7.2 Transferring location.** Wharves at which liquid cargoes are to be transferred in bulk quantities to or from tank vessels shall be not less than 100 feet (30 480 mm) from any bridge over a navigable waterway; or from an entrance to, or superstructure of, any vehicular or railroad tunnel under a waterway. The termination of the fixed piping used for loading or unloading at a wharf shall be not less than 200 feet (60 960 mm) from a bridge or from an entrance to, or superstructures of, a tunnel.

❖ Transportation facilities on a wharf must be protected by separation from public thoroughways. The separation distance required for vessel loading or unloading is 100 feet (30 480 mm). Fixed piping must terminate 200 feet (60 960 mm) from the same thoroughways.

**5706.4.7.3 Superstructure and decking material.** Superstructure and decking shall be designed for the intended use. Decking shall be constructed of materials that will afford the desired combination of flexibility, resistance to shock, durability, strength and *fire resistance*.

❖ The wharf superstructure and decking materials have to be selected to withstand normal loads, impact loads, fire exposure, environmental factors, etc.

**5706.4.7.4 Tanks allowed.** Tanks used exclusively for ballast water or Class II or III liquids are allowed to be installed on suitably designed wharves.

❖ Tanks other than tanks used for Class I liquids can be installed on a wharf if the wharf is designed for this purpose.

**5706.4.7.5 Transferring equipment.** Loading pumps capable of building up pressures in excess of the safe working pressure of cargo hose or loading arms shall be provided with bypasses, relief valves or other arrangements to protect the

loading facilities against excessive pressure. Relief devices shall be tested not less than annually to determine that they function satisfactorily at their set pressure.

❖ Pump systems must be designed so that excess pressure cannot be created in the piping and storage system. If excess pressure develops and is not relieved, the equipment or piping and storage system can be damaged. A damaged system could develop a leak.

**5706.4.7.6 Piping, valves and fittings.** Piping valves and fittings shall be in accordance with Section 5703.6 except as modified by the following:

1. Flexibility of piping shall be ensured by appropriate layout and arrangement of piping supports so that motion of the wharf structure resulting from wave action, currents, tides or the mooring of vessels will not subject the pipe to repeated excessive strain.
2. Pipe joints that depend on the friction characteristics of combustible materials or on the grooving of pipe ends for mechanical continuity of piping shall not be used.
3. Swivel joints are allowed in piping to which hoses are connected and for articulated, swivel-joint transfer systems, provided the design is such that the mechanical strength of the joint will not be impaired if the packing materials fail such as by exposure to fire.
4. Each line conveying Class I or II liquids leading to a wharf shall be provided with a readily accessible block valve located on shore near the approach to the wharf and outside of any diked area. Where more than one line is involved, the valves shall be grouped in one location.
5. Means shall be provided for easy access to cargo line valves located below the wharf deck.
6. Piping systems shall contain a sufficient number of valves to operate the system properly and to control the flow of liquid in normal operation and in the event of physical damage.
7. Piping on wharves shall be bonded and grounded where Class I and II liquids are transported. Where excessive stray currents are encountered, insulating joints shall be installed. Bonding and grounding connections on piping shall be located on the wharf side of hose riser insulating flanges, where used, and shall be accessible for inspection.
8. Hose or articulated swivel-joint pipe connections used for cargo transfer shall be capable of accommodating the combined effects of change in draft and maximum tidal range, and mooring lines shall be kept adjusted to prevent surge of the vessel from placing stress on the cargo transfer system.
9. Hoses shall be supported to avoid kinking and damage from chafing.

❖ The general requirements of Section 5703.6 apply to the piping on a wharf, with the exception of specific

requirements that are unique to the design and operation of a wharf, as indicated in this section:

1. Wharves, especially floating wharves, need flexible piping that can withstand wharf movement.
2. Slip-joint pipe connections and threaded connections are prohibited. The flexible piping required to handle the wharf's movement may move enough to cause these types of joints to loosen. A loose joint can create a leak or a spill.
3. Swivel joints are necessary for connections between wharves, between the wharf and land, and between the wharf and marine vessels. These joints are to be designed to withstand loads placed on them even if the packing material used to seal the joint fails.
4. Lines carrying Class I and II liquids require a block valve on each line feeding the wharf. The block valve is to be near the wharf and outside of the dike area. A block valve is used to isolate the line from the wharf.
5. Piping under a wharf used to transfer flammable and combustible liquids must be accessible. If these lines are not accessible, it may be difficult or impossible to inspect, maintain or provide fire protection to these lines.
6. Valves must be installed in the piping system so that sections of the system can be isolated for maintenance or repairs or to stop the transfer of flammable and combustible liquids in case of leaks, spills or fire.
7. Piping must be bonded to prevent static sparks or sparks from the electrical equipment.
8. Swivel joints must be protected from loads caused by movement of the wharf relative to movement of the marine vessel.
9. Hoses must be maintained to prevent damage.

**5706.4.7.7 Loading and unloading.** Loading or discharging shall not commence until the wharf superintendent and officer in charge of the tank vessel agree that the tank vessel is properly moored and connections are properly made.

❖ Section 5706.4.7.1 requires approval from the individual responsible for the wharf for transferring flammable and combustible liquids over the wharf. This section requires that this same individual approve the mooring of the marine vessel before transfer begins. Failure of the moorings or excessive movement of the marine vessel can damage the piping.

**5706.4.7.8 Mechanical work.** Mechanical work shall not be performed on the wharf during cargo transfer, except under special authorization by the *fire code official* based on a

review of the area involved, methods to be employed and precautions necessary.

❖ Work on the wharf or transfer equipment and piping are prohibited during the transfer of flammable or combustible liquids. Work can introduce an ignition source or possible damage to the equipment or piping system.

**5706.4.8 Sources of ignition.** Class I, II or IIIA liquids shall not be used, drawn or dispensed where flammable vapors can reach a source of ignition. Smoking shall be prohibited except in designated locations. "No Smoking" signs complying with Section 310 shall be conspicuously posted where a hazard from flammable vapors is normally present.

❖ One of the principal safety measures for using flammable and combustible liquids is to keep sources of ignition away from the liquids.

**5706.4.9 Drainage control.** Loading and unloading areas shall be provided with drainage control in accordance with Section 5704.2.10.

❖ Flammable and combustible liquids that leak or spill from a tank must be controlled by dikes and drainage. The flammable and combustible liquids are to be collected in a manner that will not endanger other tanks, properties or waterways. The fire code official has the authority to consider installations where the use of drainage and dikes may not be necessary. Listed secondary containment tanks need not be surrounded by drainage control or dikes. The secondary containment system in these tanks is considered equivalent to drainage and diking.

**5706.4.10 Fire protection.** Fire protection shall be in accordance with Chapter 9 and Sections 5706.4.10.1 through 5706.4.10.4.

❖ Fire protection complying with Chapter 9 is required for wharves.

**5706.4.10.1 Portable fire extinguishers.** Portable fire extinguishers with a rating of not less than 20-B and complying with Section 906 shall be located within 75 feet (22 860 mm) of hose connections, pumps and separator tanks.

❖ Portable fire extinguishers must be located within 75 feet (22 860 mm) of hose connections, pumps and separator tanks. These locations are where a possible leak can occur and a portable fire extinguisher may be adequate in preventing a fire or controlling a small, flammable-liquid fire. The 20-B portable fire extinguisher is for the control of a small, flammable-liquid fire.

**5706.4.10.2 Fire hoses.** Where piped water is available, ready-connected fire hose in a size appropriate for the water supply shall be provided in accordance with Section 905 so that manifolds where connections are made and broken can be reached by not less than one hose stream.

❖ If the fire control system uses piped water, a fire hose of adequate size for the piped water and complying

with Section 905 must be available. The fire hose must be capable of washing down manifolds in case of a leak or spill or for fighting a fire at the manifold.

**5706.4.10.3 Obstruction of equipment.** Material shall not be placed on wharves in such a manner that would obstruct access to fire-fighting equipment or important pipeline control valves.

- ❖ Access for fire equipment and to valves for isolating and controlling flammable and combustible liquids must be kept clear. Obstruction would prevent or slow any response to a leak, spill or fire.

**5706.4.10.4 Fire apparatus access.** Where the wharf is accessible to vehicular traffic, an unobstructed fire apparatus access road to the shore end of the wharf shall be maintained in accordance with Chapter 5.

- ❖ Wharves that are accessible to vehicle traffic are to be made accessible for fire department equipment. The access requirements are in Chapter 5. Where vehicle access to the wharf does not exist, fire department equipment access is not required.

**5706.5 Bulk transfer and process transfer operations.** Bulk transfer and process transfer operations shall be *approved* and be in accordance with Sections 5706.5.1 through 5706.5.4.5. Motor fuel-dispensing facilities shall comply with Chapter 23.

- ❖ This section gives the fire code official the authority to require approval of bulk transfer and process transfer operations.

**5706.5.1 General.** The provisions of Sections 5706.5.1.1 through 5706.5.1.18 shall apply to bulk transfer and process transfer operations; Sections 5706.5.2 and 5706.5.2.1 shall apply to bulk transfer operations; Sections 5706.5.3 through 5706.5.3.3 shall apply to process transfer operations and Sections 5706.5.4 through 5706.5.4.5 shall apply to dispensing from tank vehicles and tank cars.

- ❖ Facilities that are used for bulk transferring, bulk processing and bulk dispensing to tank vehicles and tank cars are covered by these sections.

**5706.5.1.1 Location.** Bulk transfer and process transfer operations shall be conducted in *approved* locations. Tank cars shall be unloaded only on private sidings or railroad-siding facilities equipped for transferring flammable or *combustible liquids*. Tank vehicle and tank car transfer facilities shall be separated from buildings, above-ground tanks, combustible materials, *lot lines*, public streets, public alleys or *public ways* by a distance of 25 feet (7620 mm) for Class I liquids and 15 feet (4572 mm) for Class II and III liquids measured from the nearest position of any loading or unloading valve. Buildings for pumps or shelters for personnel shall be considered part of the transfer facility.

- ❖ The volume of flammable and combustible liquids being transferred and processed requires that the location be protected from ignition sources. This is accomplished by maintaining minimum clearance

between the transfer and process operation and buildings, property lines, streets, etc.

**5706.5.1.2 Weather protection canopies.** Where weather protection canopies are provided, they shall be constructed in accordance with Section 5004.13. Weather protection canopies shall not be located within 15 feet (4572 mm) of a building or combustible material or within 25 feet (7620 mm) of building openings, *lot lines*, public streets, public alleys or *public ways*.

- ❖ This section makes clear that an open structure consisting of only a noncombustible roof structure is considered outdoor storage. A structure with no walls and only a noncombustible roof provides sufficient ventilation for the storage area to be treated as outdoor storage. Separation from buildings and openings is needed to prevent the vapors from flammable and combustible liquids from being exposed to an ignition source. These separation requirements also limit potential property and life losses.

**5706.5.1.3 Ventilation.** Ventilation shall be provided to prevent accumulation of vapors in accordance with Section 5705.3.7.5.1.

- ❖ The requirements of this section for a mechanical ventilation system are identical to those in Section 5004.3. The mechanical ventilation system must remove vapors to prevent accumulation in concentrations in the flammable range for the flammable and combustible liquids being used. Natural ventilation complying with Section 5004.3 that can be demonstrated to be effective for the flammable and combustible liquids being used is an acceptable alternative.

**5706.5.1.4 Sources of ignition.** Sources of ignition shall be controlled or eliminated in accordance with Section 5003.7.

- ❖ Smoking and open flames are strictly limited around flammable and combustible liquids. Section 5003.7 prohibits smoking or open flames within 25 feet (7620 mm) of outdoor storage of flammable and combustible liquids and anywhere indoors where there are flammable and combustible liquids or where vapors from flammable and combustible liquids may occur.

**5706.5.1.5 Spill control and secondary containment.** Areas where transfer operations are located shall be provided with spill control and secondary containment in accordance with Section 5703.4. The spill control and secondary containment system shall have a design capacity capable of containing the capacity of the largest tank compartment located in the area where transfer operations are conducted. Containment of the rainfall volume specified in Section 5004.2.2.6 is not required.

- ❖ Where flammable or combustible liquids are present, spills must be controlled to prevent the spread of liquid and vapors. Section 5004.2 discusses the use of liquid-tight floors, curbs, dikes and drainage systems to divert the liquid to a location where it can be contained and safely handled. Section 5004.3 discusses

mechanical and natural exhaust systems for indoor facilities. The exhaust system must remove the vapors to prevent them from accumulating in concentrations in the flammable range. The diked area must have sufficient capacity to contain the largest spillage of flammable and combustible liquids that can be released from the largest tank. This would be the volume of the largest tank that extends above the top of the dike.

**5706.5.1.6 Fire protection.** Fire protection shall be in accordance with Section 5703.2.

❖ The requirements of Chapter 9 apply to flammable and combustible liquids. Fire protection is a principal means of preventing and controlling the spread of a fire.

**5706.5.1.7 Static protection.** Static protection shall be provided to prevent the accumulation of static charges during transfer operations. Bonding facilities shall be provided during the transfer through open domes where Class I liquids are transferred, or where Class II and III liquids are transferred into tank vehicles or tank cars that could contain vapors from previous cargoes of Class I liquids.

Protection shall consist of a metallic bond wire permanently electrically connected to the fill stem. The fill pipe assembly shall form a continuous electrically conductive path downstream from the point of bonding. The free end of such bond wire shall be provided with a clamp or equivalent device for convenient attachment to a metallic part in electrical contact with the cargo tank of the tank vehicle or tank car. For tank vehicles, protection shall consist of a flexible bond wire of adequate strength for the intended service and the electrical resistance shall not exceed 1 megohm. For tank cars, bonding shall be provided where the resistance of a tank car to ground through the rails is 25 ohms or greater.

Such bonding connection shall be fastened to the vehicle, car or tank before dome covers are raised and shall remain in place until filling is complete and all dome covers have been closed and secured.

**Exceptions:**

1. Where vehicles and cars are loaded exclusively with products not having a static-accumulating tendency, such as asphalt, cutback asphalt, most crude oils, residual oils and water-miscible liquids.
2. Where Class I liquids are not handled at the transfer facility and the tank vehicles are used exclusively for Class II and III liquids.
3. Where vehicles and cars are loaded or unloaded through closed top or bottom connections whether the hose is conductive or nonconductive.

Filling through open domes into the tanks of tank vehicles or tank cars that contain vapor-air mixtures within the flammable range, or where the liquid being filled can form such a mixture, shall be by means of a downspout which extends to near the bottom of the tank.

❖ Static electricity will spark between surfaces with different electrical potential. Vehicles that are or may

have been used to carry Class I liquids are to be bonded. Vehicles with open domes are to be bonded before the dome is opened. Bonding to control static electricity can be done using wires, ground cables, metal piping or other similar means that will carry current. Open dome tanks must use a downspout that extends to near the bottom of the tank. This downspout will reduce the mixing of the flammable or combustible liquid with air.

Bonding to control static electricity is not necessary where static electricity is not an issue or a static spark would not act as an ignition source. Three exceptions are given to this section:

1. Combustible liquids whose viscosity prevents the accumulation of static electricity.
2. Facilities and vehicles that do not handle Class I liquids.
3. Vehicles that use a closed system for loading and unloading flammable and combustible liquids. These closed systems prevent the vapors of flammable and combustible liquids from mixing with air to form a vapor-air mixture that can reach the LFL.

**5706.5.1.8 Stray current protection.** Tank car loading facilities where Class I, II or IIIA liquids are transferred through open domes shall be protected against stray currents by permanently bonding the pipe to not less than one rail and to the transfer apparatus. Multiple pipes entering the transfer areas shall be permanently electrically bonded together. In areas where excessive stray currents are known to exist, all pipes entering the transfer area shall be provided with insulating sections to isolate electrically the transfer apparatus from the pipelines.

❖ Bonding of piping to the transfer apparatus and to a rail prevents any stray current from arcing. Any electrical equipment can develop stray current. Grounding of electrical equipment, dispensing piping and vehicles will prevent the accumulation of electrical potential, which will prevent the stray current from arcing and forming an ignition source.

**5706.5.1.9 Top loading.** When top loading a tank vehicle with Class I and II liquids without vapor control, valves used for the final control of flow shall be of the self-closing type and shall be manually held open except where automatic means are provided for shutting off the flow when the tank is full. Where used, automatic shutoff systems shall be provided with a manual shutoff valve located at a safe distance from the loading nozzle to stop the flow if the automatic system fails.

When top loading a tank vehicle with vapor control, flow control shall be in accordance with Section 5706.5.1.10. Self-closing valves shall not be tied or locked in the open position.

❖ A top-loading tank vehicle for use with Class I and II flammable and combustible liquids must have either a self-closing valve, a control valve that is manually held open or an automatic shutoff control valve to prevent overfilling and spillage. The automatic shutoff

control valve is to have a manual backup control valve located a safe distance from the loading nozzle.

If the dispensing system includes vapor control, the top loading is to comply with Section 5706.5.1.10.

**5706.5.1.10 Bottom loading.** When bottom loading a tank vehicle or tank car with or without vapor control, a positive means shall be provided for loading a predetermined quantity of liquid, together with an automatic secondary shutoff control to prevent overflow. The connecting components between the transfer equipment and the tank vehicle or tank car required to operate the secondary control shall be functionally compatible.

- ❖ Spillage is prevented when filling a bottom-loading tank vehicle by using a loading system that loads a predetermined quantity of flammable or combustible liquid. An automatic secondary shutoff control valve is required for a bottom-loading tank vehicle.

**5706.5.1.10.1 Dry disconnect coupling.** When bottom loading a tank vehicle, the coupling between the liquid loading hose or pipe and the truck piping shall be a dry disconnect coupling.

- ❖ To prevent spillage when disconnecting the dispensing system from the bottom-loading vehicle, the system is to use a dry connection.

**5706.5.1.10.2 Venting.** When bottom loading a tank vehicle or tank car that is equipped for vapor control and vapor control is not used, the tank shall be vented to the atmosphere to prevent pressurization of the tank. Such venting shall be at a height equal to or greater than the top of the cargo tank.

- ❖ Pressure is relieved in a bottom-loading tank during the loading process by venting the tank to the atmosphere. The tank vent is to be above the top of the upper limit to which flammable and combustible liquid can be loaded. This prevents the vent from spilling flammable or combustible liquid.

**5706.5.1.10.3 Vapor-tight connection.** Connections to the plant vapor control system shall be designed to prevent the escape of vapor to the atmosphere when not connected to a tank vehicle or tank car.

- ❖ Vapor recovery systems must be designed so that when they are not in use, vapors cannot escape the connection to the tank vehicle.

**5706.5.1.10.4 Vapor-processing equipment.** Vapor-processing equipment shall be separated from above-ground tanks, warehouses, other plant buildings, transfer facilities or nearest *lot line* of adjoining property that can be built on by a distance of not less than 25 feet (7620 mm). Vapor-processing equipment shall be protected from physical damage by remote location, guard rails, curbs or fencing.

- ❖ Vapor recovery is the most dangerous component of flammable or combustible liquid transfer. To protect property and life, the vapor recovery equipment is to be separated from other buildings, equipment, property lines, etc. The vapor recovery equipment must be protected from physical damage either by separa-

tion or by physical barriers. Any damage to the vapor recovery equipment could create a vapor-air mixture that is flammable. The same damage could generate an ignition source.

**5706.5.1.11 Switch loading.** Tank vehicles or tank cars that have previously contained Class I liquids shall not be loaded with Class II or III liquids until such vehicles and all piping, pumps, hoses and meters connected thereto have been completely drained and flushed.

- ❖ Class I liquids and their vapors must be cleaned from a tank vehicle before loading it with Class II or III combustible liquids. The vapors from Class I liquids can affect the response to Class II or III liquids by being the source of ignition and the initial fuel source to start a Class II or III liquid fire.

**5706.5.1.12 Loading racks.** Where provided, loading racks, *stairways* or platforms shall be constructed of noncombustible materials. Buildings for pumps or for shelter of loading personnel are allowed to be part of the loading rack. Wiring and electrical equipment located within 25 feet (7620 mm) of any portion of the loading rack shall be in accordance with Section 5703.1.1.

- ❖ Loading racks and buildings that are part of the loading rack and used to shelter pumps and loading personnel are to be noncombustible. This reduces the fuel sources in the vicinity of the flammable and combustible liquids. Electrical equipment within 25 feet (7620 mm) of the loading racks is to be classified as a hazardous location. This removes an ignition source from the immediate vicinity.

**5706.5.1.13 Transfer apparatus.** Bulk and process transfer apparatus shall be of an *approved* type.

- ❖ This section gives the fire code official the authority to approve any transfer apparatus.

**5706.5.1.14 Inside buildings.** Tank vehicles and tank cars shall not be located inside a building while transferring Class I, II or IIIA liquids, unless *approved* by the *fire code official*.

**Exception:** Tank vehicles are allowed under weather protection canopies and canopies of automobile motor vehicle fuel-dispensing stations.

- ❖ Tank vehicles are to be loaded outside of a building unless approved by the fire code official. The potential for the accumulation of vapors in a building where the bulk loading of tank vehicles takes place produces an unacceptable hazard.

The exception allows loading tank vehicles under a canopy because a canopy structure is considered to be outdoor usage.

**5706.5.1.15 Tank vehicle and tank car certification.** Certification shall be maintained for tank vehicles and tank cars in accordance with DOTn 49 CFR Parts 100-185.

- ❖ Tank vehicles for use with flammable and combustible liquids are regulated under DOTn 49 CFR, Parts 100-185. Tank vehicles and tank cars not having a current certification are not to be used.

**5706.5.1.16 Tank vehicle and tank car stability.** Tank vehicles and tank cars shall be stabilized against movement during loading and unloading in accordance with Sections 5706.5.1.16.1 through 5706.5.1.16.3.

❖ The stability of tank vehicles and tank cars is to be maintained during loading and unloading. The movement of a tank vehicle or tank car during loading or unloading could cause a spill.

**5706.5.1.16.1 Tank vehicles.** When the vehicle is parked for loading or unloading, the cargo trailer portion of the tank vehicle shall be secured in a manner that will prevent unintentional movement.

❖ Cargo trailers must be secured to prevent movement during loading and unloading.

**5706.5.1.16.2 Chock blocks.** Not less than two chock blocks not less than 5 inches by 5 inches by 12 inches (127 mm by 127 mm by 305 mm) in size and dished to fit the contour of the tires shall be used during transfer operations of tank vehicles.

❖ Tank vehicles are to use chock blocks that conform to the wheels to prevent movement. Movement of the tank vehicle could cause a spill.

**5706.5.1.16.3 Tank cars.** Brakes shall be set and the wheels shall be blocked to prevent rolling.

❖ Tank cars are to use both the tank car brakes and blocks to prevent movement. Movement of the tank car could cause a spill.

**5706.5.1.17 Monitoring.** Transfer operations shall be monitored by an *approved* monitoring system or by an attendant. Where monitoring is by an attendant, the operator or other competent person shall be present at all times.

❖ To prevent spillage, the transfer operations are to be continually monitored by an individual at the site.

**5706.5.1.18 Security.** Transfer operations shall be surrounded by a noncombustible fence not less than 5 feet (1524 mm) in height. Tank vehicles and tank cars shall not be loaded or unloaded unless such vehicles are entirely within the fenced area.

**Exceptions:**

1. Motor fuel-dispensing facilities complying with Chapter 23.
2. Installations where adequate public safety exists because of isolation, natural barriers or other factors as determined appropriate by the *fire code official*.
3. Facilities or properties that are entirely enclosed or protected from entry.

❖ Transfer operations must take place in a fenced-in area to prevent access by unauthorized personnel and the possibility of introduction of ignition sources around the transfer operation.

The three exceptions cover special sets of circumstances:

1. Motor fuel-dispensing facilities that comply with Chapter 23.

2. Installation approved by the fire code official that provides security complying with the intent of the code.
3. Facilities or properties that are completely enclosed or protected from entry by unauthorized persons.

**5706.5.2 Bulk transfer.** Bulk transfer shall be in accordance with Sections 5706.5.1 and 5706.5.2.1.

❖ The operation of a motor vehicle is prohibited during bulk transfer to prevent the presence of an ignition source.

**5706.5.2.1 Vehicle motor.** Motors of tank vehicles or tank cars shall be shut off during the making and breaking of hose connections and during the unloading operation.

**Exception:** Where unloading is performed with a pump deriving its power from the tank vehicle motor.

❖ The engine of a motor vehicle is a source of ignition. This source of ignition is to be turned off during transfer of flammable or combustible liquids.

The exception allows the engine of a motor vehicle to operate during transfer of flammable or combustible liquids only if the pump to move the flammable or combustible liquids is powered by the vehicle engine.

**5706.5.3 Process transfer.** Process transfer shall be in accordance with Section 5706.5.1 and Sections 5706.5.3.1 through 5706.5.3.3.

❖ Safety features are installed in the processing system to protect the system from failure. The failure may be caused by operational procedures or equipment. The process transfer is to be designed and operated to prevent leaks, spills, overpressure buildup, siphonage, accumulation of vapors, exposure to ignition sources, etc.

**5706.5.3.1 Piping, valves, hoses and fittings.** Piping, valves, hoses and fittings that are not a part of the tank vehicle or tank car shall be in accordance with Section 5703.6. Caps or plugs that prevent leakage or spillage shall be provided at all points of connection to transfer piping.

❖ Piping complying with Section 5703.6 provides protection against leaks and overpressures that may create leaks at joints or rupture of the pipes. To prevent any residue from leaking or spilling from the piping system, caps or plugs are to be available for all openings.

**5706.5.3.1.1 Shutoff valves.** *Approved* automatically or manually activated shutoff valves shall be provided where the transfer hose connects to the process piping, and on both sides of any exterior fire-resistance-rated wall through which the piping passes. Manual shutoff valves shall be arranged so that they are accessible from grade. Valves shall not be locked in the open position.

❖ Shutoff valves must be installed to isolate portions of the piping system. The valves must be located where the flammable or combustible liquids connect to the process equipment. Valves are to be located on both

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sides of exterior fire-resistance-rated walls. Valves are not to be locked in the open position.

**5706.5.3.1.2 Hydrostatic relief.** Hydrostatic pressure-limiting or relief devices shall be provided where pressure buildup in trapped sections of the system could exceed the design pressure of the components of the system.

Devices shall relieve to other portions of the system or to another *approved* location.

❖ Pressure relief valves must be installed to prevent damage to the system by releasing the pressure either into another portion of the system or to an *approved* location. This prevents any vapors from the flammable and combustible liquids from being released into the atmosphere of the building or facility.

**5706.5.3.1.3 Antisiphon valves.** Antisiphon valves shall be provided where the system design would allow siphonage.

❖ To prevent leakage or spillage by siphoning flammable or combustible liquids from one portion of the process system to another, an *approved* antisiphon device must be installed.

**5706.5.3.2 Vents.** Normal and emergency vents shall be maintained operable at all times.

❖ Vents are installed to help prevent overpressurization of tanks and transfer piping. If these vents fail to operate as designed, serious damage to the system could result.

**5706.5.3.3 Motive power.** Motors of tank vehicles or tank cars shall be shut off during the making and breaking of hose connections and during the unloading operation.

**Exception:** When unloading is performed with a pump deriving its power from the tank vehicle motor.

❖ Because there is always a possibility that vapors or minor liquid spillage could present a fire hazard, it is important to remove all possible sources of ignition from the vicinity. Requiring internal combustion engines to be shut off before connections are made or broken removes an ignition source from the vicinity.

The exception acknowledges that some pumps are powered by the engine of the tank vehicle involved in the liquid transfer operation.

**5706.5.4 Dispensing from tank vehicles and tank cars.** Dispensing from tank vehicles and tank cars into the fuel tanks of motor vehicles shall be prohibited unless allowed by and conducted in accordance with Sections 5706.5.4.1 through 5706.5.4.5.

❖ The dispensing of flammable or combustible liquids from a tank vehicle or tank car into the fuel tank of a motor vehicle is covered by this section.

**5706.5.4.1 Marine craft and special equipment.** Liquids intended for use as motor fuels are allowed to be transferred from tank vehicles into the fuel tanks of marine craft and spe-

cial equipment where *approved* by the *fire code official*, and where:

1. The tank vehicle's specific function is that of supplying fuel to fuel tanks.
2. The operation is not performed where the public has access or where there is unusual exposure to life and property.
3. The dispensing line does not exceed 50 feet (15 240 mm) in length.
4. The dispensing nozzle is *approved*.

❖ Transfer of motor fuel into marine craft and special equipment is covered by this section.

The tank vehicle or tank car must be designed and equipped specifically for fueling other vehicles and equipment and the dispensing equipment must be *approved* for this use. The dispensing line cannot be more than 50 feet (15 240 mm) long. The dispensing must be done in a controlled area where there is minimal exposure to life or property.

**5706.5.4.2 Emergency refueling.** Where *approved* by the *fire code official*, dispensing of motor vehicle fuel from tank vehicles into the fuel tanks of motor vehicles is allowed during emergencies. Dispensing from tank vehicles shall be in accordance with Sections 5706.2.8 and 5706.6.

❖ Emergency refueling of vehicles is permitted only when *approved* by the *fire code official*.

**5706.5.4.3 Aircraft fueling.** Transfer of liquids from tank vehicles to the fuel tanks of aircraft shall be in accordance with Chapter 20.

❖ Chapter 20 covers the requirements for aircraft fueling.

**5706.5.4.4 Fueling of vehicles at farms, construction sites and similar areas.** Transfer of liquid from tank vehicles to motor vehicles for private use on farms and rural areas and at construction sites, earth-moving projects, gravel pits and borrow pits is allowed in accordance with Section 5706.2.8.

❖ Fueling of vehicles at farms, construction sites and similar areas is covered by Section 5706.2.8. The dispensing of fuel at a farm or construction site may be from a tanker to a vehicle or equipment. Dispensing using a tanker requires that the tanker be designed and equipped specifically for fueling other vehicles and equipment. The dispensing equipment must be *approved* for this use. The dispensing line cannot be more than 100 feet (30 480 mm) long.

The tanker operator is responsible for the dispensing line and the tanker, so these two items need to be in the same area. The dispensing cannot be done around an ignition source, such as smoking, or electrical equipment that is not classified for use in hazardous locations.

**5706.5.4.5 Commercial, industrial, governmental or manufacturing.** Dispensing of Class II and III motor vehicle fuel

from tank vehicles into the fuel tanks of motor vehicles located at commercial, industrial, governmental or manufacturing establishments is allowed where permitted, provided such dispensing operations are conducted in accordance with the following:

1. Dispensing shall occur only at sites that have been issued a permit to conduct mobile fueling.
2. The *owner* of a mobile fueling operation shall provide to the jurisdiction a written response plan which demonstrates readiness to respond to a fuel spill and carry out appropriate mitigation measures, and describes the process to dispose properly of contaminated materials.
3. A detailed site plan shall be submitted with each application for a permit. The site plan shall indicate: all buildings, structures and appurtenances on site and their use or function; all uses adjacent to the lot lines of the site; the locations of all storm drain openings, adjacent waterways or wetlands; information regarding slope, natural drainage, curbing, impounding and how a spill will be retained upon the site property; and the scale of the site plan.

Provisions shall be made to prevent liquids spilled during dispensing operations from flowing into buildings or off-site. Acceptable methods include, but shall not be limited to, grading driveways, raising doorsills or other *approved* means.

4. The *fire code official* is allowed to impose limits on the times and days during which mobile fueling operations is allowed to take place, and specific locations on a site where fueling is permitted.
5. Mobile fueling operations shall be conducted in areas not accessible to the public or shall be limited to times when the public is not present.
6. Mobile fueling shall not take place within 15 feet (4572 mm) of buildings, property lines, combustible storage or storm drains.

**Exceptions:**

1. The distance to storm drains shall not apply where an *approved* storm drain cover or an *approved* equivalent that will prevent any fuel from reaching the drain is in place prior to fueling or a fueling hose being placed within 15 feet (4572 mm) of the drain. Where placement of a storm drain cover will cause the accumulation of excessive water or difficulty in conducting the fueling, such cover shall not be used and the fueling shall not take place within 15 feet (4572 mm) of a drain.
2. The distance to storm drains shall not apply for drains that direct influent to *approved* oil interceptors.
7. The tank vehicle shall comply with the requirements of NFPA 385 and local, state and federal require-

ments. The tank vehicle's specific functions shall include that of supplying fuel to motor vehicle fuel tanks. The vehicle and all its equipment shall be maintained in good repair.

8. Signs prohibiting smoking or open flames within 25 feet (7620 mm) of the tank vehicle or the point of fueling shall be prominently posted on three sides of the vehicle including the back and both sides.
9. A portable fire extinguisher with a minimum rating of 40:BC shall be provided on the vehicle with signage clearly indicating its location.
10. The dispensing nozzles and hoses shall be of an *approved* and *listed* type.
11. The dispensing hose shall not be extended from the reel more than 100 feet (30 480 mm) in length.
12. Absorbent materials, nonwater-absorbent pads, a 10-foot-long (3048 mm) containment boom, an *approved* container with lid and a nonmetallic shovel shall be provided to mitigate a minimum 5-gallon (19 L) fuel spill.
13. Tank vehicles shall be equipped with a "fuel limit" switch such as a count-back switch, to limit the amount of a single fueling operation to not more than 500 gallons (1893 L) before resetting the limit switch.

**Exception:** Tank vehicles where the operator carries and can utilize a remote emergency shut-off device which, when activated, immediately causes flow of fuel from the tank vehicle to cease.

14. Persons responsible for dispensing operations shall be trained in the appropriate mitigating actions in the event of a fire, leak or spill. Training records shall be maintained by the dispensing company.
15. Operators of tank vehicles used for mobile fueling operations shall have in their possession at all times an emergency communications device to notify the proper authorities in the event of an emergency.
16. The tank vehicle dispensing equipment shall be constantly attended and operated only by designated personnel who are trained to handle and dispense motor fuels.
17. Fuel dispensing shall be prohibited within 25 feet (7620 mm) of any source of ignition.
18. The engines of vehicles being fueled shall be shut off during dispensing operations.
19. Nighttime fueling operations shall only take place in adequately lighted areas.
20. The tank vehicle shall be positioned with respect to vehicles being fueled to prevent traffic from driving over the delivery hose.
21. During fueling operations, tank vehicle brakes shall be set, chock blocks shall be in place and warning lights shall be in operation.
22. Motor vehicle fuel tanks shall not be topped off.

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23. The dispensing hose shall be properly placed on an *approved* reel or in an *approved* compartment prior to moving the tank vehicle.
  24. The *fire code official* and other appropriate authorities shall be notified when a reportable spill or unauthorized discharge occurs.
  25. Operators shall place a drip pan or an absorbent pillow under each fuel fill opening prior to and during dispensing operations. Drip pans shall be liquid-tight. The pan or absorbent pillow shall have a capacity of not less than 3 gallons (11.36 L). Spills retained in the drip pan or absorbent pillow need not be reported. Operators, when fueling, shall have on their person an absorbent pad capable of capturing diesel fuel overfills. Except during fueling, the nozzle shall face upward and an absorbent pad shall be kept under the nozzle to catch drips. Contaminated absorbent pads or pillows shall be disposed of regularly in accordance with local, state and federal requirements.
- ❖ This section codifies minimum safety requirements for the regulation of certain mobile fueling operations, provides administrative controls over fueling sites, specifies the types of tank vehicles required in such operations and specifies training and licensing requirements for persons engaged in mobile fueling operations.

Regardless of previous allowances or restrictions by the legacy model fire codes (i.e., national, standard and uniform), mobile fueling is flourishing nationally and is welcomed in many jurisdictions. In fact, a number of local jurisdictions have developed regulations specifically allowing for expanded mobile fueling operations. The regulations in this section are consistent with those local regulations as well as those contained in NFPA 30A and provide an international model for jurisdictions to follow.

The greatest operational uses of mobile fueling are in conjunction with fueling of fleets, such as trucking companies, bus companies, delivery companies, municipal fleets, the U.S. Postal Service fleets and similar operations. Nationwide, the annual mobile fueling volume is conservatively estimated to exceed 500,000,000 gallons (18,992,500,000 L) and it is increasing at a rate exceeding 30 percent per year. It is a business carried out by both public and private entities. One private company alone delivers over 120,000,000 gallons (454,200,000 L) per year. There are several other companies that deliver from 500,000 to 3,000,000 gallons (1,892,500 to 11,355,000 L) per month. These operations are occurring in all regions of the United States since the early 1990s and in some areas, even longer.

Mobile fueling thrives because it meets several needs:

1. It is more cost efficient to bring delivery of fuel to high-volume consuming vehicles versus having each of those vehicles go to the fuel source.

2. Fueling is a safer operation when carried out by a trained, focused specialist who is familiar with the dispensing equipment and safety regulations, is trained in spill control and mitigation and knows what steps to take should an incident occur.
3. Fuel-consuming fleet operators recognize both safety and cost benefits by not involving a multitude of employees in a fueling operation for which they are not trained and are not likely to develop an overriding concern for safety.
4. Additional safety controls are evolving through the use of technology systems. Some systems are not economically feasible unless they include additional services. For example, some mobile fueling operations bring cost-saving advantages to their clients through the provision of a data-capturing system. In addition to having instant remote fuel-flow stopping capabilities, the system frees the operator to concentrate solely on the task of safe dispensing.
5. On-site mobile fueling eliminates the traffic hazards and air pollution problems associated with driving fleets of vehicles to a fixed fueling facility.

There is no known adverse fire incident history associated with mobile fueling. Given the length of time that mobile fueling has been occurring, the data points to an outstanding safety record. There is no safety-related reason that mobile fueling operations should not be allowed, provided such operations are carried out in keeping with reasonable safety requirements, including those designed to protect water supply and environment, as provided in this section.

**5706.6 Tank vehicles and vehicle operation.** Tank vehicles shall be designed, constructed, equipped and maintained in accordance with NFPA 385 and Sections 5706.6.1 through 5706.6.4.

❖ This section sets forth rules for the operation of tank vehicles used for the transportation of flammable and combustible liquids. Included are parking and garaging regulations, fire extinguisher requirements and regulations for the discharge of flammable and combustible liquids into underground storage tanks. These requirements are intended to apply to the extent that they do not conflict with federal requirements detailed in DOTn 49 CFR and other federal transportation regulations.

NFPA 385 details requirements for materials and methods of construction for flammable and combustible liquid tank vehicles to provide protection for their cargo under highway conditions. Design and construction of these vehicles must also conform to the requirements set forth in DOTn 49 CFR.

**5706.6.1 Operation of tank vehicles.** Tank vehicles shall be utilized and operated in accordance with NFPA 385 and Sections 5706.6.1.1 through 5706.6.1.11.

- ❖ NFPA 385 outlines the requirements for the operation of tank vehicles. These requirements detail required practices during transit, parking, loading and unloading, maintenance and repair designed to reduce the potential for accidental release of the vehicle cargo.

**5706.6.1.1 Vehicle maintenance.** Tank vehicles shall not be operated unless they are in proper state of repair and free from accumulation of grease, oil or other flammable substance, and leaks.

- ❖ Good housekeeping practices extend to tank vehicles just as much as they do to permanent facilities. Keeping vehicles clean and in good repair reduces the possibility for accumulations of flammable materials to become a fuel source for a fire.

**5706.6.1.2 Leaving vehicle unattended.** The driver, operator or attendant of a tank vehicle shall not remain in the vehicle cab and shall not leave the vehicle while it is being filled or discharged. The delivery hose, when attached to a tank vehicle, shall be considered to be a part of the tank vehicle.

- ❖ The tank vehicle driver, operator or attendant must be prepared to immediately suspend dispensing, loading or unloading operations; control a spill; or extinguish a fire should an incident occur. This section and NFPA 385 emphasize that the driver, operator or attendant must be outside the cab of the vehicle in order to be in compliance. It further clarifies that the driver, operator or attendant may be no further away from the vehicle than the length of the delivery hose connected to the vehicle. These restrictions are especially important in climates subject to extreme weather, where drivers are often tempted to sit in the truck cab or go into a building to keep cool or warm. Keeping the person most qualified to take prompt emergency action in the best possible location to do so reduces the likelihood of a major spill in the event of an equipment failure or accident.

**5706.6.1.3 Vehicle motor shutdown.** Motors of tank vehicles or tractors shall be shut down during the making or breaking of hose connections. If loading or unloading is performed without the use of a power pump, the tank vehicle or tractor motor shall be shut down throughout such operations.

- ❖ Motors must be shut down when not required to operate unloading equipment. When the vehicle motor is required to operate transfer pumps, it must be shut off when loading or unloading is commencing or is completed and before hose connections are made or broken in order to control it as a source of ignition.

**5706.6.1.4 Outage.** A cargo tank or compartment thereof used for the transportation of flammable or *combustible liquids* shall not be loaded to absolute capacity. The vacant space in a cargo tank or compartment thereof used in the transportation of flammable or *combustible liquids* shall be not less than 1 percent. Sufficient space shall be left vacant to prevent leakage from or distortion of such tank or compart-

ment by expansion of the contents caused by rise in temperature in transit.

- ❖ To allow for the thermal expansion of flammable or combustible liquids, the maximum allowable capacity of a cargo tank or compartment is 99 percent of the actual capacity. The expansion of flammable or combustible liquids in a confined space will create internal pressures, which may damage the cargo tank or compartment, possibly creating a leak.

**5706.6.1.5 Overfill protection.** The driver, operator or attendant of a tank vehicle shall, before making delivery to a tank, determine the unfilled capacity of such tank by a suitable gauging device. To prevent overfilling, the driver, operator or attendant shall not deliver in excess of that amount.

- ❖ The individual responsible for the operation of the tank vehicle is also responsible for overfill protection. This individual is to calculate the fill quantity. This is the maximum quantity that the individual responsible for the operation of the tank vehicle is to deliver.

**5706.6.1.6 Securing hatches.** During loading, hatch covers shall be secured on all but the receiving compartment.

- ❖ To ensure that the minimum amount of flammable and combustible liquids is exposed to air or to an ignition source, only hatches in actual use during dispensing are to be opened.

**5706.6.1.7 Liquid temperature.** Materials shall not be loaded into or transported in a tank vehicle at a temperature above the material's ignition temperature unless safeguarded in an *approved* manner.

- ❖ Loading and transporting of flammable and combustible liquids above their ignition temperature are prohibited unless the loading operation and the transporting process are protected from the hazards involved in this process. Risks are increased significantly when the liquid is at an elevated temperature.

**5706.6.1.8 Bonding to underground tanks.** An external bond-wire connection or bond-wire integral with a hose shall be provided for the transferring of flammable liquids through open connections into underground tanks.

- ❖ Static electricity will spark between surfaces with different electrical potential. This spark is an ignition source for flammable and combustible liquids. Bonding of the dispensing hose to the underground tank is required, if the transfer is through an open connection. Bonding can be done using wires, ground cables, metal piping or other similar means that will carry current.

**5706.6.1.9 Smoking.** Smoking by tank vehicle drivers, helpers or other personnel is prohibited while they are driving, making deliveries, filling or making repairs to tank vehicles.

- ❖ Smoking is prohibited in the vicinity of the tank vehicle. This eliminates a source of ignition.

**5706.6.1.10 Hose connections.** Delivery of flammable liquids to underground tanks with a capacity of more than 1,000 gallons (3785 L) shall be made by means of *approved* liquid

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and vapor-tight connections between the delivery hose and tank fill pipe. Where underground tanks are equipped with any type of vapor recovery system, all connections required to be made for the safe and proper functioning of the particular vapor recovery process shall be made. Such connections shall be made liquid and vapor tight and remain connected throughout the unloading process. Vapors shall not be discharged at grade level during delivery.

❖ The delivery of Class I liquids to either an above-ground or underground storage tank that exceeds 1,000 gallons (3785 L) in capacity must be through a liquid- and vapor-tight fitting to reduce the potential for the escape of flammable liquid or vapors at the point of connection. These fittings include liquid transfer lines and vapor recovery lines, which are designed to prevent the release of polluting, flammable vapors during transfer. These requirements prohibit the extremely dangerous, but not uncommon, practice of delivery tanker operators not connecting vapor return hoses, thus allowing the vapors displaced during delivery to escape at grade level from the unmade connections. Incidents have been reported where the vapors have traveled to nearby buildings, found an ignition source and exploded (see also commentary, Section 2305.1.3).

**5706.6.1.10.1 Simultaneous delivery.** Simultaneous delivery to underground tanks of any capacity from two or more discharge hoses shall be made by means of mechanically tight connections between the hose and fill pipe.

❖ The simultaneous delivery of flammable and combustible liquids to an underground tank using two or more hoses requires a mechanically tight connection for

each delivery hose to the tank fill pipe. The pressure generated by the delivery could cause one or more of the delivery hoses to leak or to disconnect if the connections are not tight.

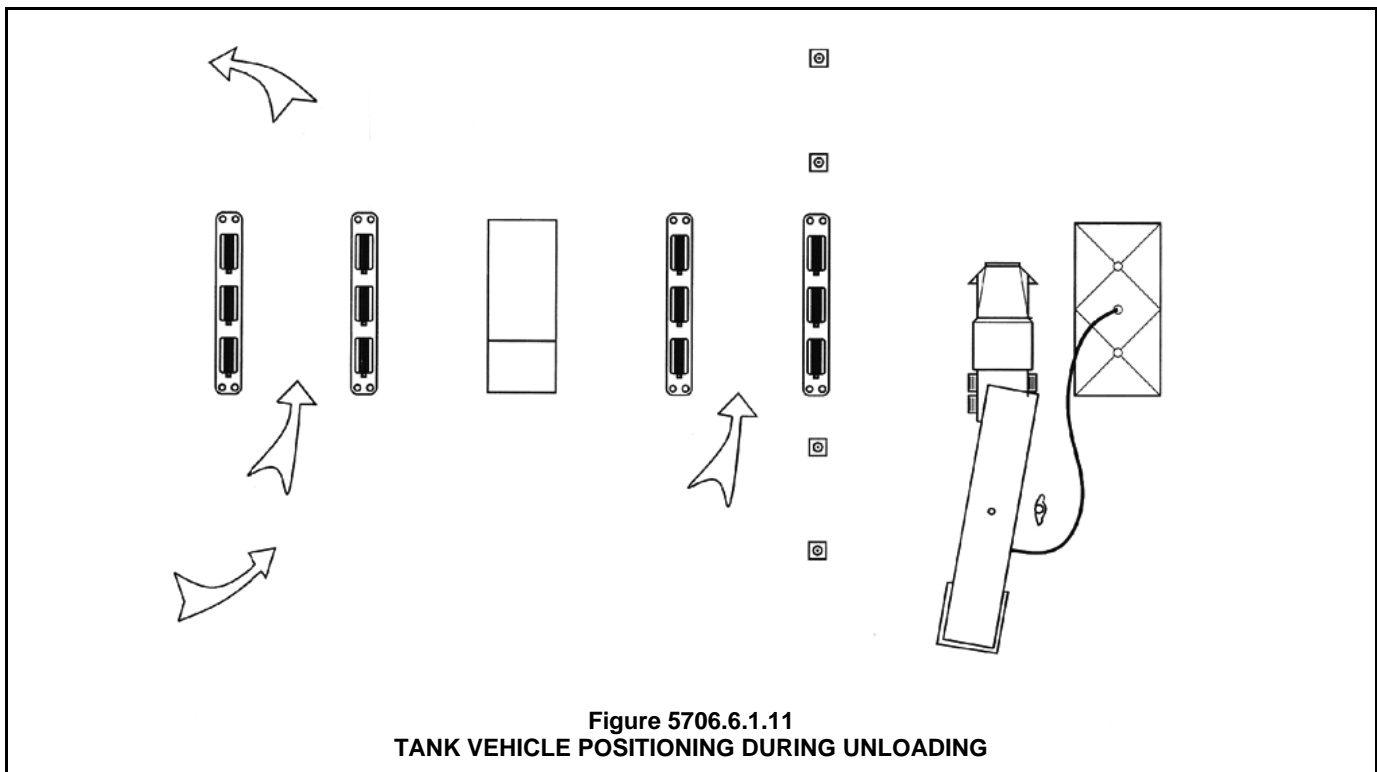
**5706.6.1.11 Hose protection.** Upon arrival at a point of delivery and prior to discharging any flammable or *combustible liquids* into underground tanks, the driver, operator or attendant of the tank vehicle shall ensure that all hoses utilized for liquid delivery and vapor recovery, where required, will be protected from physical damage by motor vehicles. Such protection shall be provided by positioning the tank vehicle to prevent motor vehicles from passing through the area or areas occupied by hoses, or by other *approved* equivalent means.

❖ Whenever possible, fill connections for new underground storage tanks should be located where tank vehicle hose lines will be out of the way of traffic during liquid transfer operations. Otherwise, the tank vehicle should be positioned to minimize the likelihood of damage to the discharge line (which could result in a large spill and potentially a large fire), or traffic cones or pylons should be placed to warn approaching vehicles (see Commentary Figure 5706.6.1.11).

**5706.6.2 Parking.** Parking of tank vehicles shall be in accordance with Sections 5706.6.2.1 through 5706.6.2.3.

**Exception:** In cases of accident, breakdown or other emergencies, tank vehicles are allowed to be parked and left unattended at any location while the operator is obtaining assistance.

❖ The parking of tank vehicles is as important as above-ground tank storage. The quantity of flamma-



**Figure 5706.6.1.11**  
**TANK VEHICLE POSITIONING DURING UNLOADING**

ble and combustible liquids can be substantial in a tank vehicle and exposure to ignition sources is more problematic than in a secured area. The facilities adjacent to the tank vehicle may represent a potential for large loss of life or large property damage. The spread of fire from a tank vehicle is not contained by dikes or a similar containment and drainage system. The fire can spread to areas outside of the tank vehicle location and fire-fighting operations may not be effective if the fire goes into an underground drainage system.

The restrictions on parking do not apply in case of a vehicle breakdown. Because it is impossible to predict or prevent all vehicle failures, the code does not make temporary parking resulting from mechanical failure of the tank vehicle a violation.

**5706.6.2.1 Parking near residential, educational and institutional occupancies and other high-risk areas.** Tank vehicles shall not be left unattended at any time on residential streets, or within 500 feet (152 m) of a residential area, apartment or hotel complex, educational facility, hospital or care facility. Tank vehicles shall not be left unattended at any other place that would, in the opinion of the fire chief, pose an extreme life hazard.

❖ Tank vehicles must not be parked or left unattended in residential districts or near schools, nursing homes, hospitals or similar buildings where the hazards to life may be high and the occupants are more vulnerable.

Maintaining a distance of 500 feet (152 400 mm) to the listed premises provides a spatial buffer between the tank vehicle and the high life-risk property in case of a spill, accident or ignition. This section also allows the fire chief to declare certain other areas of the jurisdiction as being off limits to parking, based on the hazard exposures present. Some jurisdictions have, by local ordinance, specified certain road routes to be used by hazardous cargo vehicles, further reducing the likelihood of a major hazardous materials incident or fire.

**5706.6.2.2 Parking on thoroughfares.** Tank vehicles shall not be left unattended on a public street, highway, public avenue or public alley.

**Exceptions:**

1. The necessary absence in connection with loading or unloading the vehicle. During actual fuel transfer, Section 5706.6.1.2 shall apply. The vehicle location shall be in accordance with Section 5706.6.2.1.
2. Stops for meals during the day or night, where the street is well lighted at the point of parking. The vehicle location shall be in accordance with Section 5706.6.2.1.

❖ Leaving a tank vehicle parked or unattended in a public way invites malicious vandalism to the vehicle or an accidental collision by another vehicle, either of which could cause a release of the cargo, creating a large-scale spill or possible large-area fire if ignition were to occur. The exceptions in this section are very

specific in describing the limited conditions under which the vehicle operator may be absent from the vehicle. The locations where such absence is permitted may be expected to be generally off limits to the public (i.e., unauthorized personnel) or, in the case of meal breaks, sufficiently lighted so as to discourage vandalism and reduce the likelihood of accidental collision.

**5706.6.2.3 Duration exceeding 1 hour.** Tank vehicles parked at one point for longer than 1 hour shall be located off of public streets, highways, public avenues or alleys, and in accordance with either of the following:

1. Inside of a bulk plant and either 25 feet (7620 mm) or more from the nearest *lot line* or within a building *approved* for such use.
2. At other *approved* locations not less than 50 feet (15 240 mm) from the buildings other than those *approved* for the storage or servicing of such vehicles.

❖ In order to prevent the tank vehicle from being subject to accidents or vandalism, this section requires tank vehicles that are parked for durations exceeding 1 hour to be located off streets, highways, avenues or alleys, and either inside of a bulk plant or at other approved locations as specified in the code.

Security should be a major consideration in approving an off-street location for overnight parking. If a satisfactory location cannot be found, as an alternative method based on Section 104.9, the fire code official could consider designating areas in a parking lot for tank vehicles that provide the maximum available separation from buildings and are well-lighted, away from traffic areas, drained away from buildings, etc.

**5706.6.3 Garaging.** Tank vehicles shall not be parked or garaged in buildings other than those specifically *approved* for such use by the *fire code official*.

❖ This section prohibits the parking or garaging of tank vehicles inside of buildings. There is an exception, although it is not shown in the code style, that allows the fire code official to specifically approve a building for the parking or garaging of tank vehicles. Criteria for such specific approval could include a requirement that all liquid cargo be off-loaded (outside the building), and the tank vehicle's cargo tank, piping and hoses cleaned and purged of vapors or made inert in an approved manner before moving into any building or structure.

An alternative criterion for specific approval could be that the building or structure be specifically designed for that purpose and classified in Group H-3 (assuming that the cargo tank is at atmospheric pressure). Group H buildings used for the garaging of tank vehicles would include all code-required safety features for the indoor storage of flammable or combustible liquids, including safety features for control of leaks, spills and ignition sources; fire and fire containment and higher levels of ventilation that are not found in other buildings.

In a Group H-3 scenario, the cargo would not need to be off-loaded and the tank and appurtenances purged or inerted; however, the length of time that a tank vehicle is allowed to be kept inside of a building must be included in the approval and permit process since Section 5704.2.2 very specifically prohibits the use of tank vehicles as storage tanks, whether inside or outside of a building.

**5706.6.4 Portable fire extinguisher.** Tank vehicles shall be equipped with a portable fire extinguisher complying with Section 906 and having a minimum rating of 2-A:20-B:C.

During unloading of the tank vehicle, the portable fire extinguisher shall be out of the carrying device on the vehicle and shall be 15 feet (4572 mm) or more from the unloading valves.

- ❖ A fire extinguisher (2-A:20-B:C) must be available to control a small fire. The fire extinguisher is designed for use on ordinary combustible fires, flammable liquid fires and electrical fires. The extinguisher is to be at least 15 feet (4572 mm) from the unloading valve. This location is convenient for the attendant to close the valve, control the flow of the flammable or combustible liquid and have access to the fire extinguisher to control a fire.

**5706.7 Refineries.** Plants and portions of plants in which flammable liquids are produced on a scale from crude petroleum, natural gasoline or other hydrocarbon sources shall be in accordance with Sections 5706.7.1 through 5706.7.3. Petroleum-processing plants and facilities or portions of plants or facilities in which flammable or *combustible liquids* are handled, treated or produced on a commercial scale from crude petroleum, natural gasoline, or other hydrocarbon sources shall also be in accordance with API 651, API 653, API 752, API 1615, API 2001, API 2003, API 2009, API 2015, API 2023, API 2201 and API 2350.

- ❖ Refineries process crude petroleum or other hydrocarbon sources into flammable or combustible liquids on a commercial scale. These facilities are covered by American Petroleum Institute (API) standards:

*API RP 651:* The standard describes corrosion problems characteristic to above-ground storage tanks and associated piping systems. The standard covers the two current methods used to provide cathodic protection against corrosion.

*API STD 653:* The standard covers the inspection, repair, alteration and reconstruction of steel above-ground storage tanks and includes the minimum requirements for maintaining the integrity of welded or riveted, nonrefrigerated, atmospheric pressure, above-ground storage tanks that have been placed in service.

*API RP 752:* The guide describes a methodology for assessing and evaluating the hazards associated with the location of process plant buildings.

*API RP 1615:* The guide contains the procedures and lists equipment needed for the proper installation of

underground petroleum storage systems. The guide applies to underground storage tank systems that store petroleum products for retail and commercial facilities.

*API RP 2001:* The publication provides an understanding of the fire protection problems and the steps needed to ensure the safe storage, handling and processing of petroleum products in refineries and the safe shipment of petroleum products.

*API RP 2003:* The publication describes some of the conditions that have resulted in fires caused by electrical sparks and arcs from natural causes. The publication describes methods currently used to prevent ignition from these sources.

*API Publ. 2009:* The publication contains suggested precautions for the protection of personnel from injury and property from damage by fire that may arise during the operation of gas and electric cutting and welding equipment in and around petroleum operations.

*API STD 2015:* The standard contains safety procedures for preparing, emptying, isolating, ventilating, atmospheric testing, cleaning, entry, hot work and recommissioning activities in, on and around atmospheric and low pressure [15 psig (103 kPa) or less] above-ground storage tanks. The standard applies to stationary tanks used in petroleum and petrochemical plants and terminals.

*API RP 2023:* The publication is a recommended practice that describes the phenomena that can occur and precautions to be taken in the storage of asphalt products and residue derived from crude oil petroleum. The recommendations apply when these materials are stored in heated tanks at refineries and bulk storage facilities and transported in tank vehicles.

*API RP 2201:* The publication covers the safety aspects to be considered when hot tapping or welding without hot tapping on in-service piping or equipment.

*API RP 2350:* The publication is a recommended practice to prevent petroleum storage tanks from being overfilled. Tank overfill can be effectively reduced by developing and implementing practical and safe operating procedures for storage facilities and by providing for careful selection and application of equipment, scheduled maintenance programs and personnel training. The publication covers overfill protection for above-ground storage tanks in petroleum facilities, including refineries, terminals, bulk plants and pipeline terminals for Class I liquids from main-line pipelines or marine vessels.

**5706.7.1 Corrosion protection.** Above-ground tanks and piping systems shall be protected against corrosion in accordance with API 651.

- ❖ Above-ground tanks must have corrosion protection complying with API 651. Soil and environmental con-

ditions can cause the deterioration of tanks. Corrosion can weaken the tank, creating a potential for leakage.

Cathodic protection uses a sacrificial metal to prevent the corrosion of the metal storage tank. The sacrificial metal is bonded to the tank so the electrochemical reaction of the sacrificial metal prevents the corrosion of the steel storage tank. The sacrificial metal is the anode, the steel storage tank is the cathode and a power supply connects the two. Replacement of the anode will depend on the rate of corrosion.

**5706.7.2 Cleaning of tanks.** The safe entry and cleaning of petroleum storage tanks shall be conducted in accordance with API 2015.

- ❖ The safe entry and cleaning of tanks must comply with API 2015. The environment in a storage tank can be hostile for personnel because the air may not be breathable or may contain a vapor-air mixture within the flammable range. The standard provides mitigation protocols for personnel hazards. See the commentary to Section 5706.7 for a more detailed description of the standard.

**5706.7.3 Storage of heated petroleum products.** Where petroleum-derived asphalts and residues are stored in heated tanks at refineries and bulk storage facilities or in tank vehicles, such products shall be in accordance with API 2023.

- ❖ The storage of heated petroleum products must comply with API 2023. The guide describes the phenomena that can occur and the precautions to be taken in the storage and handling of asphalt products and residue derived from crude-oil petroleum. The heating of these flammable and combustible liquids can result in the release of vapors as well as increase the potential for ignition.

**5706.8 Vapor recovery and vapor-processing systems.** Vapor-processing systems in which the vapor source operates at pressures from vacuum, up to and including 1 psig (6.9 kPa) or in which a potential exists for vapor mixtures in the flammable range, shall comply with Sections 5706.8.1 through 5706.8.5.

**Exceptions:**

1. Marine systems complying with federal transportation waterway regulations such as DOTn 33 CFR Parts 154 through 156, and CGR 46 CFR Parts 30, 32, 35 and 39.
  2. Motor fuel-dispensing facility systems complying with Chapter 23.
- ❖ Vapor-recovery systems must function to prevent the release of vapors and protect the vapor-recovery system during operation in the flammable range.
 

Exception 1 covers marine systems complying with federal regulations. A marine system not complying with federal regulations is in violation of the code and should be reported to the appropriate federal authority for enforcement of federal regulations. Exception 2 addresses service station systems complying with

Chapter 23. A service station system not complying with Chapter 23 is in violation of the code. The motor fuel-dispensing facility system is to be brought into compliance with Chapter 23.

**5706.8.1 Over-pressure/vacuum protection.** Tanks and equipment shall have independent venting for over-pressure or vacuum conditions that might occur from malfunction of the vapor recovery or processing system.

**Exception:** For tanks, venting shall comply with Section 5704.2.7.3.

- ❖ A vapor-recovery system must be equipped with an independent system for venting overpressure or a vacuum. An overpressure condition can damage the vapor-recovery system, creating leaks or other damage. The leak or damage could allow the vapor from a flammable or combustible liquid to escape and generate a vapor-air mixture in the flammable range.

A vacuum condition can result in the introduction of air into the vapor-recovery system. The introduction of air could generate a vapor-air mixture in the flammable range within the vapor-recovery system.

The exception recognizes that tank venting complying with Section 5704.2.7.3 is exempt from this requirement. Tanks are vented to maintain the internal tank pressure within the design operating range. A low pressure can increase the generation of vapors. A high pressure can damage the tank or piping system. Any pressure outside of the design pressure range can have an adverse affect on the operation of the system as well as the piping and equipment.

**5706.8.2 Vent location.** Vents on vapor-processing equipment shall be not less than 12 feet (3658 mm) from adjacent ground level, with outlets located and directed so that flammable vapors will disperse to below the lower flammable limit (LFL) before reaching locations containing potential ignition sources.

- ❖ The termination of a vent pipe must direct vapors away from the building. Vapors from flammable liquids are normally heavier than air so that the vapor will settle to lower levels. The termination of a vent pipe a minimum of 12 feet (3658 mm) above grade will provide space for the vapors to disperse to below the LFL. This high termination elevation also reduces the potential for the termination being in close proximity to grade-level ignition sources. Because flammable liquid vapor is heavier than air, attention must be given to the building design near the termination.

**5706.8.3 Vapor collection systems and overfill protection.** The design and operation of the vapor collection system and overfill protection shall be in accordance with this section and Section 19.5 of NFPA 30.

- ❖ The vapor collection system and overfill protection are to comply with Section 7.10 of NFPA 30. This section addresses the same topics as Section 5706.8. Section 7.10 of NFPA 30 contains additional requirements not specifically listed in Section 5706.8. These requirements are in other sections of this

chapter, but not specifically contained in this section.

These additional requirements are: 1. The vapor collection system is to be designed not to trap liquid in the vapor collection piping; 2. Unless the vapor-recovery system is designed to handle flammable or combustible liquid, the system is to be designed to eliminate any liquid from the vapor-recovery system; 3. Provide protection from ignition sources; 4. Classification of locations for electrical system; 5. Protection from static electricity; 6. Precautions against spontaneous ignition; 7. Prevent friction heat or sparks from mechanical equipment; 8. Prevent the propagation of flame through the vapor-recovery system; 9. When necessary, provisions for explosion prevention; and 10. Requirements for an emergency shutdown system.

**5706.8.4 Liquid-level monitoring.** A liquid knock-out vessel used in the vapor collection system shall have means to verify the liquid level and a high-liquid-level sensor that activates an alarm. For unpopulated facilities, the high-liquid-level sensor shall initiate the shutdown of liquid transfer into the vessel and shutdown of vapor recovery or vapor-processing systems.

❖ Liquid monitoring is necessary to prevent the liquid knockout vessel from overfilling. The liquid-level monitor must sound an alarm or shut down the vapor-recovery process before the liquid knockout vessel is overfilled. Overfill of the liquid knockout vessel could cause a spill of the flammable or combustible liquid.

**5706.8.5 Overfill protection.** Storage tanks served by vapor recovery or processing systems shall be equipped with overfill protection in accordance with Section 5704.2.7.5.8.

❖ Section 5704.2.7.5.8 requires compliance with Sections 5704.2.9.6.6 through 5704.2.9.6.6.2 for tanks storing Class I, II and IIIA liquids. To prevent spillage of liquid from storage tanks served by a vapor-recovery or processing system, the tanks are limited to 95 percent of their capacity by an overfill protection system. Several methods are acceptable. The protection system must include provisions for draining the vapor-recovery or processing system into the storage tank without exceeding the 95-percent capacity.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

*Code Changes Resource Collection—2015 International Fire Code.* Washington, DC: International Code Council, 2014.

NFPA 30-12, *Flammable and Combustible Liquids Code.* Quincy, MA: National Fire Protection Association, 2011.

# Chapter 58: Flammable Gases and Flammable Cryogenic Fluids

## General Comments

The requirements of Chapter 58 address flammable gases and flammable cryogenic fluids, principally bulk hydrogen gas stored as either a compressed gas or as a cryogenic fluid. Note that, while Chapter 55 is intended to apply to all cryogenic fluids regardless of classification, the flammable characteristics will now be regulated by Chapter 58.

Excluding liquefied petroleum gases whose requirements are contained in Chapter 61, this chapter aggregates all of the requirements for flammable gases that are compressed, liquefied compressed or stored as a cryogenic fluid. Section 5806 is divided into two major subsections: Section 5806.3 addresses requirements for above-ground liquid hydrogen vessels and Section 5806.4 addresses the requirements for underground liquid hydrogen vessels. Sections 5806.3.1 and 5806.4.1 require above-ground liquid hydrogen tanks that are not U.S. Department of Transportation (DOT) cylinders and underground liquid hydrogen tanks to be constructed to the requirements of the American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code* (BPVC), Section VIII, Division 1 for unfired pressure vessels. Section 5807 provides regulation of metal hydride storage systems.

Of the three physical states of matter, only gas will ignite without preheating. In order to burn, all other materials must be transformed into a vaporous or gaseous state, regardless of their initial phase. The principal hazard posed by flammable gas and flammable cryogenic fluids is ready ignitability, or even explosivity, when mixed with air in the proper proportions. The question in a release usually is not whether the mixture will ignite, but rather when or how it will ignite if not controlled. Consequently, occupancies storing or handling more than 1,000 cubic feet (28 m<sup>3</sup>) of flammable gas or 30 gallons (114 L) of liquefied flammable gas per control area or 45 gallons (170 L) of flammable cryogenic fluid are classified as Group H-2 (high hazard) by the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>).

## Purpose

Chapter 58 sets requirements for the storage and use of flammable gases and flammable cryogenic fluids. For safety purposes, there is a limit on the quantities allowed per control area. Exceeding these limitations increases the possibility of damage to both property and individuals.

## SECTION 5801 GENERAL

**5801.1 Scope.** The storage and use of flammable gases and flammable cryogenic fluids shall be in accordance with this chapter and NFPA 55. Compressed gases shall also comply with Chapter 53 and cryogenic fluids shall also comply with Chapter 55. Flammable cryogenic fluids shall comply with Section 5806. Hydrogen motor fuel-dispensing stations and repair garages and their associated above-ground hydrogen storage systems shall also be designed, constructed and maintained in accordance with Chapter 23 and NFPA 2.

### Exceptions:

1. Gases used as refrigerants in refrigeration systems (see Section 606).
2. Liquefied petroleum gases and natural gases regulated by Chapter 61.

3. Fuel-gas systems and appliances regulated under the *International Fuel Gas Code* other than gaseous hydrogen systems and appliances.
4. Pyrophoric gases in accordance with Chapter 64.

❖ This section establishes the scope of Chapter 58 with respect to the storage and use of flammable and non-flammable gases, cryogenic fluids and flammable cryogenic fluids. The requirements of this chapter and the referenced standards are applicable in addition to the general storage requirements of Chapter 23 for flammable gas motor fuel dispensing facilities and Chapter 50 for hazardous materials.

**5801.2 Permits.** Permits shall be required as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regu-

late hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit, Sections 105.6.9 and 105.6.11 for discussion of specific quantity-based operational permits for the materials regulated in this chapter and Section 105.7 for a general discussion of activities requiring a construction permit. The permit process also notifies the fire department of the need for prefire planning for hazardous property.

**SECTION 5802  
DEFINITIONS**

**5802.1 Definitions.** The following terms are defined in Chapter 2:

**FLAMMABLE GAS.**

**FLAMMABLE LIQUEFIED GAS.**

**GASEOUS HYDROGEN SYSTEM.**

**HYDROGEN FUEL GAS ROOM.**

**METAL HYDRIDE.**

**METAL HYDRIDE STORAGE SYSTEM.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*® as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4).

**SECTION 5803  
GENERAL REQUIREMENTS**

**5803.1 Quantities not exceeding the maximum allowable quantity per control area.** The storage and use of flammable gases in amounts not exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Sections 5001, 5003, 5801 and 5803.

❖ When the amounts stored or used do not exceed the maximum allowable quantities per control area (MAQs), certain factors that must be adhered to include systems and processes, release of hazardous materials into the air, Material Safety Data Sheets (MSDS), hazard identification signs, sources of ignition and construction requirements.

**5803.1.1 Special limitations for indoor storage and use.** Flammable gases shall not be stored or used in Group A, E, I or R occupancies or in offices in Group B occupancies.

**Exceptions:**

1. Cylinders of nonliquefied *compressed gases* not exceeding a capacity of 250 cubic feet (7.08 m<sup>3</sup>) or

liquefied gases not exceeding a capacity of 40 pounds (18 kg) each at *normal temperature and pressure (NTP)* used for maintenance purposes, patient care or operation of equipment.

2. Food service operations in accordance with Section 6103.2.1.7.
3. Hydrogen gas systems located in a hydrogen fuel gas room constructed in accordance with Section 421 of the *International Building Code*.

❖ Flammable gases must not be stored or used where an accident could cause a large loss of life. They must be stored and used in accordance with preventive guidelines for safety purposes. The limitation to office spaces in Group B occupancies allows small laboratories, doctor or dental spaces or other nonoffice uses classified as Group B to store and use quantities up to the MAQs of flammable or oxidizing gases.

Exception 1 provides that small quantities of liquefied or nonliquefied gases are allowed for maintenance of buildings, taking care of patients and equipment operation. Flammable gas systems are not allowed for these purposes because the large volume would create the potential for a catastrophic event with large loss of life and property.

Exception 2 refers the code user to the code provisions for use of liquefied petroleum gas (LP-gas) in cooking operations in buildings.

Starting with the 2003 editions of the code and the IBC, there existed provisions for the use of a "hydrogen cutoff room" as an incidental use for the storage and use of hydrogen. The purpose was to provide rules for the indoor application of the then-new hydrogen fuel technology. Though language was added to Chapter 23 pointing to the "hydrogen cutoff room" provisions for indoor motor fuel dispensing operations, no pointer was provided for other uses of the new technology, such as the use of hydrogen fuel cells with hydrogen gas cylinders as a fuel supply for clean energy backup power systems. The use of the hydrogen fuel cell for backup power supplies is not occupancy group specific and, though Exception 1 permits the use of hydrogen for operation of equipment, the allowed hydrogen capacity is insufficient for the backup power application. Exception 3 provides a needed pointer to the use of the "hydrogen cutoff room" (renamed "hydrogen fuel gas room") and allows use of this technology in the occupancy groups otherwise restricted by this section. The limiting factor would be the MAQ for flammable gas currently specified by the code. See the commentary to Section 5808.

**5803.1.1.1 Medical gases.** Medical gas system supply cylinders shall be located in medical gas storage rooms or gas cabinets as set forth in Section 5306.

❖ Section 5306 gives requirements for storage rooms and gas cabinets. Storage rooms are to be of 1-hour-

rated construction and be either interior or exterior rooms. Gas cabinets must be connected to an exhaust system, sprinklered internally and meet certain air velocity ventilation requirements.

**5803.1.1.2 Aggregate quantity.** The aggregate quantities of flammable gases used for maintenance purposes and operation of equipment shall not exceed the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1).

❖ Table 5003.1.1(1) contains categories of storage, use-closed systems and use-open systems. Flammable gas is categorized only in the storage and use-closed systems. Because gas is in closed containers and systems, use-open systems do not apply. The base MAQ for either storage or use-closed systems is 1,000 cubic feet (28 m<sup>3</sup>); however, increases for sprinklers and using approved storage cabinets may be applied.

**5803.1.2 Storage containers.** Cylinders and pressure vessels for flammable gases shall be designed, constructed, installed, tested and maintained in accordance with Chapter 53.

❖ Sections 5303 and 5304 give requirements for storage containers, such as markings on tanks, securing the tanks to prevent dislodging, protection of the valves, separation from hazards, electrical wiring, exposure to fire, unauthorized use, leak prevention, overhead protection and grounding to properly prevent a lightning hazard.

**5803.1.3 Emergency shutoff.** *Compressed gas* systems conveying flammable gases shall be provided with *approved* manual or automatic emergency shutoff valves that can be activated at each point of use and at each source.

❖ In order to maintain control over the flow of flammable gases under emergency conditions, each supply source, as well as each point of use of flammable compressed gas, must have an approved emergency shutoff valve. These valves must be excess flow control valves to regulate the rate of flow of hazardous materials within the piping system, fail-safe valves or other approved types that will operate automatically, or there must be a manual means of operation to give the fire department or other responsible persons the ability to stop the flow of hazardous materials in an emergency. The valves must be readily accessible and comply with Section 5003.2.2.1. See also the commentary to the definitions of “Emergency shutoff valve,” “Emergency shutoff valve, manual” and “Emergency shutoff valve, automatic” in Section 202.

**5803.1.3.1 Shutoff at source.** A manual or automatic fail-safe emergency shutoff valve shall be installed on supply piping at the cylinder or bulk source. Manual or automatic cylinder valves are allowed to be used as the required emergency shutoff valve where the source of supply is limited to unmanifolded cylinder sources.

❖ Where the source of the gas is limited to cylinder sources that are not manifolded, the shutoff valve can be the cylinder valve itself. If cylinders are manifolded

or if the source is other than cylinders, an independent shutoff valve is required to be installed in the piping system.

**5803.1.3.2 Shutoff at point of use.** A manual or automatic emergency shutoff valve shall be installed on the supply piping at the point of use or at a point where the equipment using the gas is connected to the supply system.

❖ Emergency shutoff valves are to be installed on the supply piping either at the use point or where equipment is connected. Either manual or automatic valves are allowed to be used. For example, it is common in some installations to have gas piped to a room for use with portable or fixed equipment. Emergency shutoff valves are typically provided at the point where the piping first enters the room. Equipment may not be connected to the valve; however, the valve represents the point of connection for use. When equipment is connected to the supply system, a valve that isolates the equipment is required. It may or may not be the same valve as that used at the point of penetration. Either valve is allowed to be manual or automatic, and either valve serves as an emergency shutoff valve.

**5803.1.4 Ignition source control.** Ignition sources in areas containing flammable gases in storage or in use shall be controlled in accordance with Section 5003.7.

**Exception:** Fuel gas systems connected to building service utilities in accordance with the *International Fuel Gas Code*.

❖ As discussed in the commentary to Chapter 3, an ignition source is needed to ignite a fuel load and cause a fire. Making sure electrical equipment located in gas storage areas is properly grounded is one of the primary ways to control ignition sources. The exception exempts flammable gas systems that are used primarily as a source of fuel furnished by a public utility service. The term “service utilities” is used in IBC Section 112 to describe those utilities that are used to provide building service. Without this exception, any area in which a fuel gas is used would be required to be posted.

The exception is focused on building services and as such is not intended to address the use of flammable gases such as hydrogen that may be generated on site, or otherwise supplied to an area of dispensing or use.

**5803.1.4.1 Static-producing equipment.** Static-producing equipment located in flammable gas storage areas shall be grounded.

❖ This requirement is intended to reduce the likelihood of a buildup of static electricity that could produce a spark that may become an ignition source for flammable gas. This requirement is similar to grounding requirements for electrical equipment in other hazardous material storage and handling areas, such as flammable liquids or LP-gas, and in combustible dust-producing environments. Although the text of this

section is the same as that of Section 5803.1.5.2, the applicability here is to equipment other than electrical wiring and equipment.

**5803.1.4.2 Signs.** “No Smoking” signs shall be posted at entrances to rooms and in areas containing flammable gases in accordance with Section 5003.7.1.

❖ Establishing no-smoking zones in, around and at the entrance to flammable gas storage and use areas is another means of controlling a common ignition source. Section 5003.7.1, Item 4 requires signage in the room or area where flammable materials are stored, dispensed or used. Even if the entire facility is designated as a “No Smoking” facility, entrance doors to flammable gas areas are required to be posted (see Section 5003.7.1, Item 3). With the development of provisions for the use of hydrogen as an alternative fuel, hydrogen cutoff rooms have been created. These rooms are to be used for compression, generation, storage and dispensing of hydrogen. See IBC Section 421 for further information on hydrogen cutoff rooms.

There are a multitude of other instances where posting should be provided to warn users of the potential presence of flammable gases prior to entering a room or area. Posting at the entrance to the room or area in which flammable gases are compressed or generated provides early warning of the hazard prior to entering the space. Signage on the outside entrances to such areas, as well as inside the area, is warranted. Signs should be in accordance with Section 310.

**5803.1.5 Electrical.** Electrical wiring and equipment shall be installed and maintained in accordance with Section 605 and NFPA 70.

❖ This section establishes the applicability of NFPA 70 to all electrical wiring and equipment in flammable gas occupancies. In order to control the ignition and personnel hazards of electrical wiring located where flammable gas might be released by malfunctioning equipment, rupture or breakage, they are typically classified as Class I, Division 2 wiring methods and equipment under the provisions of NFPA 70.

**5803.1.5.1 Bonding of electrically conductive materials and equipment.** Exposed noncurrent-carrying metal parts, including metal gas piping systems, that are part of flammable gas supply systems located in a hazardous (electrically classified) location shall be bonded to a grounded conductor in accordance with the provisions of NFPA 70.

❖ NFPA 70 requires bonding and grounding of metal gas piping systems and other noncurrent-carrying metal parts that are likely to become energized. Flammable gas piping and supply and transfer systems are subject to differences in electrical potential as gas is transferred from one portion of the system to another. By bonding the system and connecting the bond to ground, the system will be brought to a common potential. The limitation is placed on sys-

tems located in hazardous or electrically classified areas, because in these areas ignition is likely and differences in electrical potential represent the greatest hazard.

**5803.1.5.2 Static-producing equipment.** Static-producing equipment located in flammable gas storage or use areas shall be grounded.

❖ This requirement is intended to reduce the likelihood of a buildup of static electricity that could produce a spark that may become an ignition source for flammable gas. This requirement is similar to grounding requirements for electrical equipment in other hazardous material storage and handling areas, such as flammable liquids or LP-gas, and in combustible dust-producing environments. Although the text of this section is the same as that of Section 5803.1.4.1, the applicability here is to electrical wiring and equipment as sources of static electricity.

**5803.1.6 Liquefied flammable gases and flammable gases in solution.** Containers of liquefied flammable gases and flammable gases in solution shall be positioned in the upright position or positioned so that the pressure relief valve is in direct contact with the vapor space of the container.

**Exceptions:**

1. Containers of flammable gases in solution with a capacity of 1.3 gallons (5 L) or less.
2. Containers of flammable liquefied gases, with a capacity not exceeding 1.3 gallons (5 L), designed to preclude the discharge of liquid from safety relief devices.

❖ This section requires that pressure relief valves communicate with the container vapor space where there is a liquid component to the flammable gas storage method. Pressure relief valves are designed on the basis of gas flow, not liquid flow. As such, in the event of an abnormal increase in container pressure that could cause the pressure relief valve to operate, a pressure relief valve that is in contact with and attempts to pass liquid will operate much more slowly to reduce container pressure, thus increasing the potential for container failure. Passing liquid through a pressure relief valve to the atmosphere can also lead to a sudden vaporization of the liquid into a much larger quantity of flammable gas than would be released had the valve communicated with the vapor space. The magnitude of the vaporization depends upon the expansion ratio [from liquid to gas at 14.7 psia (101 kPa)] of the liquefied gas being stored. Propane, for example, has an expansion ratio of 1 to 270.

The exceptions recognize the lesser hazard of small containers used in everyday commerce, such as torch cylinders, table-top grill cylinders, etc. Exception 1 focuses on small containers containing gases that are dissolved in solution (such as acetylene dissolved in acetone). Exception 2 focuses on similar small containers that are designed specifically

to prevent liquid discharge through the pressure relief valve.

**5803.2 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of flammable gases in amounts exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Chapter 50 and this chapter.

❖ Section 5003.1.4 addresses quantities that exceed the MAQ. The MAQs are located in Tables 5003.1.1(1) through 5003.1.1(4).

### SECTION 5804 STORAGE

**5804.1 Indoor storage.** Indoor storage of flammable gases in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1), shall be in accordance with Sections 5001, 5003 and 5004, and this chapter.

❖ Sections 5003.1 through 5003.11 give the requirements for the indoor storage of flammable gases, including design and construction; equipment; maintenance; markings and signs.

**5804.1.1 Explosion control.** Buildings or portions thereof containing flammable gases shall be provided with explosion control in accordance with Section 911.

❖ Table 911.1 gives the barricade and explosion control requirements for flammable gases. Section 911 gives deflagration, explosion venting and barricade requirements.

**5804.2 Outdoor storage.** Outdoor storage of flammable gases in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(3) shall be in accordance with Sections 5001, 5003 and 5004, and this chapter.

❖ Section 5001 covers the classification of the hazard of flammable gases. The MAQs of the gases are given in Table 5003.1.1(3). Section 5004 deals with the storage of flammable gases. The section covers ventilation, separation, fire-extinguishing systems, emergency power, limit controls, supervision and weather protection.

### SECTION 5805 USE

**5805.1 General.** The use of flammable gases in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) or 5003.1.1(3) shall be in accordance with Sections 5001, 5003 and 5005, and this chapter.

❖ Section 5005 addresses separation, spill control, limit controls, lighting, fire-extinguishing systems, open systems, ventilation, outdoor dispensing and handling of flammable gases.

### SECTION 5806 FLAMMABLE CRYOGENIC FLUIDS

**5806.1 General.** The storage and use of flammable *cryogenic fluids* shall be in accordance with Sections 5806.2 through 5806.4.8.3 and Chapter 55.

❖ This section introduces the following sections that address the requirements for the storage and use of flammable cryogenic fluids. In addition to these hazard-specific requirements, the general provisions applicable to cryogenic fluids in Chapter 55 also apply. Note that Sections 5806.4 through 5806.4.8.3 were formerly contained in Chapter 55.

**5806.2 Limitations.** Storage of flammable *cryogenic fluids* in stationary containers outside of buildings is prohibited within the limits established by law as the limits of districts in which such storage is prohibited (see Section 3 of the Sample Legislation for Adoption of the *International Fire Code* on page xxi).

❖ This section reminds users that there may be an ordinance in the jurisdiction that would limit the location or amount of cryogenic fluid that could be stored outside of buildings. Generally, such restrictions will be based on locations in densely populated areas or similar factors. This section does not limit the amount that can be stored; it is simply a note to the code user to review any local rules or ordinances for restrictions before investing time and money in designing a facility that may not be usable. If such areas do exist in the adopting community, they must be enumerated in the adopting ordinance.

**5806.3 Above-ground tanks for liquid hydrogen.** Above-ground tanks for the storage of liquid hydrogen shall be in accordance with Sections 5806.3 through 5806.3.2.1.

❖ This section introduces the following sections that address the requirements for above-ground tank construction in a more specific manner than that described in Section 5003.2.1. The requirements for construction for above-ground tanks parallel those found for underground tanks with the exception that the vacuum jacket (outer tank) is not required to be constructed to meet requirements of the ASME BPVC. The vacuum jacket is designed to provide an insulated layer around the inner vessel through the use of vacuum and an insulating layer. It is also designed to contain and relieve a release of hydrogen should a leak occur in the annular space. The jacket is designed to a safety factor of two. For underground tanks, the safety factor is increased due to potential loading by the use of ASME requirements where the safety factor of three and a half is used.

The design criteria are found in CGA H-3 which, while not referenced in the code, is available for use by those that seek to establish more detailed design requirements than would otherwise be available through the use of Section 5003.2.1. The minimum design requirements established by Section 5806.3

coupled with the general requirements of Chapter 55 applicable to all cryogenics result in greater consistency and an increase in public safety.

**5806.3.1 Construction of the inner vessel.** The inner vessel of storage tanks in liquid hydrogen service shall be designed and constructed in accordance with Section VIII, Division 1, of the ASME *Boiler and Pressure Vessel Code* and shall be vacuum jacketed in accordance with Section 5806.3.2.

❖ Hydrogen in a liquid state must be stored at very low temperatures in tanks insulated to maintain that temperature. The inner vessel of the assembly must be constructed as a pressure vessel in accordance with the ASME BPVC, Section VIII, Division 1 to withstand the liquid hydrogen pressures.

Liquid hydrogen storage tanks are designed and manufactured as double-walled tanks equipped with a layer of insulation between the inner tank and the outer jacket. Additionally, the annular space between the inner tank and outer jacket is held under a vacuum for further insulation. Leakage of either the outer jacket through external corrosion or the inner tank through an internal crack will result in a loss of vacuum and early detection of the leak.

**5806.3.2 Construction of the vacuum jacket (outer vessel).**

The vacuum jacket used as an outer vessel for storage tanks in liquid hydrogen service shall be of welded steel construction designed to withstand the maximum internal and external pressure to which it will be subjected under operating conditions to include conditions of emergency pressure relief of the annular space between the inner and outer vessel. The jacket shall be designed to withstand a minimum collapsing pressure differential of 30 psi (207 kPa).

❖ The construction requirements for the vacuum jacket will be different depending on whether the vessel will be installed above ground or underground. For above-ground liquid hydrogen vessels, the requirements in this section are applicable and for underground vessels, Section 5806.4.8.

Above-ground vacuum-jacketed vessels must be designed to withstand the maximum internal and external pressure to which they may be subjected. Because the primary inner vessel is designed as a pressure vessel, the vacuum jacket must be designed to withstand a collapse due to the loss of vacuum and be capable of withstanding the pressure that can result in the event the liquid hydrogen vessel becomes involved in a fire or is subjected to the radiation energy of an exposure fire. While the probability of such an event is low, it is possible that hydrogen could leak from the primary pressure vessel into the annular space created by the vacuum jacket. This section requires that the outer vessel be designed for a minimum collapse pressure differential of 30 psig (207 kPa) and with a means of pressure relief to ensure that the inner primary vessel and the outer jacket safely relieve any pressure in the event the vessel is subjected to fire exposure.

**5806.3.2.1 Vacuum-level monitoring.** A connection shall be provided on the exterior of the vacuum jacket to allow measurement of the pressure within the annular space between the inner and outer vessel. The connection shall be fitted with a bellows-sealed or diaphragm-type valve equipped with a vacuum gauge tube that is shielded to protect against damage from impact.

❖ This section and Section 5806.4.8.3 require a means of monitoring the underground and above-ground liquid hydrogen tanks to ensure that vacuum pressure is maintained. Loss of vacuum pressure will result in the increased heating of the primary vessel, which will increase the pressure inside of the container. Eventually the pressure will reach and exceed the vessel's maximum allowable working pressure, which will result in the operation of the pressure relief device. For above-ground liquid hydrogen tanks, a connection with a tube or pipe terminated into the vacuum space is required by this section to terminate at a valve equipped with a vacuum pressure gauge so the pressure can be monitored. This section specifies the use of a bellows-sealed or diaphragm valve. A bellows valve is constructed with a steel bellows that is welded to the valve stem and the valve bonnet. This bellows creates a multiple layer barrier that prevents the release of any product around the valve packing or the valve gasket. Bellows valves are generally specified based on the number of cycles the valve can anticipate over its service life, which can vary from 2,000 to 10,000 cycles. A diaphragm valve is constructed in a similar manner in that the internal diaphragm isolates the working parts of the valve from the cryogenic hydrogen and isolates the valve inlet from the valve outlet. Regarding underground liquid hydrogen containers, Section 5806.4.8.3 requires that the method of monitoring the vacuum pressure be approved.

**5806.4 Underground tanks for liquid hydrogen.** Underground tanks for the storage of liquid hydrogen shall be in accordance with Sections 5806.4.1 through 5806.4.8.3.

❖ Underground storage of fuel is a common practice at consumer sites such as motor fuel-dispensing facilities. The benefits of underground storage include reduced risk of fire and hazards resulting from damage caused by vehicles or vandals. Also, unlike underground fuel storage tanks containing petroleum products, liquid hydrogen tanks present no known risk to groundwater should a leak, spill or overflow occur. Released hydrogen will evaporate to the atmosphere and will not contaminate groundwater.

Cryogenic liquid storage tanks traditionally have been installed above ground. This practice is documented in CGA P-12, which states, "Bulk storage tanks and vessels should be installed above ground and out-of-doors so that they are readily accessible to mobile supply equipment at ground level and to authorized personnel." Further, CGA G-5.4 states, "Liquid hydrogen piping shall not be installed underground."

The current interest in hydrogen vehicle fueling stations in locations similar to present gasoline-fueling stations demonstrates an increased need to place liquid hydrogen tanks at sites with limited space for a typical above-ground installation. Based on the compressed gas industry's extensive experience with cryogenic liquid storage tanks and their associated piping systems, installing cryogenic liquid storage tanks underground with proper engineering and controls is thought to be a safe alternative to the traditional practice of limiting installations to above ground only.

Underground tanks require special care and attention in design and installation because they are exposed to conditions not associated with above-ground tanks. Leakage is harder to detect and protection from loads being placed on top of or adjacent to the underground tank is needed to prevent damage to it. Additionally, the underground tank must be protected from flooding and from floating in areas having a groundwater table that may be above the bottom of the underground tank. Safeguards to mitigate these effects are contained in Sections 5806.4.1 through 5806.4.8.3.

**5806.4.1 Construction.** Storage tanks for liquid hydrogen shall be designed and constructed in accordance with ASME *Boiler and Pressure Vessel Code* (Section VIII, Division 1) and shall be vacuum jacketed in accordance with Section 5806.4.8.

❖ Hydrogen in a liquid state must be stored at very low temperatures, usually at or below -423°F (-253°C), in tanks insulated to maintain that temperature and constructed to withstand the liquid hydrogen pressures.

Liquid hydrogen storage tanks, designed, built and stamped in accordance with ASME BPVC, Section VIII, Division 1, can be installed underground as long as certain minimum criteria are met. Liquid hydrogen tanks are designed and manufactured as double-walled tanks equipped with a layer of insulation between the inner tank and the outer jacket. Additionally, the annular space between the tanks is held under a vacuum for further insulation. Leakage of either the outer jacket through external corrosion or the inner tank through an internal crack will result in a loss of vacuum and early detection of the leak.

**5806.4.2 Location.** Storage tanks shall be located outside in accordance with the following:

1. Tanks and associated equipment shall be located with respect to foundations and supports of other structures such that the loads carried by the latter cannot be transmitted to the tank.
2. The distance from any part of the tank to the nearest wall of a *basement*, pit, cellar or *lot line* shall be not less than 3 feet (914 mm).

3. A minimum distance of 1 foot (305 mm), shell to shell, shall be maintained between underground tanks.

❖ Underground tanks must be located away from a building or structure so that the tank does not support the building or structure since such loads can cause the underground tank to rupture.

Underground tanks are to be a minimum of 3 feet (914 mm) from the nearest below-grade wall or property line because any leakage from an underground tank may migrate through the soil and enter an adjacent basement, cellar or pit. The accumulation of hydrogen gas in such locations could develop into a hazardous condition. Because the owner of the underground tank does not own the adjacent property, the location of the underground tank should not have the potential to affect the adjacent property or the use of this property.

To provide physical independence between underground tanks so that they share no common or projected loads, a minimum shell-to-shell clearance of 1 foot (305 mm) is required between adjacent underground tanks.

**5806.4.3 Depth, cover and fill.** The tank shall be buried such that the top of the vacuum jacket is covered with not less than 1 foot (305 mm) of earth and with concrete not less than 4 inches (102 mm) thick placed over the earthen cover. The concrete shall extend not less than 1 foot (305 mm) horizontally beyond the footprint of the tank in all directions. Underground tanks shall be set on firm foundations constructed in accordance with the *International Building Code* and surrounded with not less than 6 inches (152 mm) of noncorrosive inert material, such as sand.

**Exception:** The vertical extension of the vacuum jacket as required for service connections.

❖ Excavation for underground tanks must not damage existing adjacent structures and must provide a sound foundation for the underground tank. The use of 6 inches (152 mm) of well-tamped, noncorrosive material (e.g., sand or clean pea gravel) around an underground tank prevents concentrated loads from being applied to the tank. These concentrated loads can be caused during backfilling when a hard solid object, such as a rock, comes in contact with the underground tank. Soil pressures on the rock can be concentrated into a small contact area with the underground tank and lead to a leak in the vacuum jacket.

While the 1 foot (305 mm) of earth cover plus a 4-inch (102 mm) concrete slab will provide physical protection for the tank from most predictable load scenarios, it would not alone provide adequate protection from the imposition of vehicular loads upon the tank. However, the provisions of this section and those for vacuum jacket construction in Section 5806.4.8 of the code are intended to work together to provide adequate protection from all anticipated loads, including vehicle loads.

The exception recognizes the practical limitations of maintaining the required burial depth and cover on vertical vacuum jacket extensions used to provide above-ground control and monitoring points, such as for vacuum and liquid level gauges, manually operated valves, controls, pressure relief devices and instrumentation, which need to be readily accessible to mobile supply equipment at ground level and to authorized personnel.

**5806.4.4 Anchorage and security.** Tanks and systems shall be secured against accidental dislodgement in accordance with this chapter.

❖ Sections 5503.5.2 and 5504.3.1.1.4 of the code detail the provisions for security of cryogenic fluid containers. See the commentary to those sections for further information.

**5806.4.5 Venting of underground tanks.** Vent pipes for underground storage tanks shall be in accordance with Section 5503.3.

❖ Section 5503.3 regulates pressure relief vent piping. Additional venting requirements were formerly contained in Section 2309.5.4 but were removed in the 2012 edition. For additional pressure relief device venting, the provisions of Chapter 8 of NFPA 2 apply in accordance with Section 5801.1. See the commentary to Sections 5503.3 through 5503.3.2.

**5806.4.6 Underground liquid hydrogen piping.** Underground liquid hydrogen piping shall be vacuum jacketed or protected by *approved* means and designed in accordance with Chapter 55.

❖ Piping associated with underground liquid hydrogen storage tanks must be provided with the same level of design integrity as the tank that it serves. If the piping is not designed with a vacuum jacket, an engineered design complying with the performance requirements of Chapter 55 and approved by the fire code official must be provided.

**5806.4.7 Overfill protection and prevention systems.** An *approved* means or method shall be provided to prevent the overfill of all storage tanks.

❖ The purpose of spill and overfill protection equipment is to reduce the potential for a hydrogen release during deliveries by stopping product flow, reducing product flow or alerting the delivery person during delivery before the tank becomes full and begins releasing hydrogen into the environment. The equipment must be maintained in proper working order and used properly to provide adequate protection from overfills.

**5806.4.8 Vacuum jacket construction.** The vacuum jacket shall be designed and constructed in accordance with Section VIII of ASME *Boiler and Pressure Vessel Code* and shall be designed to withstand the anticipated loading, including loading from vehicular traffic, where applicable. Portions of the

vacuum jacket installed below grade shall be designed to withstand anticipated soil, seismic and hydrostatic loading.

❖ This section, along with Section 5806.4.3, requires that the design of the tank's vacuum jacket and the tank's burial depth and cover work together to provide a tank installation unlikely to be affected by any anticipated loading conditions, including the possibility of vehicles being driven over the installation site.

**5806.4.8.1 Material.** The vacuum jacket shall be constructed of stainless steel or other *approved* corrosion-resistant material.

❖ Soil conditions and environmental conditions can cause tanks to deteriorate. Corrosion can weaken the tank, creating a potential for leakage. The tank must be protected from corrosion by use of corrosion-resistant material, coatings, cathodic protection or alternative methods approved by the fire code official.

**5806.4.8.2 Corrosion protection.** The vacuum jacket shall be protected by *approved* or *listed* corrosion-resistant materials or an engineered cathodic protection system. Where cathodic protection is utilized, an *approved* maintenance schedule shall be established. Exposed components shall be inspected not less than twice a year. Records of maintenance and inspection events shall be maintained.

❖ Deterioration of tanks, piping and components caused by corrosion can allow leaks and spillage of liquid hydrogen. Using noncorrodible materials of construction or cathodic (galvanic) protection can protect the tank, piping and components from deterioration and failure from corrosive effects.

Cathodic protection uses a sacrificial anode to prevent the corrosion of the metal vacuum jacket of the storage tank. The sacrificial anode is electrically bonded to the tank, so the electrochemical reaction of the sacrificial anode reduces or prevents the corrosion of the steel vacuum jacket of the storage tank. The sacrificial anode and the steel vacuum jacket of the storage tank, acting as a cathode, are interconnected with a power supply. The need to replace the anode will depend on the rate of corrosion.

While not specifically prohibited by this section, the joining of dissimilar metals in system construction should be avoided because of the localized galvanic action that could occur between them. This localized galvanic action could cause one of the metals to corrode to failure so that the other metal is protected from corrosion.

Because cathodic protection systems are more complex than other corrosion protection methodologies and in order to verify that the system is functioning properly, a fire code official's approved maintenance and inspection schedule must be established with all activities recorded. Records must be retained and should be made available for examination by the fire code official or a duly authorized representative of the fire code official when requested.

**5806.4.8.3 Vacuum-level monitoring.** An *approved* method shall be provided to indicate loss of vacuum within the vacuum jacket(s).

- ❖ In order for vacuum-jacketed tanks to be effective in maintaining liquid hydrogen at the required subzero temperature, the vacuum must be maintained at the manufacturer's design level. This section requires that an approved method of monitoring the integrity of the vacuum jacket be provided. Though no alarm system is required to be activated upon loss of the interstitial vacuum, it is important that administrative procedures require regular checking of the monitoring method to reduce the likelihood of loss of the liquid hydrogen (see also commentary, Section 5806.3.2.1).

## SECTION 5807 METAL HYDRIDE STORAGE SYSTEMS

**5807.1 General requirements.** The storage and use of metal hydride storage systems shall be in accordance with Sections 5801, 5803, 5804, 5805 and 5807. Those portions of the system that are used as a means to store or supply hydrogen shall also comply with Chapters 50 and 53 as applicable.

- ❖ Metal hydride storage systems (MHSS) are subject to the requirements in Section 5003.1.1 and IBC Sections 414 and 415 for hazardous materials, in addition to the indicated provisions of this chapter. The requirements include that the total volume of hydrogen in the fuel cells cannot exceed the compressed flammable gas MAQ of 1,000 cubic feet (28 m<sup>3</sup>) at NTP in a single control area located at the grade plane of a building.

**5807.1.1 Classification.** The hazard classification of the metal hydride storage system, as required by Section 5001.2.2, shall be based on the hydrogen stored without regard to the metal hydride content.

- ❖ When classifying the metals and hydrogen contained in an MHSS, this section prescribes that only the compressed hydrogen be considered in the classification and determination of the amount of compressed gas. The type and amount of metal used to adsorb the hydrogen is not considered when classifying hazardous materials contained in a MHSS. For the purpose of determining the MAQ, Section 5807.1.1 specifies all MHSSs should only be evaluated based on the amount of compressed flammable gas.

**5807.1.2 Listed or approved systems.** Metal hydride storage systems shall be *listed* or *approved* for the application and designed in a manner that prevents the addition or removal of the metal hydride by other than the original equipment manufacturer.

- ❖ The design of an MHSS must prevent the addition or removal of the metal hydride by unauthorized individuals. Some metal hydrides can present other physical and health hazards. This section requires that MHSS

be either listed or approved by the code official and any addition or removal of metal hydrides is to be performed by the original equipment manufacturer. When being filled, Section 5807.1.9.2 requires that the hydrogen be of a purity specified by the manufacturer.

**5807.1.3 Containers, design and construction.** *Compressed gas* containers, cylinders and tanks shall be designed and constructed in accordance with Section 5303.2.

- ❖ Containers, tanks and cylinders used in MHSS are to be constructed in accordance with U.S. DOT and Compressed Gas Association (CGA) requirements for cylinders or in accordance with Section VIII, Division 1 of the ASME BPVC. This section requires all cylinders, containers or tanks used for the primary containment of metal hydrides and hydrogen to meet the requirements of Section 5303.2. See the commentary to that section for further information.

**5807.1.4 Service life and inspection of containers.** Metal hydride storage system cylinders, containers or tanks shall be inspected, tested and requalified for service at not less than 5-year intervals.

- ❖ To ensure that hydrogen and metal hydrides are safely contained, the cylinders, tanks and containers are also subject to periodic inspection and requalification in accordance with U.S. DOT requirements and this section. This section establishes a maximum requalification frequency of 5 years.

**5807.1.5 Marking and labeling.** Marking and labeling of cylinders, containers, tanks and systems shall be in accordance with Section 5303.4 and Sections 5807.1.5.1 through 5807.1.5.4.

- ❖ The requirements for MHSS include marking and labeling of important system components to confirm that the design complies with the requirements of Chapters 50 and 53, as well as those in Section 5807.

**5807.1.5.1 System marking.** Metal hydride storage systems shall be marked with all of the following:

1. Manufacturer's name.
2. Service life indicating the last date the system can be used.
3. A unique code or serial number specific to the unit.
4. System name or product code that identifies the system by the type of chemistry used in the system.
5. Emergency contact name, telephone number or other contact information.
6. Limitations on refilling of containers to include rated charging pressure and capacity.

- ❖ The marking requirements in this section for various components of the assembled MHSS are intended to ensure that the MHSS is properly filled and the design pressure and temperature of the system is not exceeded. The markings must also identify the basic chemistry of the MHSS in the unlikely event a metal

hydride is released from a container. Markings are required for the cylinder valve in accordance with Section 5807.1.5.2, the pressure relief device in accordance with the requirements in Section 5807.1.5.3 and the cylinder or pressure vessel containing the metal hydride and hydrogen in accordance with Section 5807.1.5.4.

**5807.1.5.2 Valve marking.** Metal hydride storage system valves shall be marked with all of the following:

1. Manufacturer's name.
2. Service life indicating the last date the valve can be used.
3. Metal hydride service in which the valve can be used, or a product code that is traceable to this information.

❖ See the commentary to Section 5807.1.5.1.

**5807.1.5.3 Pressure relief device marking.** Metal hydride storage system pressure relief devices shall be marked with all of the following:

1. Manufacturer's name.
2. Metal hydride service in which the device can be used, or a product code that is traceable to this information.
3. Activation parameters to include temperature, pressure or both.

❖ See the commentary to Section 5807.1.5.1.

**5807.1.5.3.1 Pressure relief devices integral to container valves.** The required markings for pressure relief devices that are integral components of valves used on cylinders, containers and tanks shall be allowed to be placed on the valve.

❖ See the commentary to Section 5807.1.5.1.

**5807.1.5.4 Pressure vessel markings.** Cylinders, containers and tanks used in metal hydride storage systems shall be marked with all of the following:

1. Manufacturer's name.
2. Design specification to which the vessel was manufactured.
3. Authorized body approving the design and initial inspection and test of the vessel.
4. Manufacturer's original test date.
5. Unique serial number for the vessel.
6. Service life identifying the last date the vessel can be used.
7. System name or product code that identifies the system by the type of chemistry used in the system.

❖ See the commentary to Section 5807.1.5.1.

**5807.1.6 Temperature extremes.** Metal hydride storage systems, whether full or partially full, shall not be exposed to artificially created high temperatures exceeding 125°F (52°C) or subambient (low) temperatures unless designed for use under the exposed conditions.

❖ The intent of this section is to prevent damage to the MHSS or the accidental release of hydrogen due to the cylinder exceeding its design pressure. As such,

this section requires that MHSS be located in an area where they are not subject to artificially high or low temperatures. It prohibits any MHSS from exposure to temperatures in excess of 125°F (52°C) or excessively low temperatures unless it is designed for use in such environments.

**5807.1.7 Falling objects.** Metal hydride storage systems shall not be placed in areas where they are capable of being damaged by falling objects.

❖ The intent of this section is to prevent damage to the MHSS from falling objects. As such, this section requires that MHSS be located in an area where they are not subject to being struck by falling objects. In climates subject to freezing, this could include keeping the MHSS well clear of buildings or other structures where accumulated ice could fall from the structure and strike the MHSS.

**5807.1.8 Piping systems.** Piping, including tubing, valves, fittings and pressure regulators, serving metal hydride storage systems, shall be maintained gas tight to prevent leakage.

❖ All apparatus, connected and part of the MHSS, shall comply with this section and Chapter 50. Proper maintenance of all the components ensures that gas leaks with possible ignition are prevented.

**5807.1.8.1 Leaking systems.** Leaking systems shall be removed from service.

❖ Accidental spills create a vapor release that can quickly travel from the spill point to an ignition source. Because spills need immediate attention to neutralize and remove the hazard, the local fire department should be notified; it is the agency best prepared to deal with the immediate hazards of a spill.

Leaks can indicate a developing problem with equipment or piping needing immediate repair. Until repairs are made, the equipment or piping must be taken out of service.

**5807.1.9 Refilling of containers.** The refilling of *listed* or *approved* metal hydride storage systems shall be in accordance with the listing requirements and manufacturer's instructions.

❖ MHSS that are listed or approved in accordance with Section 5807.1.2 must be refilled strictly in accordance with their manufacturer's instructions which are considered part of the listing of a system. MHSS that are approved but not listed must also be refilled in accordance with their manufacturer's instructions, which were included in the fire code official's approval. Approval records should also be reviewed for any additional conditions for refilling of the system.

**5807.1.9.1 Industrial trucks.** The refilling of metal hydride storage systems serving powered industrial trucks shall be in accordance with Section 309.

❖ One MHSS application is fuel cells powering material-handling equipment such as forklifts or motorized pallet jacks. At locations where industrial trucks are fueled, this section requires that the fueling area comply with the requirements of Section 309, which, in

turn, includes requirements for proper refilling of equipment.

**5807.1.9.2 Hydrogen purity.** The purity of hydrogen used for the purpose of refilling containers shall be in accordance with the listing and the manufacturer's instructions.

❖ Keeping the hydrogen as pure as possible in keeping with the MHSS's listing is critical for the efficient operation of a turbine. Every 2-percent reduction in the purity of the hydrogen coolant increases windage losses in the turbine and the cost of running an 800-megawatt generator is increased significantly. Contaminants in the hydrogen can also be very dangerous and air is the most common impurity due to leaks. When the oxygen in the air is mixed with hydrogen, a potentially explosive condition can be created. However, hydrogen does not support combustion in a nearly pure state (greater than 90 percent) with the balance being air. By using a continuous gas analyzer transmitter to constantly monitor the hydrogen purity, any potentially hazardous condition can be avoided, enhancing safety and maximizing efficiency and profitability (see also commentary to Section 5807.1.9).

**5807.1.10 Electrical.** Electrical components for metal hydride storage systems shall be designed, constructed and installed in accordance with NFPA 70.

❖ NFPA 70 regulates the design and installation of electrical systems, components and equipment. All electrical work must also be in compliance with any specific electrical classifications and conditions contained in the listing or approval for each MHSS.

**5807.2 Portable containers or systems.** Portable containers or systems shall comply with Sections 5807.2.1 through 5807.2.2.

❖ This section introduces the provisions for portable metal hydride containers or MHSS.

**5807.2.1 Securing containers.** Containers, cylinders and tanks shall be secured in accordance with Section 5303.5.3.

❖ See the commentary to Section 5303.5.3.

**5807.2.1.1 Use on mobile equipment.** Where a metal hydride storage system is used on mobile equipment, the equipment shall be designed to restrain containers, cylinders or tanks from dislodgement, slipping or rotating when the equipment is in motion.

❖ This section requires MHSS installed on mobile equipment to be designed for such an application and be capable of restraining cylinders from movement while in motion so as to avoid damage to the equipment.

**5807.2.1.2 Motorized equipment.** Metal hydride storage systems used on motorized equipment, shall be installed in a manner that protects valves, pressure regulators, fittings and controls against accidental impact.

❖ This section requires MHSS installed on motorized equipment to be designed to be capable of restrain-

ing cylinders from movement, dislodgement or impact with other objects while the equipment is in operation so as to avoid damage to the equipment.

**5807.2.1.2.1 Protection from damage.** Metal hydride storage systems, including cylinders, containers, tanks and fittings, shall not extend beyond the platform of the mobile equipment.

❖ To protect MHSS components such as cylinders, regulators, pipe, valves and fittings from impact, the MHSS and its components must be installed so they do not extend beyond the platform of the mobile equipment.

**5807.2.2 Valves.** Valves on containers, cylinders and tanks shall remain closed except when containers are connected to *closed systems* and ready for use.

❖ In order to reduce the likelihood of hydrogen leakage from containers, cylinders and tanks when they are not connected to or in use in a closed system, their valves must be kept closed.

## SECTION 5808 HYDROGEN FUEL GAS ROOMS

**5808.1 General.** Where required by this code, hydrogen fuel gas rooms shall be designed and constructed in accordance with Sections 5808.1 through 5808.7 and the *International Building Code*.

❖ This section is simply stating that all hydrogen fuel gas rooms are to be constructed in accordance with the provisions contained in this section and IBC Section 421. Hydrogen fuel gas rooms were created to address the increasing and emerging concepts of fuel cells that use hydrogen and actually generate hydrogen on site to run the fuel cells. The provisions of this section and IBC Section 421 address construction-related issues for hydrogen cutoff rooms such as location, fire-resistance-rated separation, ventilation and safety features such as gas detection and explosion control. The provisions of Section 5808 are intended to be consistent with those of the referenced standard, NFPA 2.

**5808.2 Location.** Hydrogen fuel gas rooms shall not be located below grade.

❖ Restrictions against installation of hydrogen fuel gas rooms below grade are similar to those restricting the location of flammable and combustible liquids in basements. Explosion hazards are the primary concern, and placement of materials that have an ability to cause an explosion in below-grade spaces is not appropriate. Such spaces are more difficult to evacuate, create a fire and explosion hazard to the structure above and are very difficult for the fire department to access.

**5808.3 Design and construction.** Hydrogen fuel gas rooms not exceeding the *maximum allowable quantity per control area* in Table 5003.1.1(1) shall be separated from other areas

of the building in accordance with Section 509.1 of the *International Building Code*.

- ❖ Hydrogen fuel gas rooms are required to be separated by not less than 1-hour fire-resistance-rated fire barriers or horizontal assemblies, or both, which is consistent with the requirements in IBC Table 509 for incidental uses. In addition, the classification of the space will affect the separation requirements. Hydrogen fuel gas rooms can contain any amount of hydrogen up to the maximum allowable quantities per control area (MAQ). However, if the MAQs are exceeded, the room can no longer be considered an incidental use and instead must be classified as a separated Group H-2 occupancy. In all cases, separation in accordance with IBC Table 508.4 would apply in addition to the applicable occupancy-specific requirements.

**5808.3.1 Pressure control.** Hydrogen fuel gas rooms shall be provided with a ventilation system designed to maintain the room at a negative pressure in relation to surrounding rooms and spaces.

- ❖ This section requires hydrogen fuel gas rooms to be maintained at a negative pressure with regard to surrounding spaces to provide some level of protection against a flammable mixture being attained in other parts of the building.

**5808.3.2 Windows.** Operable windows in interior walls shall not be permitted. Fixed windows shall be permitted where in accordance with Section 716 of the *International Building Code*.

- ❖ Operable windows are prohibited in order to further reduce the likelihood of allowing hydrogen to escape from the room into other portions of the building that may not be properly ventilated. An operable window could inadvertently be left in the open or partially open position and go unnoticed. Fixed window openings must meet the requirements of IBC Section 716 to ensure that the requirements for opening protectives are met. More specifically, the proper fire protection ratings for openings in fire barriers are required.

**5808.4 Exhaust ventilation.** Hydrogen fuel gas rooms shall be provided with mechanical exhaust ventilation in accordance with the applicable provisions of Section 2311.7.1.1.

- ❖ The purpose of this section is to prevent a dangerous accumulation of flammable gas in the room through the use of an exhaust ventilation system. The ventilation must be at the rate of 1 cfm per 12 cubic feet of room volume, which is as required for ventilation of motor vehicle repair shops that repair hydrogen-fueled vehicles and is consistent with the requirements in Chapter 5 of the *International Mechanical Code*® (IMC®). See the commentary to Section 2311.7.1.1.

**5808.5 Gas detection system.** Hydrogen fuel gas rooms shall be provided with an approved flammable gas detection system in accordance with Sections 5808.5.1 through 5808.5.4.

- ❖ Some gases contain additives that produce pungent odors for easy recognition. Systems using nonodorized gases, such as hydrogen and liquefied natural gas (LNG), must utilize gas detection systems to detect leaks. This section specifically requires such detection due to the hazards associated with a build-up of hydrogen at hazardous levels within a building.

**5808.5.1 System design.** The flammable gas detection system shall be *listed* for use with hydrogen and any other flammable gases used in the hydrogen fuel gas room. The gas detection system shall be designed to activate when the level of flammable gas exceeds 25 percent of the lower flammable limit (LFL) for the gas or mixtures present at their anticipated temperature and pressure.

- ❖ The detection system must initiate the operations specified in Section 5808.5.3 at any time that the flammable gas concentration exceeds one-fourth of the concentration necessary to support combustion. Early detection of the presence of a flammable gas will allow adequate mitigation procedures to be taken. Hydrogen fires are not normally extinguished until the supply of hydrogen has been shut off because of the danger of reignition or explosion. A gas detection system in the room or space housing a gaseous hydrogen system results in early notification of a leak that is occurring before the escaping gas reaches a hazardous concentration.

**5808.5.2 Gas detection system components.** Gas detection system control units shall be *listed* and *labeled* in accordance with UL 864 or UL 2017. Gas detectors shall be *listed* and *labeled* in accordance with UL 2075 for use with the gases and vapors being detected.

- ❖ This section requires gas detection equipment to be listed in accordance with UL 2075 for use with the different gases it will detect. Under UL 2075, a set of flammable gases and concentrations, measured in parts per million (ppm), is developed for each detector or sensor, and the manufacturer is required to provide information as to what gases and the concentrations the device is designed to detect. Tests under the standard then verify the performance of each detector or sensor for each gas it is designed to detect. The gases that the equipment will detect may be shown in the manufacturer's instructions rather than on the product. This section also is intended to ensure that gas detection system control components are listed in accordance with nationally recognized safety standards. These standards include a comprehensive set of construction and performance requirements that are used to evaluate and list gas detection system control units and gas detectors.

**5808.5.3 Operation.** Activation of the gas detection system shall result in both of the following:

1. Initiation of distinct audible and visual alarm signals both inside and outside of the hydrogen fuel gas room.
  2. Activation of the mechanical exhaust ventilation system.
- ❖ The required local alarm is intended to alert the occupants to an emerging hazardous condition in the vicinity. The monitor control equipment must also initiate operation of the mechanical ventilation system in the event of a leak or rupture in the gaseous hydrogen system to prevent an accumulation of flammable gas.
- In addition to causing alarms to activate the detection system must also activate the mechanical ventilation system required by Section 5808.4.

**5808.5.4 Failure of the gas detection system.** Failure of the gas detection system shall result in activation of the mechanical exhaust ventilation system, cessation of hydrogen generation and the sounding of a trouble signal in an approved location.

- ❖ Gas detection systems must be designed to be self-monitoring and fail-safe in that all safety systems are activated to alert any occupants that a problem exists and to prevent more hydrogen from being generated by any appliances in the room when hazardous conditions cannot be monitored.

**5808.6 Explosion control.** Explosion control shall be provided where required by Section 911.

- ❖ The requirements of this section are intended to address the circumstance resulting from a catastrophic failure of the hydrogen fuel gas room. These requirements are the final safeguard in case safety features such as interlocked doors, ventilation and gas detection systems should fail. An ignited hydrogen mixture produces large quantities of heat, causing a rapid expansion of the surrounding air. This can cause a pressure increase in a confined space and a catastrophic failure. Explosion control methods are identified in Section 911 to prevent such a catastrophic failure. The explosion control requirements for gaseous and liquefied hydrogen are consistent with the requirements in Section 6.9 of NFPA 2.

**5808.7 Standby power.** Mechanical ventilation and gas detection systems shall be connected to a standby power system in accordance with Section 604.

- ❖ The ventilation system and gas detection system are life safety systems and, therefore, must be dependable. Both safety systems must remain active in the event of a failure of the primary power supply. Hydrogen is a colorless, odorless gas; a release might go undetected if detection systems are not functioning. The accumulation of hydrogen in an unventilated area can lead to mixtures in the flammable range if safety systems and mechanical ventilation systems are not in operation. Section 604 and Chapter 50 address standby power requirements for essential

systems. Chapter 50 also allows for systems that are fail-safe in Sections 5004.7.2 and 5005.1.5.1 in hydrogen fuel gas rooms where hydrogen is either generated or stored.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

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- Fire Protection Guide to Hazardous Materials*, 13th ed. Quincy MA: National Fire Protection Association, 2001.
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- Handbook of Compressed Gases*, 3rd ed. Arlington, VA: Compressed Gas Association, 1999.



# Chapter 59: Flammable Solids

## General Comments

This chapter addresses magnesium almost to the exclusion of all other flammable solids; however, it is important to know that several other solid materials, primarily metals, are also flammable and under the right conditions can be explosion hazards. It should also be noted that, although the definition of “Flammable solid” could be literally interpreted as being applicable to a much wider variety of common materials having an ignition temperature below 212°F (100°C), it is not the intent of this chapter to regulate such materials. See the commentary for “Flammable solid” in Chapter 2.

The list of other metals that can become fire hazards consists of titanium, zirconium, hafnium, calcium, zinc, sodium, lithium, potassium, sodium/potassium alloys, aluminum, iron and steel, uranium, thorium and plutonium. Some of these metals have a few highly specialized commercial uses; they are almost exclusively laboratory materials. But because of where they are used, both plant and fire service personnel must be trained to handle emergency situations. Because uranium, thorium and plutonium are also radioactive materials, they present still more specialized problems for plant fire brigades and local fire service personnel.

The form of the material being used (powder, sheets, castings or billets) also is critical to the way fire services respond to an incident. Fine powders of any of the materials listed can ignite or even explode under various atmospheres, including nitrogen. Some molten metals can ignite or explode under certain conditions. Castings of some of these metals can ignite or detonate if they are not handled properly. Even bulky billets can be ignited if there is sufficient heat to bring the metal to its ignition temperature, resulting in self-sustained burning.

Conventional fire-extinguishing agents may only increase the intensity of the fire being fought. Magnesium, for example, burns fiercely in a steam atmosphere. Likewise, carbon dioxide, foam and dry

chemical extinguishers are not effective on titanium fires. Additionally, water, foam and vaporizing liquids should never be used on lithium, sodium and potassium fires. Each material is different and requires different extinguishing treatment.

The National Fire Protection Association (NFPA) has developed standards for handling several of the listed materials, which are included in the bibliography at the end of this chapter. Most industry associations and companies manufacturing primary metals and alloys also have available recommended practices for storage, handling, use and scrap disposal that are based on extensive testing and usage history. The fire code official should require any person or business storing, handling or processing any of these materials to demonstrate a thorough knowledge of safe practices in both facility design and operating procedures.

## Purpose

This chapter sets general requirements for storage and handling of flammable solids in the first five sections before addressing the subject of magnesium in Section 5906.

A word of caution is necessary when applying the general requirements stated in Sections 5901 through 5905. Each of the flammable metals mentioned in the “General Comments” section requires special precautions. What works with one material may cause a major disaster with another. It is always best to make certain the building, facility and operating conditions proposed by the owner, architect or builder are based on the latest safety information available from the suppliers of the materials to be used or stored. The fire code official should verify that the emergency plan prepared for use by the owner or tenant is workable and compatible with the emergency response personnel and equipment available to the jurisdiction.

## SECTION 5901 GENERAL

**5901.1 Scope.** The storage and use of flammable solids shall be in accordance with this chapter.

❖ This section establishes the applicability of this chapter to all materials meeting the definition of and classified as flammable solids.

**5901.2 Permits.** Permits shall be required as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is

issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit and Section 105.6.21 for discussion of specific operational permits for hazardous materials, Section 105.7 for a general discussion of activities requiring a construction permit and Section 105.7.10 for discussion of specific construction permits for hazardous materials. The permit process also notifies the fire department of the need for pre-fire planning for hazardous properties.

**SECTION 5902  
DEFINITIONS**

**5902.1 Definitions.** The following terms are defined in Chapter 2:

**FLAMMABLE SOLID.  
MAGNESIUM.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*® as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4).

**SECTION 5903  
GENERAL REQUIREMENTS**

**5903.1 Quantities not exceeding the maximum allowable quantity per control area.** The storage and use of flammable solids in amounts not exceeding the *maximum allowable quantity per control area* as indicated in Section 5003.1 shall be in accordance with Sections 5001, 5003 and 5901.

❖ This section complements the requirements of Chapter 50 in structures occupied for the storage, handling or use of flammable solids. The regulations assume that the quantity of flammable solids in a given building is limited to the maximum allowable quantity per control area (MAQ) as established in Section 5003.1; thus, the building is not classified in Occupancy Group H. The general requirements of Sections 5001 and 5003 are fully applicable to the storage and use of flammable solids, in addition to the requirements of this chapter.

**5903.2 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of flammable solids exceeding the *maximum allowable quantity per control area* as indicated in Section 5003.1 shall be in accordance with Chapter 50 and this chapter.

❖ This section complements the requirements of Chapter 50 for structures occupied for the storage, handling or use of flammable solids. The regulations contained in this section assume that the quantity of flammable solids in a given building is in excess of the MAQ as established in Section 5003.1; thus, the

building is classified in Occupancy Group H. The requirements of Chapter 50 apply to the storage and use of flammable solids, in addition to the requirements of this chapter.

**SECTION 5904  
STORAGE**

**5904.1 Indoor storage.** Indoor storage of flammable solids in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) shall be in accordance with Sections 5001, 5003, 5004 and this chapter.

❖ This section regulates the indoor storage of flammable solids when in excess of the MAQ in buildings or portions of buildings classified in Occupancy Group H. The general and storage requirements of Chapter 50 are applicable in addition to the requirements of this section. Storage of flammable solids inside of structures must comply with Sections 5904.1.1 through 5904.1.3 to prevent exposure to conditions that may result in a fire or explosion.

**5904.1.1 Pile size limits and location.** Flammable solids stored in quantities greater than 1,000 cubic feet (28 m<sup>3</sup>) shall be separated into piles each not larger than 1,000 cubic feet (28 m<sup>3</sup>).

❖ Storage piles are restricted to 1,000 cubic feet (28 m<sup>3</sup>) in size to limit the quantity of flammable solids exposed to a single fire and to facilitate fire-fighting operations. Aisles must be provided on all sides to permit access for fire fighting and reduce the likelihood of the spread of fire to adjacent piles if a pile collapse occurs.

**5904.1.2 Aisles.** Aisle widths between piles shall not be less than the height of the piles or 4 feet (1219 mm), whichever is greater.

❖ As with all other storage, aisles allow fire response personnel ready access to the immediate area of the fire. The requirement that aisle width depends on pile height acknowledges the effectiveness of physical separation in preventing fire spread as well as making room for more or larger fire-fighting equipment that may be needed to fight fires in large storage piles of flammable solids. Additionally, keeping aisle widths the same as the pile heights reduces the likelihood of the spread of fire to adjacent piles or creating a “domino effect” in the event of a pile collapse, since a pile will generally not tip over intact.

**5904.1.3 Basement storage.** Flammable solids shall not be stored in *basements*.

❖ Basement storage is prohibited because of the limited access for fire suppression and ventilation operations in most basements and the hazards associated with the vigorous and persistent fires that can occur in flammable solids.

**5904.2 Outdoor storage.** Outdoor storage of flammable solids in amounts exceeding the *maximum allowable quantities per control area* indicated in Table 5003.1.1(1) shall be in

accordance with Sections 5001, 5003, 5004 and this chapter. Outdoor storage of magnesium shall be in accordance with Section 5906.

- ❖ This section regulates the outdoor storage of flammable solids when in excess of the MAQ established by Table 5003.1.1(3). The general and storage requirements of Chapter 50 are applicable, in addition to the requirements of this section. Storage of flammable solids in outdoor control areas must comply with Sections 5904.2.1 and 5904.2.2 to reduce the likelihood of uncontrolled release or exposure to conditions that may result in a fire or explosion.

**5904.2.1 Distance from storage to exposures.** Outdoor storage of flammable solids shall not be located within 20 feet (6096 mm) of a building, *lot line*, public street, public alley, *public way* or *means of egress*. A 2-hour *fire barrier* without openings or penetrations and extending 30 inches (762 mm) above and to the sides of the storage area is allowed in lieu of such distance. The wall shall either be an independent structure, or the *exterior wall* of the building adjacent to the storage area.

- ❖ The required separation distance is intended to minimize radiant heat transfer between exposures. Separation distances provide a measure of protection against the possibility of fire spread if a fire occurs involving either the stored material or another exposure, such as a building located on the same or an adjacent lot or a vehicle in the public right-of-way.

An alternative to the 20-foot (6069 mm) distance is offered in this section. Essentially, it would allow the use of a 2-hour fire barrier, constructed in accordance with Section 707 of the *International Building Code*® (IBC®) and without openings, that extends 30 inches (763 mm) above and to the sides of the storage.

**5904.2.2 Pile size limits.** Outdoor storage of flammable solids shall be separated into piles not larger than 5,000 cubic feet (141 m<sup>3</sup>) each. Piles shall be separated by aisles with a minimum width of not less than one-half the pile height or 10 feet (3048 mm), whichever is greater.

- ❖ Outside storage piles may be increased in size (over inside storage) to 5,000 cubic feet (141 m<sup>3</sup>) based on the reduced danger to people and property associated with outdoor storage. Required aisles are intended to facilitate fire-fighting access and prevent the spread of fire to adjacent piles if a pile collapse occurs. Aisles should permit unobstructed access to the pile on all sides, as well as permit approach from more than one direction.

## SECTION 5905 USE

**5905.1 General.** The use of flammable solids in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) or 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5005 and this chapter.

The use of magnesium shall be in accordance with Section 5906.

- ❖ This section applies to all indoor and outdoor use and handling operations involving flammable solids, except magnesium, when the amounts being used or handled are in excess of the MAQ [buildings or portions of buildings classified in Occupancy Group H and outdoor control area indicated in Tables 5003.1.1(1) and 5003.1.1(3), respectively]. The administrative, general use and handling provisions of Chapter 50 are applicable, in addition to the requirements of this chapter.

## SECTION 5906 MAGNESIUM

**5906.1 General.** Storage, use, handling and processing of magnesium, including the pure metal and alloys of which the major part is magnesium, shall be in accordance with Chapter 50 and Sections 5906.2 through 5906.5.8.

- ❖ This section establishes the applicability of Section 5906 and Chapter 50 to the production, storage, processing and disposal of magnesium products. These requirements are applicable not only to pure magnesium but also to alloys having a magnesium content in excess of 50 percent.

**5906.2 Storage of magnesium articles.** The storage of magnesium shall comply with Sections 5906.2.1 through 5906.4.3.

- ❖ The requirements of Sections 5906.2.1 through 5906.4.3 apply to the storage of any quantity of magnesium based on the various physical forms of the material and the fire hazard and extinguishing problems it poses.

**5906.2.1 Storage of greater than 50 cubic feet.** Magnesium storage in quantities greater than 50 cubic feet (1.4 m<sup>3</sup>) shall be separated from storage of other materials that are either combustible or in combustible containers by aisles. Piles shall be separated by aisles with a minimum width of not less than the pile height.

- ❖ This is a general criterion applicable to all forms of magnesium. As is noted in the following sections, storage requirements and allowable quantities vary with the form of the product being stored.

Isolation of magnesium from other combustible materials of any kind helps reduce the amount of magnesium exposed to a single fire originating outside of the magnesium pile and protects materials outside the magnesium pile from exposure to it. Properly established and maintained aisles provide fire suppression personnel ready access to the immediate area of the fire as well as proper egress circulation in the storage area. The requirement that aisle width depends on pile height acknowledges the effectiveness of physical separation in preventing fire spread.

**5906.2.2 Storage of greater than 1,000 cubic feet.** Magnesium storage in quantities greater than 1,000 cubic feet (28 m<sup>3</sup>) shall be separated into piles not larger than 1,000 cubic feet (28 m<sup>3</sup>) each. Piles shall be separated by aisles with a minimum width of not less than the pile height. Such storage shall not be located in nonsprinklered buildings of Type III, IV or V construction, as defined in the *International Building Code*.

❖ Again, this is a general criterion applicable to all forms of magnesium and establishes the maximum pile size at 1,000 cubic feet (28 m<sup>3</sup>) of material (see also the discussion in the commentary to Section 5906.2.1). In this scenario, a pile could be approximately 10 feet long by 10 feet wide by 10 feet high (3048 mm by 3048 mm by 3048 mm) with an established aisle width between piles of 10 feet (3048 mm). Note that when the quantity of stored magnesium exceeds 1,000 cubic feet (28 m<sup>3</sup>), this section requires that the storage building be of Type I or II construction, or when equipped throughout with an automatic sprinkler system, of Type III, IV or V construction.

**5906.2.3 Storage in combustible containers or within 30 feet of other combustibles.** Where in nonsprinklered buildings of Type III, IV or V construction, as defined in the *International Building Code*, magnesium shall not be stored in combustible containers or within 30 feet (9144 mm) of other combustibles.

❖ This section recognizes the increased hazard of storing magnesium in nonsprinklered buildings of Type III, IV and V construction by requiring that any containers used for the storage of magnesium be constructed of noncombustible material to provide a layer of shielding to the magnesium in the event of a fire. To further isolate magnesium piles, reduce the likelihood of fire spread among adjacent piles and enhance the effectiveness of the shielding provided by noncombustible storage containers where used, this section requires a substantial increase in the spatial separation between the magnesium and any other combustible materials. Note that this increased separation is not related to pile height.

**5906.2.4 Storage in foundries and processing plants.** The size of storage piles of magnesium articles in foundries and processing plants shall not exceed 1,250 cubic feet (25 m<sup>3</sup>). Piles shall be separated by aisles with a minimum width of not less than one-half the pile height.

❖ Allowing storage of an increased quantity of flammable solids in foundries and processing plants acknowledges that ignition of pigs, ingots and billets is unlikely under conditions normally found in foundries and other processing buildings where ordinary combustible materials are rarely found in any significant quantity.

**5906.3 Storage of pigs, ingots and billets.** The storage of magnesium pigs, ingots and billets shall comply with Sections 5906.3.1 and 5906.3.2.

❖ The requirements of Sections 5906.3.1 and 5906.3.2 apply to the storage of any quantity of magnesium in the forms of pigs (a mass of magnesium that has been run into a mold while molten), ingots (a mass of magnesium cast in a convenient form for further processing) and billets (a bar of magnesium forged from an ingot) and the hazards they pose. The quantities allowed again indicate that ignition of these large shapes is unlikely under the conditions required.

**5906.3.1 Indoor storage.** Indoor storage of pigs, ingots and billets shall only be on floors of noncombustible construction. Piles shall not be larger than 500,000 pounds (226.8 metric tons) each. Piles shall be separated by aisles with a minimum width of not less than one-half the pile height.

❖ This section establishes maximum quantity for single piles, but does not restrict the number of piles that can be located in one building or structure. The requirement for aisles that are at least half the pile height allows adequate clearance for both materials-handling equipment and emergency response equipment and personnel. Where pile heights are kept low, the aisles must still be maintained at a width that will allow for equipment travel between piles. Requiring storage on a noncombustible surface reduces the likelihood that the floor would contribute any fuel or contribute to the spread of a fire involving magnesium.

**5906.3.2 Outdoor storage.** Outdoor storage of magnesium pigs, ingots and billets shall be in piles not exceeding 1,000,000 pounds (453.6 metric tons) each. Piles shall be separated by aisles with a minimum width of not less than one-half the pile height. Piles shall be separated from combustible materials or buildings on the same or adjoining property by a distance of not less than the height of the nearest pile.

❖ This section recognizes the inherently higher level of safety provided by the storage of materials outdoors by doubling the amount of magnesium per pile that can be stored. The required separation distance is intended to minimize radiant heat transfer between exposures. Separation distances provide a measure of protection against the possibility of fire spread if a fire occurs either in the stored material or in another exposure, such as a building located on the same or an adjacent lot. Separation also serves the purpose of allowing passage of materials-handling equipment and emergency response equipment.

**5906.4 Storage of fine magnesium scrap.** The storage of scrap magnesium shall comply with Sections 5906.4.1 through 5906.4.3.

❖ The requirements of Sections 5906.4.1 through 5906.4.3 apply to the storage of any quantity of mag-

nesium in the form of scrap chips, fines and dust and the hazards they pose. These less-dense forms of magnesium, typically produced in machine processing and recovered for subsequent reuse, present a substantial fire and explosion risk, which is addressed in the following sections.

**5906.4.1 Separation.** Magnesium fines shall be kept separate from other combustible materials.

❖ Separation of stored magnesium fines from ordinary combustible materials is required because fines are extremely combustible and easily ignitable. A small pile of fines can be ignited by a common match flame. Section 5906.2.1 contains minimum separation criteria for all types of magnesium storage.

**5906.4.2 Storage of 50 to 1,000 cubic feet.** Storage of fine magnesium scrap in quantities greater than 50 cubic feet (1.4 m<sup>3</sup>) [six 55-gallon (208 L) steel drums] shall be separated from other occupancies by an open space of not less than 50 feet (15 240 mm) or by a *fire barrier* constructed in accordance with Section 707 of the *International Building Code*.

❖ Because fines are usually wet with coolant from the processing operation, there is a possibility of hydrogen generation. For this reason, fines must be stored in approved steel containers with vented lids to prevent hydrogen buildup. Because there is also a possibility of spontaneous heating of fines, they must be stored separately from combustible materials, including other storage piles of magnesium. The required separation distance is intended to minimize radiant heat transfer between the stored magnesium and other materials and provide a measure of protection against the possibility of spread if a fire occurs.

An alternative to the 20-foot (6069 mm) distance is offered in this section. Essentially, it would allow the use of a 2-hour fire barrier, constructed in accordance with IBC Section 707 and without openings, that extends 30 inches (763 mm) above and to the sides of the storage.

**5906.4.3 Storage of greater than 1,000 cubic feet.** Storage of fine magnesium scrap in quantities greater than 1,000 cubic feet (28 m<sup>3</sup>) shall be separated from all buildings other than those used for magnesium scrap recovery operations by a distance of not less than 100 feet (30 480 mm).

❖ This section recognizes the increased risk associated with the storage of significant quantities of magnesium fines by establishing a blanket 100-foot (30 480 mm) separation distance to any building that is not specifically part of a magnesium recovery operation.

**5906.5 Use of magnesium.** The use of magnesium shall comply with Sections 5906.5.1 through 5906.5.8.

❖ The requirements of Sections 5906.5.1 through 5906.5.8 apply to the use, handling and processing of

any quantity of magnesium and the processing hazards it poses.

**5906.5.1 Melting pots.** Floors under and around melting pots shall be of noncombustible construction.

❖ This requirement should seem obvious for any operation that involves melting any quantity of any metal. It is particularly important with flammable metals, however, because of the possibility of fire from an overheated melting pot or an explosion caused by the addition of alloying metal to the molten magnesium that has not been thoroughly dried before being added to the pot. Any quantity of absorbed moisture on the added metal will turn instantly to steam and cause a violent eruption of molten metal from the pot.

Eruptions of molten metal present a serious burn hazard to personnel as well as the potential for the hot metal to ignite combustible construction under or near the pot.

When molten magnesium is handled according to standard industry safety practices, it is not a serious hazard. Magnesium has been used for well over 50 years in both military and commercial applications with very few serious fires. This long history of safe operations suggests that safety rules and precautions developed by both suppliers and users are effective. The fire code official must require that a user of molten magnesium have safe operating procedures in place as well as an emergency response plan that includes both plant fire brigades and jurisdiction emergency response units.

**5906.5.2 Heat-treating ovens.** *Approved* means shall be provided for control of magnesium fires in heat-treating ovens.

❖ Heat-treating ovens present a significant potential for fires. Some of the heat treatments required to obtain the physical properties necessary for certain applications are done at temperatures very close to the ignition temperature of magnesium. Accordingly, this section requires that fire control means approved by the fire code official be readily available to the heat-treating process. Large castings that have thick sections are not as likely to ignite, but fine fins or very thin sections can ignite if overheated, as can dust or fine chips. For this reason, oven controls are critical to safe operation. Making sure items to be heat treated are free of dust and chips is also essential. Fire control can also be achieved in higher temperature ovens by operating them with an inert gas atmosphere to reduce the risk of magnesium ignition.

Although not stated specifically in this section, the requirement for keeping the heat-treating area clear of scrap and other combustibles should be obvious.

**5906.5.3 Dust collection.** Magnesium grinding, buffing and wire-brushing operations, other than rough finishing of cast-

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ings, shall be provided with *approved* hoods or enclosures for dust collection that are connected to a liquid-precipitation type of separator that converts dust to sludge without contact (in a dry state) with any high-speed moving parts.

❖ The potential for fires and explosions involving magnesium dust and other fines has already been stated. The dust from grinding, buffing and wire brushing operations must be collected and contained in a closed system that is equipped with a water spray dust precipitator and an exhaust blower. The exhaust system is required because wet magnesium fines will generate hydrogen gas that must be diluted below its lower flammable limit (LFL).

Equipment used for grinding, buffing and wire-brushing must be dedicated for use on magnesium only. Commentary Figure 5906.5.3 shows a typical grinding machine setup.

**5906.5.3.1 Duct construction.** Connecting ducts or suction tubes shall be completely grounded, as short as possible, and without bends. Ducts shall be fabricated and assembled with a smooth interior, with internal lap joints pointing in the direction of airflow and without unused capped side outlets, pockets or other dead-end spaces that allow an accumulation of dust.

❖ Although the requirements stated in this section are applicable to magnesium manufacturing operations, they are virtually the same as the requirements for handling any other kind of flammable or detonable dust and fine particles. The construction specifications are intended to prevent fines from accumulating in sufficient quantities to become a hazard. Grounding is required to prevent sparking that could become a source of ignition. See the commentary to Sections 510 and 511 of the *International Mechanical Code*® (IMC®) for a discussion of hazardous exhaust systems and dust conveying systems.

**5906.5.3.2 Independent dust separators.** Each machine shall be equipped with an individual dust-separating unit.

### Exceptions:

1. One separator is allowed to serve two dust-producing units on multiunit machines.
2. One separator is allowed to serve not more than four portable dust-producing units in a single enclosure or stand.

❖ This requirement complements Section 5906.5.3.1, which mandates that ducts be straight and of minimum length in order to reduce the likelihood of static buildup and dust buildup in the duct.

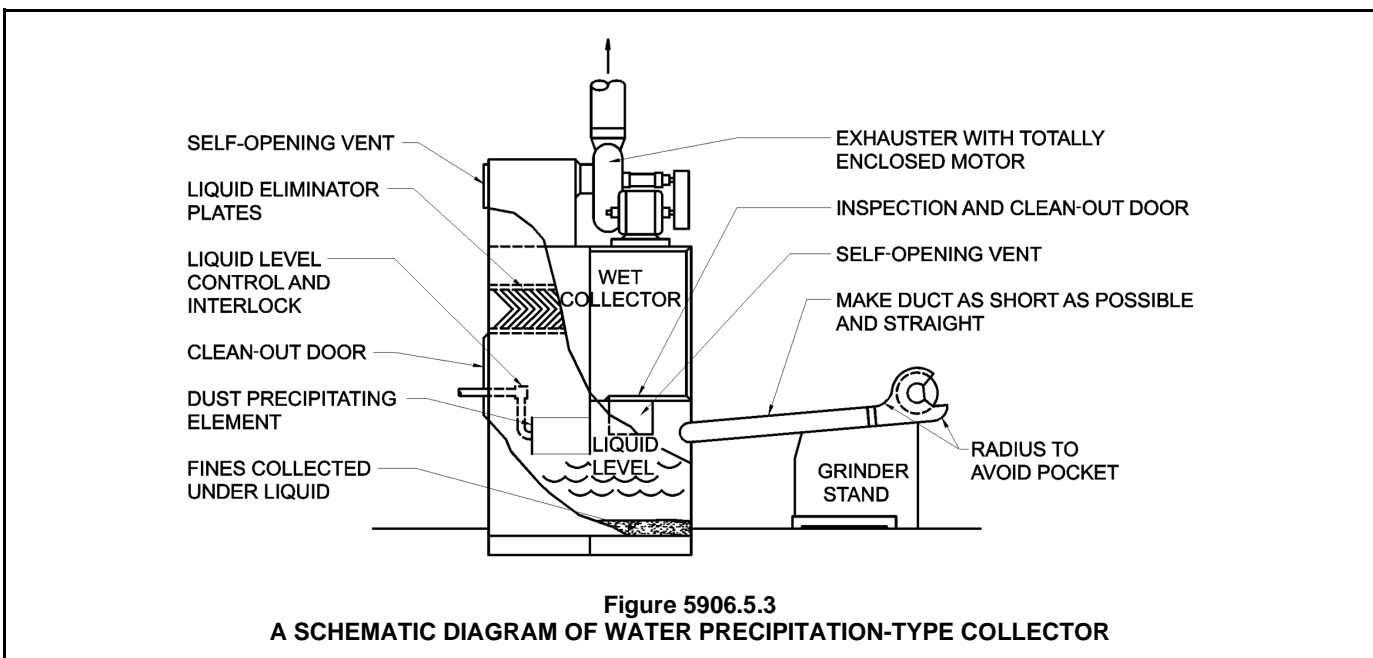
Exception 1 does allow two units working in tandem to be served by one collector; however, the ducts must still meet the specifications in Section 5906.5.3.1.

Exception 2 allows one collector to serve up to four small units if they are operated in an enclosure that would prevent dust from escaping into the general work area. The collector would function in approximately the same way as a vacuum system in a paint booth. The requirements for exhausting, water spray and ductwork would still apply.

Chapter 22 regulates combustible dusts and includes a reference to NFPA 484, *Standard for Combustible Metals*. See the commentary to that chapter for further information.

**5906.5.4 Power supply interlock.** Power supply to machines shall be interlocked with exhaust airflow, and liquid pressure level or flow. The interlock shall be designed to shut down the machine it serves when the dust removal or separator system is not operating properly.

❖ Allowing magnesium dust-producing operations to continue when the dust collection system required by Section 5906.5.3 is malfunctioning could allow the



dangerous buildup of extremely flammable magnesium fines at the machines. The ready ignitability of this collected material creates a hazard that this section is intended to mitigate by interlocking the dust-producing machines with the exhaust system so that the production of dust and flyings will halt if the exhaust is not performing as designed.

**5906.5.5 Electrical equipment.** Electric wiring, fixtures and equipment in the immediate vicinity of and attached to dust-producing machines, including those used in connection with separator equipment, shall be of *approved* types and shall be *approved* for use in Class II, Division 1 hazardous locations in accordance with NFPA 70.

❖ This requirement for classified electrical equipment is intended to reduce the likelihood that any fixed or portable electrical wiring and electrical equipment attached to or located or used near dust-producing and dust-collecting machines will become an ignition source.

**5906.5.6 Grounding.** Equipment shall be securely grounded by permanent ground wires in accordance with NFPA 70.

❖ As with Section 5906.5.5, this requirement is intended to reduce the likelihood of a buildup of static electricity that could produce a spark that would be an ignition source for flammable solids dust. This requirement is similar to grounding requirements for electrical equipment in other dust-producing environments.

**5906.5.7 Fire-extinguishing materials.** Fire-extinguishing materials shall be provided for every operator performing machining, grinding or other processing operation on magnesium in accordance with either of the following:

1. Within 30 feet (9144 mm), a supply of extinguishing materials in an *approved* container with a hand scoop or shovel for applying the material.
2. Within 75 feet (22 860 mm), a portable fire extinguisher complying with Section 906.

All extinguishing materials shall be *approved* for use on magnesium fires. Where extinguishing materials are stored in cabinets or other enclosed areas, the enclosures shall be openable without the use of a key or special knowledge.

❖ Magnesium fires present unusual fire suppression challenges because none of the common extinguishing materials can be used safely. The problem of using water has already been mentioned, but it must be emphasized again. Water sprayed on a magnesium fire will do two things. First, if the fire involves small pieces such as chips, fines or dust, the reaction of the burning metal with water can be explosive, causing burning brands to fly onto surrounding materials and equipment. Second, the extraordinary heat generated by burning magnesium can break the chemical bonds between hydrogen and oxygen atoms in the water molecule. Once this occurs, the hydrogen will be burned and the oxygen will support continued combustion, making the fire that much more intense; however, the danger of a hydrogen explosion under

fire conditions is generally slight. If magnesium burns in the open, an excess of oxygen will be available to burn any hydrogen as rapidly as it is generated, thus preventing formation of an explosive accumulation of gas. Despite the noted dangers, however, magnesium fires can be extinguished by cooling the metal below its melting point using relatively large amounts of water carefully applied from a safe distance.

The use of sand can produce a similar reaction to the use of water. Sand is composed of silicon dioxide (SiO<sub>2</sub>) molecules that will break down, allowing the oxygen to support the combustion of the magnesium.

Carbon dioxide cannot be used on magnesium fires for the same reason. Magnesium reacts so strongly with oxygen that the carbon dioxide will decompose, giving the fire additional oxygen and making it burn more intensely.

In extreme cases, magnesium will even burn in a nitrogen atmosphere, forming magnesium nitride.

Halon cannot be used because magnesium reacts violently with the chlorine molecules in the gas to form magnesium chloride.

Consequently, special fire-fighting agents are required for fighting magnesium and other flammable metal fires. Because flammable metal fires are considered Class D fires, it is important to verify that portable fire extinguishers provided in accordance with this section are labeled as being effective on such fires. Similarly, any installed fire-extinguishing system must be chosen carefully with the focus on extinguishing agent compatibility with the protected content.

The form of the material involved in the fire will dictate what can be used to extinguish it. The most difficult fire is one involving fines. Normally, a dry extinguishing agent is manually spread over the fire to smother the burning material. Care must be taken, however, to make sure the application does not raise a dust cloud that could cause an explosion.

The long history of magnesium use has resulted in a well-documented fire-fighting strategy for each form of magnesium that could be involved in a fire. The fire code official must verify that the user facility is equipped to fight potential fires and that emergency response personnel are trained in the hazards they may face as well as in the use of the available extinguishers.

Prompt control of magnesium fires requires ready access to fire-extinguishing materials and equipment by every operator at every workstation processing the metal. The fire extinguisher access travel distance of 75 feet (22 860 mm) correlates with Section 906. The 30-foot (9144 mm) travel distance to a stockpiled supply of dry extinguishing agent correlates with the travel distance for an extra-hazard occupancy and recognizes the potential need to make repeated trips to the stockpile to bring a sufficient amount of agent to accomplish extinguishment.

**5906.5.8 Collection of chips, turnings and fines.** Chips, turnings and other fine magnesium scrap shall be collected

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from the pans or spaces under machines and from other places where they collect not less than once each working day. Such material shall be placed in a covered, vented steel container and removed to an *approved* location.

❖ This requirement for collection of highly flammable material is really nothing more than good housekeeping. Keeping the working area free of accumulations of fire fuel means that the fuel load for any potential fire is minimized. As indicated in the commentary to Section 5906.4.2, because magnesium chips, turnings and fines are usually wet with coolant from the processing operation, there is a possibility of hydrogen generation. For this reason, fines must be stored in accordance with Section 5906.4 and in approved steel containers with vented lids to prevent hydrogen buildup.

As was discussed in Chapter 3, the three required elements for a fire are fuel, oxygen and an ignition source. If any one of these three is absent, there will be no fire. Depriving a potential fire of its fuel source is one of the primary ways to prevent fires. Following the other requirements in this chapter will also minimize the oxygen supply and prevent fuel from coming in contact with ignition sources.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

CPSC 16 CFR, 1500 44, *Method for Testing Extremely Flammable and Flammable Solids*. Bethesda, MD: Consumer Product Safety Commission, 2001.

*Fire Protection Handbook*, 20th Ed. Quincy, MA: National Fire Protection Association, 2008.

# Chapter 60: Highly Toxic and Toxic Materials

## General Comments

Toxic and highly toxic materials are addressed in the code because of the immediate threat they pose to occupants, others in the vicinity of a building and facility and emergency responders. As with other health hazard materials, the solid state is usually the least hazardous, while the gaseous form is the most hazardous.

Materials are often listed as being toxic or highly toxic on Material Safety Data Sheets (MSDS). These descriptors do not necessarily mean that the materials would be considered toxic or highly toxic according to the specific definitions found in Chapter 2. Those definitions provide specific criteria that will be discussed in more detail. Generally, the requirements for toxic and highly toxic materials are the most regulated health hazards in the code.

This chapter deals with all three states of toxic and highly toxic materials: solids, liquids and gases. As will be discussed, gases will generally require treatment systems and related ventilation systems.

## Purpose

The main purpose of this chapter is, as noted, to protect occupants, emergency responders and those in the immediate area of the building and facility from short-term, acute hazards associated with a release of or general exposure to toxic and highly toxic materials. The code does not address long-term exposure effects. Such issues are addressed by agencies such as the Environmental Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA).

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## SECTION 6001 GENERAL

**6001.1 Scope.** The storage and use of highly toxic and toxic materials shall comply with this chapter. *Compressed gases* shall also comply with Chapter 53.

### Exceptions:

1. Display and storage in Group M and storage in Group S occupancies complying with Section 5003.11.
2. Conditions involving pesticides or agricultural products as follows:
  - 2.1. Application and release of pesticide, agricultural products and materials intended for use in weed abatement, erosion control, soil amendment or similar applications when applied in accordance with the manufacturer's instruction and label directions.
  - 2.2. Transportation of pesticides in compliance with the Federal Hazardous Materials Transportation Act and regulations thereunder.
  - 2.3. Storage in *dwellings* or private garages of pesticides registered by the U.S. Environmental Protection Agency to be utilized in and around the home, garden, pool, spa and patio.

❖ This section states that highly toxic materials must be stored and used in accordance with this chapter. Additionally, it notes that gases are subject to the requirements in Chapter 53, which focuses on the

hazards associated with the fact that the material is a compressed gas.

There are various exceptions to this chapter. Exception 1 is related to the increased amounts allowed for storage and display in Group M and S occupancies. These increased amounts apply only to solids and liquids. For this exception to apply, all requirements found in Section 5003.11 are applicable.

Exception 2 is specific to pesticides or other agriculture-related products. Essentially, only storage in a building or facility would be regulated. The application, release or transportation of such materials would be exempt because federal standards would preempt a local jurisdiction from enforcement. In terms of application and release, regulations are specific to activities such as weed control, erosion control and soil amendment. Additionally, pesticides approved for use around homes, gardens, pools, spas and patios can be stored without regulation in private garages and within dwellings.

**6001.2 Permits.** Permits shall be required as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an opera-

tional permit, Section 105.6.21 for a discussion of specific quantity-based operational permits for the materials regulated in this chapter and Section 105.7 for a general discussion of activities requiring a construction permit. The permit process also notifies the fire department of the need for prefire planning for hazardous property.

**SECTION 6002  
DEFINITIONS**

**6002.1 Definitions.** The following terms are defined in Chapter 2:

**CONTAINMENT SYSTEM.**

**CONTAINMENT VESSEL.**

**EXCESS FLOW VALVE.**

**HIGHLY TOXIC.**

**OZONE-GAS GENERATOR.**

**PHYSIOLOGICAL WARNING THRESHOLD LEVEL.**

**REDUCED FLOW VALVE.**

**TOXIC.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4).

**SECTION 6003**

**HIGHLY TOXIC AND TOXIC SOLIDS AND LIQUIDS**

**6003.1 Indoor storage and use.** The indoor storage and use of highly toxic and toxic materials shall comply with Sections 6003.1.1 through 6003.1.5.3.

❖ As noted in the “General Comments” section, liquids and solids are dealt with in one section and gases are dealt with in another. Generally, gases pose a greater hazard because they are more difficult to contain and can have a much more immediate effect. This section contains requirements for indoor storage and use. Outdoor storage and use are discussed in Section 6003.2.

**6003.1.1 Quantities not exceeding the maximum allowable quantity per control area.** The indoor storage or use of highly toxic and toxic solids or liquids in amounts not exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(2) shall be in accordance with Sections 5001, 5003 and 6001.

❖ This section sends the code user to the appropriate sections when the maximum allowable quantities per control area (MAQs) have not been exceeded. As with other materials, when the MAQs have not been exceeded, the requirements are less restrictive. The

code user must comply with Section 6001 as well as Sections 5001 and 5003, which are the general requirements for hazardous materials related to permits, material classification and management plans, hazard identification and other basic requirements. Section 6003 would not apply.

**6003.1.2 Quantities exceeding the maximum allowable quantity per control area.** The indoor storage or use of highly toxic and toxic solids or liquids in amounts exceeding the *maximum allowable quantity per control area* set forth in Table 5003.1.1(2) shall be in accordance with Section 6001, Sections 6003.1.3 through 6003.1.5.3 and Chapter 50.

❖ When the MAQs have been exceeded, the requirements in Sections 6001 and 6003 and all of Chapter 50 are applicable.

**6003.1.3 Treatment system—highly toxic liquids.** Exhaust scrubbers or other systems for processing vapors of highly toxic liquids shall be provided where a spill or accidental release of such liquids can be expected to release highly toxic vapors at *normal temperature and pressure*. Treatment systems and other processing systems shall be installed in accordance with the *International Mechanical Code*.

❖ This requirement is specific to highly toxic liquids and would require a treatment system to collect and process any vapors that might escape if a spill should occur at “normal temperature and pressure.” In other words, if at normal temperature and pressure conditions vapors would not be highly toxic, a treatment system would not be required. The focus of this section is on the inhalation hazards associated with highly toxic materials. A material may be considered highly toxic by skin contact or ingestion, but not create an inhalation hazard because of the low volatility of the liquid.

**6003.1.4 Indoor storage.** Indoor storage of highly toxic and toxic solids and liquids shall comply with Sections 6003.1.4.1 and 6003.1.4.2.

❖ This section is specific to indoor storage and focuses on floor surfaces and separation requirements.

**6003.1.4.1 Floors.** In addition to the requirements set forth in Section 5004.12, floors of storage areas where highly toxic and toxic liquids are stored shall be of liquid-tight construction.

❖ This requirement increases the likelihood that if a highly toxic or toxic liquid comes in contact with the floor of the storage area, it will not soak in and be difficult to remove. If concrete is not properly treated, spills could seep into the floor and give off vapors over time. The use of liquid-tight floors is one of the methods mentioned in Section 5004 for drainage control and secondary containment. The requirements of this section would apply in any case.

The reference to Section 5004.12 requires the floor to be noncombustible except for the surfacing; therefore, the method used to make the floor liquid tight does not need to be noncombustible. The same requirement is stated in Section 5004.2.1.

**6003.1.4.2 Separation—highly toxic solids and liquids.** In addition to the requirements set forth in Section 5003.9.8, highly toxic solids and liquids in storage shall be located in *approved* hazardous material storage cabinets or isolated from other hazardous material storage by construction in accordance with the *International Building Code*.

❖ In order to reduce the possibility of releasing hazardous fumes and vapors due to a fire involving highly toxic liquids and solids, adequate separation from other hazardous materials is required. The intent of this section is to separate flammable, explosive or other highly reactive materials from all highly toxic solids and liquids. A 1-hour fire barrier, constructed in accordance with Section 707 of the *International Building Code*® (IBC®), a 1-hour horizontal assembly constructed in accordance with IBC Section 711 or both, or an approved hazardous material storage cabinet reduces the potential for involvement of highly toxic materials in a fire involving other hazardous materials. This section would not allow a physical separation or a fire barrier that extended above and to the sides of the material, as would be possible with other hazardous materials. Note that these requirements are in addition to the code's requirements for separation of incompatible materials. See the commentary to Section 5003.9.8 for further information on that topic.

**6003.1.5 Indoor use.** Indoor use of highly toxic and toxic solids and liquids shall comply with Sections 6003.1.5.1 through 6003.1.5.3.

❖ Use is more hazardous than storage because the materials are more susceptible to release. The focus of this particular section is on the transfer of highly toxic liquids and requirements for exhaust ventilation systems where highly toxic and toxic materials are being used.

**6003.1.5.1 Liquid transfer.** Highly toxic and toxic liquids shall be transferred in accordance with Section 5005.1.10.

❖ This section refers the code user back to Section 5005.1.10 for requirements on the transfer of liquids with a hazard ranking of 3 or 4. These liquids can be transferred using several different methods, including safety cans, closed piping, approved pump arrangements, an approved engineered liquid transfer system or, under certain conditions, by gravity. It should be noted that Section 5005.1.10 prohibits highly toxic liquids from being transferred where gravity feed is involved regardless of the safeguards. There are exceptions for small amounts of liquids [1.3 gallons (5 L) for a hazard ranking of 4 and 5.3 gallons (20 L) for a hazard ranking of 3]. Section 5005.1.10 is also referenced in Section 6003.2.6 for outdoor liquid transfer.

**6003.1.5.2 Exhaust ventilation for open systems.** Mechanical exhaust ventilation shall be provided for highly toxic and

toxic liquids used in *open systems* in accordance with Section 5005.2.1.1.

**Exception:** Liquids that do not generate highly toxic or toxic fumes, mists or vapors.

❖ This section requires any open use of highly toxic or toxic liquids to be properly ventilated and refers to Section 5005.2.1.1. That section contains the general ventilation requirements for open systems using gases, liquids or solids with a hazard ranking of 3 or 4. Essentially, it requires that vapors be captured at the point of generation.

The exceptions to both Sections 5005.2.1.1 and 6003.1.5.2 state that liquids that do not produce hazardous vapors, mists or fumes need not comply with these ventilation requirements. Much of this will depend on the volatility of the liquid, the degree of hazard of the liquid and how it is used.

**6003.1.5.3 Exhaust ventilation for closed systems.** Mechanical exhaust ventilation shall be provided for highly toxic and toxic liquids used in *closed systems* in accordance with Section 5005.2.2.1.

**Exception:** Liquids that do not generate highly toxic or toxic fumes, mists or vapors.

❖ Section 5005.2.2.2 requires ventilation in accordance with Section 5005.1.1 if the closed system is designed to be opened during normal operations. Section 5005.1.1 is for open systems using materials with a hazard ranking of 3 or 4. The same exception is stated in Section 6003.1.5.2, which exempts liquids that do not produce highly toxic or toxic fumes, vapors or mists (see commentary, Section 6003.1.5.2).

**6003.2 Outdoor storage and use.** Outdoor storage and use of highly toxic and toxic materials shall comply with Sections 6003.2.1 through 6003.2.6.

❖ Outdoor storage and use is generally less hazardous than indoor storage and use because the vapors can disperse more easily to the atmosphere, posing less of a hazard to occupants and those in the vicinity of the building. Because the materials are located outside, however, there are other exposure concerns, such as weather and location of storage and use.

**6003.2.1 Quantities not exceeding the maximum allowable quantity per control area.** The outdoor storage or use of highly toxic and toxic solids or liquids in amounts not exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(4) shall be in accordance with Sections 5001, 5003 and 6001.

❖ As with indoor storage and use, when the MAQs have not been exceeded, the only requirements are those found in Section 6001 and the general requirements of Chapter 50. These requirements address issues such as permits, hazardous materials plans, pipe connections (especially with health-hazard rank-

ing materials of 3 or 4), facility closures and hazard identification and signage.

**6003.2.2 Quantities exceeding the maximum allowable quantity per control area.** The outdoor storage or use of highly toxic and toxic solids or liquids in amounts exceeding the *maximum allowable quantity per control area* set forth in Table 5003.1.1(4) shall be in accordance with Sections 6001 and 6003.2 and Chapter 50.

❖ When the MAQs have been exceeded for the outdoor control areas, the requirements become more extensive. More specifically, compliance with Section 6003.2 is required in addition to Section 6001 and Chapter 50, as applicable.

**6003.2.3 General outdoor requirements.** The general requirements applicable to the outdoor storage of highly toxic or toxic solids and liquids shall be in accordance with Sections 6003.2.3.1 and 6003.2.3.2.

❖ This section sets general requirements for the location and the need for treatment systems to collect vapors from highly toxic liquids.

**6003.2.3.1 Location.** Outdoor storage or use of highly toxic or toxic solids and liquids shall not be located within 20 feet (6096 mm) of *lot lines*, public streets, public alleys, *public ways*, *exit discharges* or *exterior wall* openings. A 2-hour *fire barrier* without openings or penetrations extending not less than 30 inches (762 mm) above and to the sides of the storage is allowed in lieu of such distance. The wall shall either be an independent structure, or the exterior wall of the building adjacent to the storage area.

❖ This section requires that toxic and highly toxic solids and liquids be at least 20 feet (6096 mm) from possible exposure hazards, such as an exit discharge. The concern with highly toxic and toxic materials is the health hazards for building occupants, emergency responders and others in the immediate area.

An alternative to the 20-foot (6096 mm) distance is offered in this section. Essentially, it would allow the use of a 2-hour fire barrier constructed in accordance with IBC Section 707 and without openings, that extends 30 inches (763 mm) above and to the sides of the storage. The wall can be either freestanding or a wall of the building that fits the requirements as a 2-hour fire barrier without openings. Generally, this wall and the distance requirements are for the protection of the toxic and highly toxic liquids and solids from fire exposures that could lead to the release of materials. Additionally, both methods allowed in this section result in a separation (by either distance or construction) from people to reduce the likelihood of contact with hazards.

**6003.2.3.2 Treatment system—highly toxic liquids.** Exhaust scrubbers or other systems for processing vapors of

highly toxic liquid shall be provided where a spill or accidental release of such liquids can be expected to release highly toxic vapors at *normal temperature and pressure (NTP)*. Treatment systems and other processing systems shall be installed in accordance with the *International Mechanical Code*.

❖ This section is the same as Section 6003.1.3 for indoor storage and the use of highly toxic liquids (see commentary, Section 6003.1.3).

**6003.2.4 Outdoor storage piles.** Outdoor storage piles of highly toxic and toxic solids and liquids shall be separated into piles not larger than 2,500 cubic feet (71 m<sup>3</sup>). Aisle widths between piles shall be not less than one-half the height of the pile or 10 feet (3048 mm), whichever is greater.

❖ The requirement in this section seeks to reduce the hazard level of a release of highly toxic and toxic liquids and solids by reducing the amount allowed in a single pile. Additionally, minimum separations between piles are required. These separations serve both as a fire barrier and as access for emergency responders. If the piles become too large, they become difficult to manage if a release should happen or a fire should occur.

**6003.2.5 Weather protection for highly toxic liquids and solids—outdoor storage or use.** Where overhead weather protection is provided for outdoor storage or use of highly toxic liquids or solids, and the weather protection is attached to a building, the storage or use area shall either be equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1, or storage or use vessels shall be fire resistive. Weather protection shall be provided in accordance with Section 5004.13 for storage and Section 5005.3.9 for use.

❖ This section is specific to outdoor storage or use of highly toxic liquids and solids when they are located in an area with weather protection attached to a building. The storage or use must be either sprinklered or placed within fire-resistive containers. Because the storage or use area is next to the building, the concern for a fire and the potential release of liquids and solids is greater. This poses a hazard to both building occupants and emergency responders. Section 5004.13 contains the general requirements for weather-protected storage and references the weather protection provisions of IBC Section 414.6.1.

**6003.2.6 Outdoor liquid transfer.** Highly toxic and toxic liquids shall be transferred in accordance with Section 5005.1.10.

❖ This section refers to Section 5005.1.10 for the general requirements for liquid transfer. This is the same reference used in Section 6003.1.5.1 for indoor liquid transfer (see commentary, Section 6003.1.5.1).

## SECTION 6004

## HIGHLY TOXIC AND TOXIC COMPRESSED GASES

**6004.1 General.** The storage and use of highly toxic and toxic *compressed gases* shall comply with this section.

❖ This section requires all highly toxic and toxic gases to comply with the following subsections.

**6004.1.1 Special limitations for indoor storage and use by occupancy.** The indoor storage and use of highly toxic and toxic *compressed gases* in certain occupancies shall be subject to the limitations contained in Sections 6004.1.1.1 through 6004.1.1.3.

❖ This section places additional limitations on the storage and use of toxic and highly toxic gases in several occupancy types and uses. These are further restrictions on the MAQs given in Chapter 50.

**6004.1.1.1 Group A, E, I or U occupancies.** Toxic and highly toxic *compressed gases* shall not be stored or used within Group A, E, I or U occupancies.

**Exception:** Cylinders not exceeding 20 cubic feet (0.566 m<sup>3</sup>) at *normal temperature and pressure (NTP)* are allowed within gas cabinets or fume hoods.

❖ This section prohibits having any large quantities of highly toxic and toxic gases in these occupancies. With the exception of Group U, these are occupancies that have typically high occupant densities or a vulnerable population. The prohibition for Group U occupancies is likely related to the potential lack of supervision and the types of materials that are likely to be stored along with such gases.

The exception to this section allows small amounts of gases if they are stored or used within gas cabinets or fume hoods. The allowance for small cylinders results from the small potential for release when they are stored in a cabinet or used within a fume hood and the probability that the volume of the release would be low.

**6004.1.1.2 Group R occupancies.** Toxic and highly toxic *compressed gases* shall not be stored or used in Group R occupancies.

❖ This section prohibits the storage and use of highly toxic and toxic gases in all Group R occupancies without exception. Group R occupancies cover a wide variety of dwelling-type occupancies, such as one- and two-family dwellings, apartment buildings, hotels, motels, etc. The hazards posed by the storage and use of toxic or highly toxic gases would be much higher than would reasonably be anticipated by the occupants.

**6004.1.1.3 Offices, retail sales and classrooms.** Toxic and highly toxic *compressed gases* shall not be stored or used in

offices, retail sales or classroom portions of Group B, F, M or S occupancies.

**Exception:** In classrooms of Group B occupancies, cylinders with a capacity not exceeding 20 cubic feet (0.566 m<sup>3</sup>) at *NTP* are allowed in gas cabinets or fume hoods.

❖ This section does not completely prohibit the storage and use of highly toxic liquids in these particular occupancies, but instead focuses on certain portions of occupancies. In particular, this section addresses the offices, retail sales areas and classrooms of Group B, F, M or S occupancies. A normal storage area with no public access, therefore, could be used to store highly toxic or toxic gases, but the office incidental to that storage facility could not.

The exception allows small cylinders in classrooms in Group B occupancies when they are used within gas cabinets or fume hoods. This acknowledges special needs at university laboratories and similar facilities.

**6004.1.2 Gas cabinets.** Gas cabinets containing highly toxic or toxic *compressed gases* shall comply with Section 5003.8.6 and the following requirements:

1. The average ventilation velocity at the face of gas cabinet access ports or windows shall be not less than 200 feet per minute (1.02 m/s) with not less than 150 feet per minute (0.76 m/s) at any point of the access port or window.
2. Gas cabinets shall be connected to an exhaust system.
3. Gas cabinets shall not be used as the sole means of exhaust for any room or area.
4. The maximum number of cylinders located in a single gas cabinet shall not exceed three, except that cabinets containing cylinders not exceeding 1 pound (0.454 kg) net contents are allowed to contain up to 100 cylinders.
5. Gas cabinets required by Section 6004.2 or 6004.3 shall be equipped with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1. Alternative fire-extinguishing systems shall not be used.

❖ This section sets additional requirements for gas cabinets used specifically for highly toxic and toxic gases. Section 5003.8.6 contains the general requirements for all gas cabinets. More specifically, that section sets out construction specifications, requires negative pressure for ventilation and restricts the number of cylinders to three. Section 6004.1.2 is more restrictive, requiring an air velocity of at least 200 feet per minute (1.02 m/s) at the face of the cabinet as well as a connection to an exhaust system and an area ventilation system in addition to the ventilation system in the gas cabinet. A sprinkler system is also required.

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Section 6004.2.2.7 would require the exhaust to be connected to a treatment system. Item 4 in Section 6004.1.2 does allow up to 100 small cylinders [under 1 pound (0.454 kg) each] instead of the restriction of three larger cylinders. This allowance recognizes the reduced potential for a large release and increases flexibility to meet the needs of the facilities such as laboratories.

**6004.1.3 Exhausted enclosures.** Exhausted enclosures containing highly toxic or toxic *compressed gases* shall comply with Section 5003.8.5 and the following requirements:

1. The average ventilation velocity at the face of the enclosure shall be not less than 200 feet per minute (1.02 m/s) with not less than 150 feet per minute (0.76 m/s).
  2. Exhausted enclosures shall be connected to an exhaust system.
  3. Exhausted enclosures shall not be used as the sole means of exhaust for any room or area.
  4. Exhausted enclosures required by Section 6004.2 or 6004.3 shall be equipped with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1. Alternative fire-extinguishing systems shall not be used.
- ❖ This section, like Section 6004.1.2, requires compliance with the general exhausted enclosure requirements in Section 5003.8.5. Section 5003.8.5, like Section 5003.8.6 for gas cabinets, contains basic construction specifications and requires that the enclosure be at a negative pressure. Additionally, there is a requirement in Section 5003.8.5.3 that a fire-extinguishing system be installed when the materials stored or used in the enclosure are flammable.
- Section 6004.1.3 additionally requires an air velocity of at least 200 feet per minute (1.02 m/s) at the face of the enclosure and that the enclosure be connected to an exhaust system that is not the sole source of ventilation for that area. In addition, this section requires a sprinkler system in the enclosure. This is independent of whether the material is considered flammable.

**6004.2 Indoor storage and use.** The indoor storage and use of highly toxic or toxic *compressed gases* shall be in accordance with Sections 6004.2.1 through 6004.2.2.10.4.

❖ This section is specific to the indoor storage and use of toxic and highly toxic gases. When Section 6004.2 applies, it focuses on the location of cylinders and the removal of unwanted releases of gases. Treatment systems are required to process any gases collected when ventilating results in the release of toxic and highly toxic gases.

**6004.2.1 Applicability.** The applicability of regulations governing the indoor storage and use of highly toxic and toxic

*compressed gases* shall be as set forth in Sections 6004.2.1.1 through 6004.2.1.3.

❖ This section clarifies which requirements apply based on the amount of material in storage or in use.

**6004.2.1.1 Quantities not exceeding the maximum allowable quantity per control area.** The indoor storage or use of highly toxic and toxic gases in amounts not exceeding the *maximum allowable quantity per control area* set forth in Table 5003.1.1(2) shall be in accordance with Sections 5001, 5003, 6001 and 6004.1.

❖ When the MAQs have not been exceeded, only the more general requirements would apply. These include restrictions on the storage and use in certain occupancies, piping connection requirements based on the level of health hazards, permits and other similar requirements. Tables 5003.1.1(2) and 5003.1.1(4) would require putting highly toxic gases in a gas cabinet or exhausted enclosure regardless of the amount of gases stored or used. These gas cabinets and exhausted enclosures need to be in accordance only with the basic requirements of Chapter 50 and do not need to be connected to a treatment system.

**6004.2.1.2 Quantities exceeding the maximum allowable quantity per control area.** The indoor storage or use of highly toxic and toxic gases in amounts exceeding the *maximum allowable quantity per control area* set forth in Table 5003.1.1(2) shall be in accordance with Sections 6001, 6004.1, 6004.2 and Chapter 50.

❖ If the MAQs have been exceeded, the requirements become much more extensive. This requires compliance with all applicable sections of Chapter 50 and also Section 6004.2, which has requirements for treatment systems and gas detection systems.

**6004.2.1.3 Ozone gas generators.** The indoor use of ozone gas-generating equipment shall be in accordance with Section 6005.

❖ This section is a specific reference to Section 6005, which deals with the process of ozone generation. The operation is unique and, therefore, has unique requirements. The requirements in Section 6005 apply when the ozone-generating capacity exceeds 0.5 pound (0.227 kg) in a 24-hour period.

**6004.2.2 General indoor requirements.** The general requirements applicable to the indoor storage and use of highly toxic and toxic *compressed gases* shall be in accordance with Sections 6004.2.2.1 through 6004.2.2.10.4.

❖ The requirements in this section are for both storage and use of toxic and highly toxic gases when the MAQs have been exceeded.

**6004.2.2.1 Cylinder and tank location.** Cylinders shall be located within gas cabinets, exhausted enclosures or gas

rooms. Portable and stationary tanks shall be located within gas rooms or exhausted enclosures.

❖ Toxic and highly toxic gases pose a high threat to occupants and emergency responders if released to the atmosphere; therefore, this section places restrictions on where cylinders and tanks can be located. More specifically, cylinders must be in a gas cabinet or within gas rooms or exhausted enclosures. Tanks, both portable and stationary, must be either in a gas room or an exhausted enclosure. Gas cabinets are not an option because of the size of portable and stationary tanks. Gas cabinets, exhausted enclosures and gas rooms have specific requirements in Sections 6004.1.2, 6004.1.3 and 6004.2.2.6, respectively, in addition to the general requirements in Chapter 50.

**6004.2.2.2 Ventilated areas.** The room or area in which gas cabinets or exhausted enclosures are located shall be provided with exhaust ventilation. Gas cabinets or exhausted enclosures shall not be used as the sole means of exhaust for any room or area.

❖ This section requires that gas cabinets and exhausted enclosures not be the only ventilation provided when toxic or highly toxic gases are stored or used. The room or area must have additional ventilation. The exhaust ventilation for the room need not be processed through a treatment system.

**6004.2.2.3 Leaking cylinders and tanks.** One or more gas cabinets or exhausted enclosures shall be provided to handle leaking cylinders, containers or tanks.

**Exceptions:**

1. Where cylinders, containers or tanks are located within gas cabinets or exhausted enclosures.
2. Where *approved* containment vessels or containment systems are provided in accordance with all of the following:
  - 2.1. Containment vessels or containment systems shall be capable of fully containing or terminating a release.
  - 2.2. Trained personnel shall be available at an *approved* location.
  - 2.3. Containment vessels or containment systems shall be capable of being transported to the leaking cylinder, container or tank.

❖ Section 6004.2.2.1 requires the use of gas cabinets, exhausted enclosures or gas rooms for the storage of cylinders and tanks. This section takes the requirements one step further and requires that one or more additional gas cabinets or exhausted enclosures be provided and ready to receive leaking cylinders or tanks. Exception 1 is for cylinders and tanks that are already contained within gas cabinets or exhausted enclosures.

Exception 2 allows the use of containment vessels and containment systems in place of a gas cabinet or exhausted enclosure to address the release of gases

based on three conditions: the vessel or system must be sufficiently sized to contain the potential release; a trained person must be available; and the containment vessel or system must be transportable to the leaking cylinder or tank.

**6004.2.2.3.1 Location.** Gas cabinets and exhausted enclosures shall be located in gas rooms and connected to an exhaust system.

❖ When gas cabinets and exhausted enclosures are used with leaking tanks, they must be contained in gas rooms. Containment vessels and systems would not have to be located in a gas room.

**6004.2.2.4 Local exhaust for portable tanks.** A means of local exhaust shall be provided to capture leaks from portable tanks. The local exhaust shall consist of portable ducts or collection systems designed to be applied to the site of a leak in a valve or fitting on the tank. The local exhaust system shall be located in a gas room. Exhaust shall be directed to a treatment system in accordance with Section 6004.2.2.7.

❖ This section requires portable tanks located in gas rooms to have an additional local exhaust mechanism. More specifically, Section 6004.2.2.1 requires locating portable tanks in a gas room or exhausted enclosure as a minimum. Since exhausted enclosures would be considered local, an additional local exhaust system would not be required. Only when the sole exhaust mechanism is a gas room would a local exhaust be required. The exhaust from the gas room and the local exhaust system must be processed through a treatment system in accordance with Section 6004.2.2.7. The focus of a local exhaust system should be on the valves or valve fittings where a leak is more likely.

**6004.2.2.5 Piping and controls—stationary tanks.** In addition to the requirements of Section 5003.2.2, piping and controls on stationary tanks shall comply with the following requirements:

1. Pressure relief devices shall be vented to a treatment system designed in accordance with Section 6004.2.2.7.

**Exception:** Pressure relief devices on outdoor tanks provided exclusively for relieving pressure due to fire exposure are not required to be vented to a treatment system provided that:

1. The material in the tank is not flammable.
  2. The tank is not located in a diked area with other tanks containing combustible materials.
  3. The tank is located not less than 30 feet (9144 mm) from combustible materials or structures or is shielded by a *fire barrier* complying with Section 6004.3.2.1.1.
2. Filling or dispensing connections shall be provided with a means of local exhaust. Such exhaust shall be designed to capture fumes and vapors. The exhaust shall be directed to a treatment system in accordance with Section 6004.2.2.7.

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3. Stationary tanks shall be provided with a means of excess flow control on all tank inlet or outlet connections.

### Exceptions:

1. Inlet connections designed to prevent backflow.
  2. Pressure relief devices.
- ❖ This section is in addition to Section 5003.2.2, which addresses piping, tubing, valves and fittings in general for all hazardous materials. This section focuses on exhaust ventilation for potential leaks and releases associated with piping, filling and dispensing connections on stationary tanks. Section 5003.2.2 contains general requirements covering issues such as compatibility, shutoff valves, backflow prevention and leak detection. This section is specific to stationary tanks because they are more permanent and piping and other controls are more likely on stationary tanks versus portable tanks and cylinders.

The specific requirements found in this section are as follows:

1. If a pressure relief valve is used, the release must be vented directly to a treatment system. There is an exception that pertains to outdoor tanks with pressure valves specifically for pressure relief in a fire. There are several conditions for the exception that address exposure hazards, such as neighboring tanks or combustible hazards. Also, the material in the tank itself cannot be flammable. Although this exception for outdoor tanks is found in the indoor storage and use requirements, Section 6004.3 for outdoor storage and use has a specific requirement in Section 6004.3.2.3 that refers back to this section for piping and controls for outdoor stationary tanks.
2. This item requires a local exhaust system connected to a treatment system for filling and dispensing connections.
3. Excess flow control is required at every tank inlet and outlet to reduce the size of the release and to avoid dangerous reactions and overpressures in other areas of a process designed for a particular flow rate and pressure. There are two exceptions that relate to devices serving a specific purpose, which include an inlet connection designed to address backflow or a pressure relief valve. A pressure relief valve is specifically designed to allow excessive flow beyond the design pressures of the tank to avoid overpressures in the tank.

**6004.2.2.6 Gas rooms.** Gas rooms shall comply with Section 5003.8.4 and both of the following requirements:

1. The exhaust ventilation from gas rooms shall be directed to an exhaust system.

2. Gas rooms shall be equipped with an *approved automatic sprinkler system*. Alternative fire-extinguishing systems shall not be used.

- ❖ The requirements in Chapter 50 address construction and basic ventilation. General gas room requirements are found in Section 5003.8.3. More specifically, Section 5003.8.3 requires an automatic sprinkler system, separation as required in the IBC and maintaining negative pressure in the room. This section takes the requirements one step further and requires that exhaust ventilation be directed to an exhaust system. Section 6004.2.2.7 also requires directing this exhaust system to a treatment system. The second criterion is a restriction that does not allow any alternative fire-extinguishing systems in place of an automatic sprinkler system.

**6004.2.2.7 Treatment systems.** The exhaust ventilation from gas cabinets, exhausted enclosures and gas rooms, and local exhaust systems required in Sections 6004.2.2.4 and 6004.2.2.5 shall be directed to a treatment system. The treatment system shall be utilized to handle the accidental release of gas and to process exhaust ventilation. The treatment system shall be designed in accordance with Sections 6004.2.2.7.1 through 6004.2.2.7.5 and Section 510 of the *International Mechanical Code*.

### Exceptions:

1. Highly toxic and toxic gases—storage. A treatment system is not required for cylinders, containers and tanks in storage where all of the following controls are provided:
  - 1.1. Valve outlets are equipped with gas-tight outlet plugs or caps.
  - 1.2. Handwheel-operated valves have handles secured to prevent movement.
  - 1.3. *Approved* containment vessels or containment systems are provided in accordance with Section 6004.2.2.3.
2. Toxic gases—use. Treatment systems are not required for toxic gases supplied by cylinders or portable tanks not exceeding 1,700 pounds (772 kg) water capacity where the following are provided:
  - 2.1. A *listed* or *approved* gas detection system with a sensing interval not exceeding 5 minutes.
  - 2.2. A *listed* or *approved* automatic-closing fail-safe valve located immediately adjacent to cylinder valves. The fail-safe valve shall close when gas is detected at the permissible exposure limit (PEL) by a gas detection system monitoring the exhaust system at the point of discharge from the gas cabinet, exhausted enclosure, vent-ilated enclosure or gas room. The gas detection system shall comply with Section 6004.2.2.10.

- ❖ Treatment systems are required for all exhaust ventilation and accidental releases of toxic and highly toxic

gases. A treatment system essentially treats the exhaust through methods such as diluting, absorbing, burning and other various methods, which are discussed in Section 6004.2.2.7.1. Generally, Section 6004.2.2.7 and related subsections contain the design criteria for such systems.

There are two overall exceptions where treatment systems would not be required. They are broken into storage and use, respectively. Treatment systems can be very costly and the exceptions give credit to situations where the hazard is low and the benefit of a costly treatment system cannot be justified.

Exception 1 deals with cylinders, containers and tanks in storage. A treatment system would not be required if all three criteria are met. The criteria include caps or plugs on any valves to provide a level of redundancy in case of an accidental release; hand-wheel-operated valves that are secured in place; and the installation of containment vessels or containment systems.

Exception 2 is for toxic gases supplied by cylinders limited to a size of 1,700 pounds (772 kg) water capacity. The 1,700-pound (772 kg) limit was derived as follows: A ton container typically holds about 1,600 pounds (726 kg) of water, and a filling density of approximately 125 percent of the water capacity is allowed for chlorine [ $1,600 \times 1.25 = 2,000$  pounds (908 kg)]. The resulting weight of product in a filled container is one ton for chlorine. The maximum capacity of 1,700 pounds versus 1,600 pounds (772 kg versus 726 kg) is intended to accommodate manufacturing variations that occur from one container to the next, but this does not affect the ultimate gas capacity of a filled container, which is limited to 2,000 pounds (908 kg) regardless of the variation in water capacity. To avoid the use of a treatment system, a gas detection system must also be accompanied by a fail-safe valve adjacent to the cylinder valve. The fail-safe valve must operate when gas is detected at the point of discharge of the location of the cylinder (see commentary to the Section 202 definition of "Fail-safe"). Section 6004.2.2.1 requires cylinders to be located in a gas cabinet, an exhausted enclosure or a gas room.

**6004.2.2.7.1 Design.** Treatment systems shall be capable of diluting, adsorbing, absorbing, containing, neutralizing, burning or otherwise processing the contents of the largest single vessel of compressed gas. Where a total containment system is used, the system shall be designed to handle the maximum anticipated pressure of release to the system when it reaches equilibrium.

- ❖ This section states that a treatment system must process the exhaust ventilation or an accidental release. Various methods are listed but the section is written to allow exploration of other methods. Additionally, this section sets important capacity criteria for the treatment system, which would require it to either be capable of processing the largest vessel or handle the maximum pressure of release at equilibrium when a total containment system is used.

**6004.2.2.7.2 Performance.** Treatment systems shall be designed to reduce the maximum allowable discharge concentrations of the gas to one-half immediate by dangerous to life and health (IDLH) at the point of discharge to the atmosphere. Where more than one gas is emitted to the treatment system, the treatment system shall be designed to handle the worst-case release based on the release rate, the quantity and the IDLH for all *compressed gases* stored or used.

- ❖ Now that the method and the capacity have been established in Section 6004.2.2.7.1, the actual treatment capabilities are described in this section. More specifically, this section describes how well the gases need to be treated. Once treated, the output from the treatment system must not exceed one-half of the immediately dangerous to life and health (IDLH) concentration. If the treatment system is used for a variety of different stored gases that have various levels of toxicity, the treatment system must be able to accommodate the worst-case situation. As an example, the least-toxic gas may have the largest release potential, but the treatment system does not have to work as hard to reduce the IDLH; therefore, both the level of hazard and the amount of the gas must be addressed.

**6004.2.2.7.3 Sizing.** Treatment systems shall be sized to process the maximum worst-case release of gas based on the maximum flow rate of release from the largest vessel utilized. The entire contents of the largest *compressed gas* vessel shall be considered.

- ❖ This section re-emphasizes that the treatment system must be capable of treating the largest single vessel. In addition, this section requires that the maximum flow rates be considered; therefore, it is not simply the capacity of the largest single vessel but also how fast that gas is released. Treatment systems need to account for only a single failure of a vessel, but at the highest flow rate.

**6004.2.2.7.4 Stationary tanks.** Stationary tanks shall be labeled with the maximum rate of release for the *compressed gas* contained based on valves or fittings that are inserted directly into the tank. Where multiple valves or fittings are provided, the maximum flow rate of release for valves or fittings with the highest flow rate shall be indicated. Where liquefied *compressed gases* are in contact with valves or fittings, the liquid flow rate shall be utilized for computation purposes. Flow rates indicated on the label shall be converted to cubic feet per minute (cfm/min) ( $m^3/s$ ) of gas at *normal temperature and pressure (NTP)*.

- ❖ The potential release rates of all valves directly connected to the tank that have the potential for a release of gases must be properly labeled. In addition, the valves that have the highest potential release rates need to be specifically identified. This is especially important when there are multiple valves.

Another requirement of this section is for situations in which the valve is located where it is interacting with the liquid form of the compressed gas. Such interaction will alter the release rate; therefore, the

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liquid rate of release must be used. When a gas is in liquid form it is denser than the gas form. If released, the liquid vaporizes, expanding into a much larger volume of gas. Finally, to more readily assess the amount of gas that can be released into the room or area, the tank liquid flow rate must be shown on the label as the equivalent gas volume in cubic feet per minute at normal temperature and pressure (NTP). In other words, the flow rate is not as important as the gas volume it will produce when released into the room or area. NTP provides a comparable base value.

**6004.2.2.7.5 Portable tanks and cylinders.** The maximum flow rate of release for portable tanks and cylinders shall be calculated based on the total release from the cylinder or tank within the time specified in Table 6004.2.2.7.5. Where portable tanks or cylinders are equipped with *approved* excess flow or reduced flow valves, the worst-case release shall be determined by the maximum achievable flow from the valve as determined by the valve manufacturer or *compressed gas* supplier. Reduced flow and excess flow valves shall be permanently marked by the valve manufacturer to indicate the maximum design flow rate. Such markings shall indicate the flow rate for air under *normal temperature and pressure*.

❖ Given that flow rates of different portable tanks and cylinders tend to vary because of their portability, this information would be difficult to track; therefore, this section simply requires that the maximum flow rate be determined based on the capacity of the tank and the time prescribed in Table 6004.2.2.7.5. For example, say a portable tank had a capacity (at NTP) of 1,000 cubic feet (28 m<sup>3</sup>) and was not under liquefied conditions. The maximum rate of release based on the criteria given in Table 6004.2.2.7.5 would be as follows:

$$\begin{aligned} 1,000 \text{ cubic feet}/40 \text{ minutes} &= \\ 25 \text{ cubic feet per minute at NTP} \end{aligned}$$

In some cases, portable tanks and cylinders may be equipped with valves that either alter the rate of flow or will stop in the case of flow over the designed rate. In those cases, credit is given to the actual amount of gas released at NTP in determining the maximum flow rate. Valves that are used in this manner must be properly labeled to note the specific flow rate at NTP or function.

**TABLE 6004.2.2.7.5  
RATE OF RELEASE FOR CYLINDERS AND PORTABLE TANKS**

VESSEL TYPE	NONLIQUEFIED (minutes)	LIQUEFIED (minutes)
Containers	5	30
Portable tanks	40	240

**6004.2.2.8 Emergency power.** Emergency power shall be provided for the following systems in accordance with Section 604:

1. Exhaust ventilation system.
2. Treatment system.
3. Gas detection system.

4. Smoke detection system.
5. Temperature control system.
6. Fire alarm system.
7. Emergency alarm system.

❖ Because of the immediate health hazard posed by the release of toxic or highly toxic gases, emergency, rather than standby, power is required. The major difference between them is that standby power activates within 60 seconds whereas emergency power activates within 10 seconds. This section provides a specific list of systems that would require emergency power. The most critical is likely the treatment system.

**6004.2.2.8.1 Fail-safe engineered systems.** Emergency power shall not be required for mechanical exhaust ventilation, treatment systems and temperature control systems where *approved* fail-safe engineered systems are installed.

❖ This section permits the use of an engineered system designed to fail in the appropriate design mode without human intervention in place of an emergency power system. The exception is intended to permit alternative systems that are not subject to power interruptions.

**6004.2.2.9 Automatic fire detection system—highly toxic compressed gases.** An *approved* automatic fire detection system shall be installed in rooms or areas where highly toxic *compressed gases* are stored or used. Activation of the detection system shall sound a local alarm. The fire detection system shall comply with Section 907.

❖ This section requires a fire detection system in rooms or areas where highly toxic gases are stored or used. The intent is that a fire in the area could lead to the release of the highly toxic gases. Fires can heat gases stored and cause expansion, leading to overpressures and releases; therefore, warning of a fire is critical to avoiding such releases. The alarm system needs to provide a local alarm at the building, but the detection is required only in the room or area where the highly toxic gas is stored.

**6004.2.2.10 Gas detection system.** A gas detection system shall be provided to detect the presence of gas at or below the PEL or ceiling limit of the gas for which detection is provided. The system shall be capable of monitoring the discharge from the treatment system at or below one-half the IDLH limit.

**Exception:** A gas detection system is not required for toxic gases when the physiological warning threshold level for the gas is at a level below the accepted PEL for the gas.

❖ This section requires a system to detect the presence of gas in a large enough concentration to exceed the permissible exposure limit (PEL). The system must also be designed to be capable of detecting whether one-half the IDLH has been exceeded at the discharge from the treatment system. This is to ensure that the treatment system is working to capacity or to

indicate that there may be other problems, such as a release larger than the treatment system has been designed to handle. It is important to stress the terminology of “capable,” which would not require monitoring but would require an installation that would enable such monitoring if desired. In many cases, monitoring is done intermittently with portable monitors. Such monitoring may become necessary as a result of environmental restrictions, which are beyond the scope of the code.

There is an exception to the requirement of a gas detection system where the odor of the gas or its physical effects are noticeable far before the PEL is reached. Those indicators should be sufficient to notify people to leave the area.

**6004.2.2.10.1 Gas detection system components.** Gas detection system control units shall be *listed* and *labeled* in accordance with UL 864 or UL 2017, or approved. Gas detectors shall be *listed* and *labeled* in accordance with UL 2075 for use with the gases and vapors being detected, or *approved*.

❖ This section requires gas detection equipment to be listed in accordance with UL 2075 for use with the different gases it will detect. Under UL 2075, a set of flammable gases and concentrations in parts per million (PPM) is developed for each detector or sensor and the manufacturer is required to provide information as to what gases and concentrations the device is designed to detect. Tests under the standard then verify the performance of each detector or sensor for each gas it is designed to detect. The gases that the equipment will detect may be shown in the manufacturer’s instructions rather than on the product. This section is intended to ensure that gas detection system control components are listed in accordance with nationally recognized safety standards. These standards include a comprehensive set of construction and performance requirements that are used to evaluate and list gas detection system control units and gas detectors. This section also provides the fire code official with the ability to approve gas detection system components that may not be listed and labeled.

**6004.2.2.10.2 Alarms.** The gas detection system shall initiate a local alarm and transmit a signal to a constantly attended control station when a short-term hazard condition is detected. The alarm shall be both visual and audible and shall provide warning both inside and outside the area where gas is detected. The audible alarm shall be distinct from all other alarms.

**Exception:** Signal transmission to a constantly attended control station is not required where not more than one cylinder of highly toxic or toxic gas is stored.

❖ Once the gas is detected at the levels noted in Section 6004.2.2.10, a local alarm must be initiated and a signal at a constantly attended control station (such as a security room or fire command center) must be

transmitted. The alarm is intended to alert those both inside the particular area of detection and in the immediate vicinity. This is to prevent any gases that escape from causing harm to those outside the area of release.

The notification to the control station provides information to those who must take a role in emergency response, whereas the local alarm is a warning for those in the vicinity of the release.

A signal need not be sent to the control station if the amount of gas stored or used is a maximum of one cylinder. In that case, a local alarm is sufficient to notify people of the immediate hazard.

**6004.2.2.10.3 Shut off of gas supply.** The gas-detection system shall automatically close the shutoff valve at the source on gas supply piping and tubing related to the system being monitored for whichever gas is detected.

**Exception:** Automatic shutdown is not required for reactors utilized for the production of highly toxic or toxic *compressed gases* where such reactors are:

1. Operated at pressures less than 15 pounds per square inch gauge (psig) (103.4 kPa).
2. Constantly attended.
3. Provided with readily accessible emergency shutoff valves.

❖ The gas detection system also initiates the shutdown of gases at the source for gas supply piping and tubing, making this requirement more applicable to the use of the gas than to storage. The exception applies only to equipment used to make toxic or highly toxic gases, and only when all three of the stated conditions are met. This exception recognizes that pressure is a critical element in how much and how fast a gas is released. A low operating pressure normally means a smaller, more easily controlled release. Having an operator monitoring the equipment at all times is considered an adequate safeguard when shutoff valves are easy to reach in case of an emergency. Under these circumstances, notification by an alarm system and a signal to a constantly attended control station is sufficient to deal with the particular hazard. Automatic shutoff would probably be overly restrictive.

**6004.2.2.10.4 Valve closure.** Automatic closure of shutoff valves shall be in accordance with the following:

1. Where the gas-detection sampling point initiating the gas detection system alarm is within a gas cabinet or exhausted enclosure, the shutoff valve in the gas cabinet or exhausted enclosure for the specific gas detected shall automatically close.
2. Where the gas-detection sampling point initiating the gas detection system alarm is within a gas room and *compressed gas* containers are not in gas cabinets or exhausted enclosures, the shutoff valves on all gas lines for the specific gas detected shall automatically close.

3. Where the gas-detection sampling point initiating the gas detection system alarm is within a piping distribution manifold enclosure, the shutoff valve for the compressed container of specific gas detected supplying the manifold shall automatically close.

**Exception:** Where the gas-detection sampling point initiating the gas-detection system alarm is at a use location or within a gas valve enclosure of a branch line downstream of a piping distribution manifold, the shutoff valve in the gas valve enclosure for the branch line located in the piping distribution manifold enclosure shall automatically close.

- ❖ This section describes three common situations in which gas lines need to automatically close when gas is detected. If the gas is detected within a gas cabinet or exhausted enclosure, only the gas line related to the gas cylinder or container within the cabinet or enclosure must be shut down. If the gas is detected within a gas room, all gas lines containing that particular gas must be shut down because it is difficult to determine where the leak originates when the storage and use are in a larger area. The next criterion is related to situations where the gas sampling occurs within a piping manifold enclosure. Gas sampling in such locations is much more localized and the code requires shutting down only the cylinder supplying the manifold.

The exception is for situations where the gas is clearly being released downstream from the piping distribution manifold enclosure. The problem is with the piping or perhaps at a point of use and can be isolated by simply shutting off that particular branch line from the piping distribution manifold enclosure. This would be allowed only if the gas detection system was sampling at the location of use or within a gas valve enclosure downstream from the distribution piping. Otherwise, it would be difficult to determine where the leak originated and the supply at the cylinder or tank would have to be shut down.

**6004.3 Outdoor storage and use.** The outdoor storage and use of highly toxic and toxic *compressed gases* shall be in accordance with Sections 6004.3.1 through 6004.3.4.

- ❖ Outdoor storage and use is generally less hazardous than indoor storage and use because the toxic and highly toxic gases, if released, are more easily diluted and, thus, the hazard to the people in the surrounding area is reduced. When gases are released outdoors, however, it is more difficult to control where the released gases will go and what or who is being exposed to the hazards; therefore, this section contains restrictions on locations and distance to exposures. This section refers back to many of the requirements found in Section 6004.2, such as for piping and controls for stationary tanks and gas detection.

**6004.3.1 Applicability.** The applicability of regulations governing the outdoor storage and use of highly toxic and toxic

*compressed gases* shall be as set forth in Sections 6004.3.1.1 through 6004.3.1.3.

- ❖ This section defines which requirements of the code apply based on the amount of gases stored and used.

**6004.3.1.1 Quantities not exceeding the maximum allowable quantity per control area.** The outdoor storage or use of highly toxic and toxic gases in amounts not exceeding the *maximum allowable quantity per control area* set forth in Table 5003.1.1(4) shall be in accordance with Sections 5001, 5003 and 6001.

- ❖ This section states that when the MAQs have not been exceeded, the general requirements found in Sections 5001 and 5003 would apply, as appropriate. Section 6001, primarily Section 6001.2, would also apply; therefore, the requirements would be fairly limited for amounts under the MAQs.

**6004.3.1.2 Quantities exceeding the maximum allowable quantity per control area.** The outdoor storage or use of highly toxic and toxic gases in amounts exceeding the *maximum allowable quantity per control area* set forth in Table 5003.1.1(4) shall be in accordance with Sections 6001 and 6004.3 and Chapter 50.

- ❖ When the MAQs have been exceeded, the requirements become more restrictive. All of Chapter 50 would apply, as appropriate to the outdoor storage and use of gases, and Section 6004.3 would apply in its entirety.

**6004.3.1.3 Ozone gas generators.** The outdoor use of ozone gas-generating equipment shall be in accordance with Section 6005.

- ❖ Section 6605 contains the bulk of the requirements for outdoor use of ozone gas-generating equipment (see commentary, Section 6605).

**6004.3.2 General outdoor requirements.** The general requirements applicable to the outdoor storage and use of highly toxic and toxic *compressed gases* shall be in accordance with Sections 6004.3.2.1 through 6004.3.2.4.

- ❖ This section contains the bulk of the requirements for outdoor storage and the use of highly toxic and toxic gases. In several places, the text refers back to various sections in Section 6004.2 to avoid repetitive wording when the same requirements apply to both indoor and outdoor storage and use. The sections that are unique to outdoor storage and use concern location and exposures.

**6004.3.2.1 Location.** Outdoor storage or use of highly toxic or toxic *compressed gases* shall be located in accordance with Sections 6004.3.2.1.1 through 6004.3.2.1.3.

**Exception:** *Compressed gases* located in gas cabinets complying with Sections 5003.8.6 and 6004.1.2 and located 5 feet (1524 mm) or more from buildings and 25 feet (7620 mm) or more from an *exit discharge*.

- ❖ As noted, highly toxic and toxic gases used and stored outdoors are more difficult to contain because

an accidental release could disperse in various directions based on the configuration of the storage, the properties of the gases stored and used and climatic conditions. Additionally, there is less control of exposure hazards, which may affect the storage and use of such gases. The following subsections address distance to exposures, openings in exposed buildings and hazards associated with air intakes into buildings.

There is an exception when cylinders are contained in a gas cabinet that complies with both the general requirements of Chapter 50 and the specific requirements of Section 6004.1.2 for use of highly toxic and toxic gases. In addition, the cabinet must be sufficiently separated from buildings and the exit discharge.

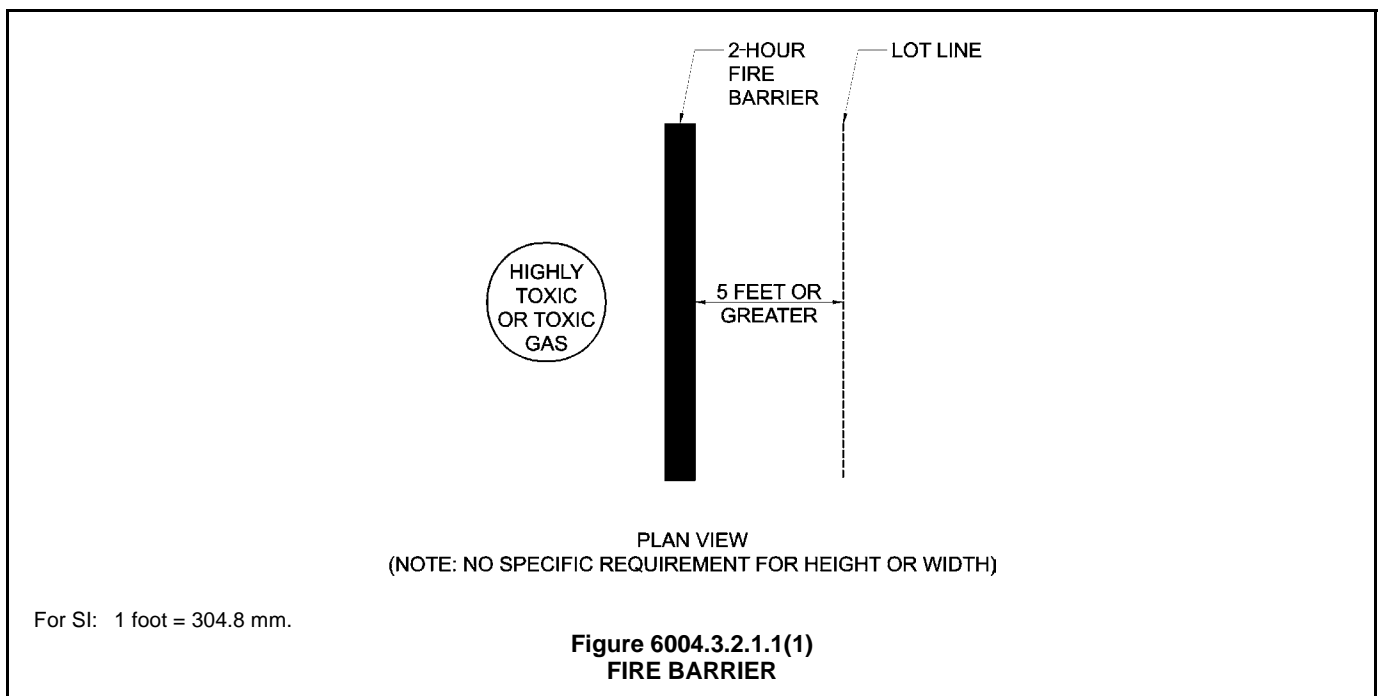
**6004.3.2.1.1 Distance limitation to exposures.** Outdoor storage or use of highly toxic or toxic *compressed gases* shall not be located within 75 feet (22 860 mm) of a *lot line*, public street, public alley, *public way*, *exit discharge* or building not associated with the manufacture or distribution of such gases, unless all of the following conditions are met:

1. Storage is shielded by a 2-hour *fire barrier* that interrupts the line of sight between the storage and the exposure.
2. The 2-hour *fire barrier* shall be located not less than 5 feet (1524 mm) from any exposure.
3. The 2-hour *fire barrier* shall not have more than two sides at approximately 90-degree (1.57 rad) directions, or three sides with connecting angles of approximately 135 degrees (2.36 rad).

❖ A minimum distance of 75 feet (22 860 mm) is required to exposures such as an exit discharge, lot line or public way. The distance to exposures is in

terms of buildings not associated with the manufacture or distribution of highly toxic and toxic gases because buildings associated with those activities would not have separation requirements. It would be impractical for such facilities to be laid out with this kind of separation, and the level of hazard is known and accepted at these facilities. An alternative to the 75-foot (22 860 mm) separation is allowed when certain conditions are met. A 2-hour fire barrier constructed in accordance with IBC Section 707 can be substituted when the conditions stated in this section are met [see Commentary Figure 6004.3.2.1.1(1)]. The code criteria do not set a limit on the height or width of the barrier as long as it interrupts the line of sight between the storage and the exposure, although areas located above and to the sides of the barrier will likely have more restrictive limitations on openings (see commentary, Section 6004.3.2.1.2). Limitations are placed on barriers in terms of the number of walls creating the separation based on the angle of the walls to one another. These are shown in Commentary Figure 6004.3.2.1.1(2). Generally, the limitations are related to the fact that when more than one wall is used there is the potential that some of the natural ventilation of the outdoor storage location would be lost. For instance, allowing three walls at 90 degrees (1.57 rad) versus two walls practically encloses the storage. The allowance of three walls at 135-degree (2.36 rad) angles still results in a level of openness that allows the benefits of natural ventilation.

**6004.3.2.1.2 Openings in exposed buildings.** Where the storage or use area is located closer than 75 feet (22 860 mm) to a building not associated with the manufacture or distribution of highly toxic or toxic *compressed gases*, openings into a building other than for piping are not allowed above the



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height of the top of the 2-hour *fire barrier* or within 50 feet (15 240 mm) horizontally from the storage area whether or not shielded by a *fire barrier*.

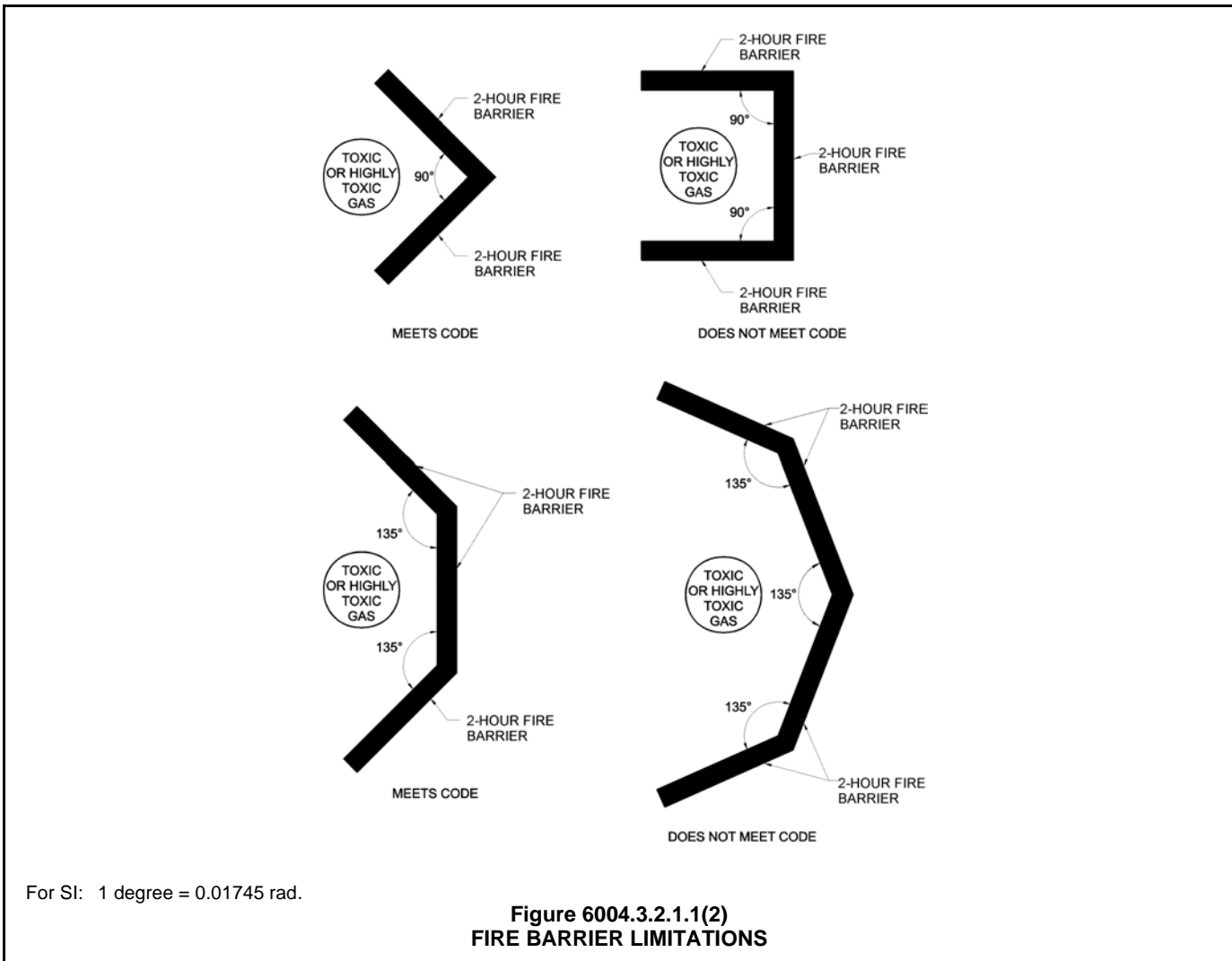
- ❖ When a fire barrier is used in place of the 75-foot (22 860 mm) separation, there are further limitations on openings. Openings other than pipe penetrations are allowed only when the exposure is 50 feet (15 240 mm) or more from the barrier, and then only below the height of the barrier. Piping penetrations are allowed because they are small enough to be considered an insignificant hazard (see Commentary Figure 6004.3.2.1.2).

The primary intent of this section is to protect the highly toxic and toxic gases from a release caused by a fire in the building. Openings such as windows increase the likelihood of a fire heating up a cylinder or tank and causing overpressures that could result in a release. A solid wall decreases the possibility of a fire penetrating or the radiation from the fire from contacting the storage area. Also, openings are a potential method for highly toxic and toxic gases to enter a building. A fire barrier will not stop gases from traveling upward if they are lighter than air.

**6004.3.2.1.3 Air intakes.** The storage or use area shall not be located within 75 feet (22 860 mm) of air intakes.

- ❖ This section addresses the threat of a release of toxic or highly toxic gases getting into a building's heating, ventilating and air-conditioning (HVAC) system. The 75-foot (22 860 mm) separation is consistent with the distances previously laid out. The important distinction with this section is that exposure of the building's exterior is not a concern. Instead, the concern is for the health risks of a gas released into the building's HVAC system.

This section does not differentiate between a building associated with the storage and manufacture of highly toxic and toxic gases and one that is not. The risk to building occupants and emergency responders and the potential hazards of such gases entering a facility's main air source would be the same in either case. Also, gases entering other openings do not have the same potential for circulation around the building as those entering an air intake with the specific purpose of circulation.



**6004.3.2.2 Leaking cylinders and tanks.** The requirements of Section 6004.2.2.3 shall apply to outdoor cylinders and tanks. Gas cabinets and exhausted enclosures shall be located within or immediately adjacent to outdoor storage or use areas.

❖ This section refers back to Section 6004.2.2.3 for requirements for handling leaking cylinders and tanks. Essentially, a gas cabinet or exhausted enclosure is required to contain leaking cylinders and tanks. Section 6004.2.2.3.1 requires that gas cabinets and exhausted enclosures used with leaking cylinders and tanks be located in a gas room. Although this section refers back to these requirements, the code was not intended to require a gas room in outdoor storage and use areas. If a gas room with either a gas cabinet or exhausted enclosure is available nearby, it can be used, but to require an outdoor storage and use area to go indoors would be impractical. Regardless, gas rooms, gas cabinets and exhausted enclosures would have to be connected to an exhaust system that would then be connected to a treatment system. The major difference between the indoor requirements and the outdoor requirements is that cylinders, portable tanks and stationary tanks stored outside of buildings need not be placed in gas cabinets, exhausted enclosures or gas rooms except when they are leaking.

A containment vessel or containment system could also be used as long as several criteria are met (see definitions for “Containment vessel” and “Containment system” in Section 202 and the commentary to Section 6004.2.2.3).

**6004.3.2.3 Local exhaust for portable tanks.** Local exhaust for outdoor portable tanks shall be provided in accordance with the requirements set forth in Section 6004.2.2.4.

❖ This section refers to Section 6004.2.2.4, which would require local exhaust systems for portable tanks to address areas on a tank where leaks are likely to occur. These systems need to be flexible to address the types of tanks likely to be stored or used. Although Section 6004.2.2.4 would require the exhaust system to be located in a gas room, the intent of this section would warrant the elimination of a gas room where the exhaust system is in or immediately adjacent to the outdoor storage area. Again, the intent is not to require outdoor storage to be placed indoors in a gas room. Outdoor storage has slightly different concerns, such as exposure hazards (see commentary, Section 6004.2.2.4).

**6004.3.2.4 Piping and controls-stationary tanks.** Piping and controls for outdoor stationary tanks shall be in accordance with the requirements set forth in Section 6004.2.2.5.



## HIGHLY TOXIC AND TOXIC MATERIALS

❖ This section refers to Section 6004.2.2.5 for requirements. The exception to Section 6004.2.2.5, Item 1 is specific to outdoor tanks. This exception allows for the elimination of a treatment system to collect a release from a pressure relief device that is specifically installed for overpressure caused by fire. To take advantage of this exception, several criteria must be met. These criteria address the reduction of possible fire hazards by ensuring both that the gas stored is not flammable and the exposures to other fire hazards are reduced. This exception recognizes that gases are more readily dispersed outside, which reduces the need for a treatment system to process a release (see commentary, Section 6004.2.2.5).

**6004.3.3 Outdoor storage weather protection for portable tanks and cylinders.** Weather protection in accordance with Section 5004.13 shall be provided for portable tanks and cylinders located outdoors and not within gas cabinets or exhausted enclosures. The storage area shall be equipped with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1.

**Exception:** An *automatic sprinkler system* is not required when:

1. All materials under the weather protection structure, including hazardous materials and the containers in which they are stored, are non-combustible.
  2. The weather protection structure is located not less than 30 feet (9144 mm) from combustible materials or structures or is separated from such materials or structures using a *fire barrier* complying with Section 6004.3.2.1.1.
- ❖ Cylinders and portable tanks that are used strictly for the outdoor storage of highly toxic and toxic gases must be placed in gas cabinets and exhausted enclosures only if they are leaking. Otherwise, outdoor storage simply requires protection from the elements. Sprinklers are required unless every material under the weather protection is noncombustible and the weather protection structure is properly separated either by distance or by construction from combustible exposures such as other storage or buildings. The exception refers back to the exposure requirements in Section 6004.3.2.1.1 for construction requirements. Protecting materials from the elements reduces the likelihood of the tanks and cylinders being damaged and potential release through corrosion. Additionally, the sprinklers protect the storage from a large release if a fire were to occur, causing overpressures in tanks and cylinders and ultimately releases of gases. This protection is especially important because these particular gases are not being processed through a treatment system should a release occur.

**6004.3.4 Outdoor use of cylinders, containers and portable tanks.** Cylinders, containers and portable tanks in out-

door use shall be located in gas cabinets or exhausted enclosures and shall comply with Sections 6004.3.4.1 through 6004.3.4.3.

❖ Because use is more likely than storage to lead to a release of gas, the cylinders, containers or portable tanks that supply the gases need to be located in a gas cabinet or exhausted enclosure and be equipped with a treatment system, emergency power and a gas detection system in accordance with Sections 6004.3.4.1 through 6004.3.4.3.

**6004.3.4.1 Treatment systems.** The treatment system requirements set forth in Section 6004.2.2.7 shall apply to highly toxic or toxic gases located outdoors.

❖ This section refers to the design criteria for treatment systems in Section 6004.2. As noted in Section 6004.2.2.7, a treatment system is required for exhaust ventilation coming from gas cabinets, exhausted enclosures, gas rooms and local exhaust systems. There are exceptions in Section 6004.2.2.7 for both storage and use. The storage exception focuses on securing valve outlets and using containment vessels and systems.

The use exception requires gas detection and fail-safe valve operation. Note that the exception for use is specific only to toxic gases.

For outdoor areas there are only a few occasions where a gas cabinet, exhausted enclosure, gas room or local exhaust would be required. Again, this is related to the fact that gases stored and used outdoors can be more easily dispersed if a release should occur, generally posing a lower hazard to those in the area. The requirements generally are based on the location of the gases. Treatment systems would come into play only for gas cabinets, exhausted enclosures and gas rooms associated with leaking cylinders or tanks and local exhaust for portable containers.

**6004.3.4.2 Emergency power.** The requirements for emergency power set forth in Section 6004.2.2.8 shall apply to highly toxic or toxic gases located outdoors.

❖ See the commentary to Section 6004.2.2.8.

**6004.3.4.3 Gas detection system.** The gas detection system requirements set forth in Section 6004.2.2.10 shall apply to highly toxic or toxic gases located outdoors.

❖ Because this section pertains to outdoor storage and use of highly toxic and toxic gases, the requirement for gas detection systems is less restrictive than it is for indoor storage and use. Essentially, detection systems would be required for small enclosures, such as gas cabinets and exhausted enclosures, and for local enclosures, such as piping manifold enclosures. Otherwise, gas detection is fairly ineffective in the outdoors. The detailed requirements for gas detection are found in Section 6004.2.2.10.

**SECTION 6005  
OZONE GAS GENERATORS**

**6005.1 Scope.** Ozone gas generators having a maximum ozone-generating capacity of 0.5 pound (0.23 kg) or more over a 24-hour period shall be in accordance with Sections 6005.2 through 6005.6.

**Exceptions:**

1. Ozone-generating equipment used in Group R-3 occupancies.
2. Ozone-generating equipment where used in Group H-5 occupancies where in compliance with Chapters 27 and 50 and the other provisions in this chapter for highly toxic gases.

❖ This section differs from most of the rest of this chapter because it deals with the generation (i.e., creation) of a highly toxic gas and not simply its storage or use. The requirements center on the design, location, piping integrity and methods of ozone generator shut-down.

Ozone is a molecule composed of three atoms of oxygen. Two atoms of oxygen form the basic oxygen molecule, which is the oxygen we breathe. The third oxygen atom can detach from the ozone molecule and reattach to molecules of other substances, thereby altering their chemical composition. Generally, this ability to reattach is the reason ozone is generated and used as a method of purification. The primary uses are for the purification of water and air. The two uses are very different in their applications and the success of the air purification is a controversial one because it appears to be ineffective unless

the ozone is present in the atmosphere at concentrations that would be harmful to people. Ozone is actually considered a pollutant when in the atmosphere we breathe.

The ability of ozone to react with organic materials is why it is used in purification. It is this same ability that causes harm to humans. The following table is taken from documentation from the EPA regarding the health effects, risk factors and health standards of various federal agencies.

Because of the nature of fire codes, the main goal of the requirements in this section is to avoid a situation where building occupants and emergency responders are exposed to unsafe levels of ozone on a more immediate basis, which is slightly different than the objectives of the federal agencies listed in Commentary Figure 6005.1.

These requirements apply only to generators that produce 0.5 pound (0.23 kg) or more over a 24-hour period. These tend to be the larger commercial and industrial application generators.

Exception 1 for ozone generators that are found in one- and two-family dwellings (Group R-3) is based on the assumption that these generators would not produce the quantity noted in this section. This exception avoids impractical enforcement.

Exception 2 clarifies that the general conditions in Section 6005.1 do not apply to ozone-generating equipment used in Group H-5 occupancies. Ozone in a Group H-5 occupancy is a hazardous production material (HPM) gas specifically regulated as a highly toxic, oxidizing HPM gas in Chapters 27, 50 and 60.

HEALTH EFFECTS	RISK FACTORS	HEALTH STANDARDS*
<p><b>Potential risk of experiencing:</b> Decreases in lung function Aggravation of asthma Throat irritation and cough Chest pain and shortness of breath Inflammation of lung tissue Higher susceptibility to respiratory infection</p>	<p><b>Factors expected to increase risk and severity of health effects are:</b> Increase in ozone concentration in air Greater duration of exposure for some health effects Activities that raise the breathing rate (e.g., exercise) Certain pre-existing lung diseases (e.g., asthma)</p>	<p><b>Food and Drug Administration (FDA)</b> requires ozone output of indoor medical devices to be no more than 0.05 ppm.</p> <p><b>Occupational Safety and Health Administration (OSHA)</b> requires that worker exposure be limited to an average concentration of no more than 0.10 ppm for a maximum of 8 hours.</p> <p><b>National Institute of Occupational Safety and Health (NIOSH)</b> recommends an upper limit of 0.10 ppm, not to be exceeded at any time.</p> <p><b>Environmental Protection Agency (EPA)</b>'s National Ambient Air Quality Standard for Ozone is a maximum of 8-hour average outdoor concentration of 0.08 ppm.</p>
<p>(*ppm = parts per million)</p>		
<p align="center"><b>Figure 6005.1 FEDERAL AGENCY OZONE STANDARDS</b></p>		

## HIGHLY TOXIC AND TOXIC MATERIALS

**6005.2 Design.** Ozone gas generators shall be designed, fabricated and tested in accordance with NEMA 250.

- ❖ Ozone is generated by applying an electrical current to at least one ozone-generating plate that then charges oxygen in the incoming air and produces ozone; therefore, the generator must comply with NEMA 250 for design, fabrication and testing.

**6005.3 Location.** Ozone generators shall be located in *approved* cabinets or ozone generator rooms in accordance with Section 6005.3.1 or 6005.3.2.

**Exception:** An ozone gas generator within an *approved* pressure vessel where located outside of buildings.

- ❖ Because of the potential health hazards related to the generation of ozone, this section states limitations on the location of generating equipment. Ozone generators must be either in an approved cabinet or in an ozone gas generator room. Details of each are discussed in the subsections that follow.

The exception for ozone gas generators located outside of buildings is applicable only if the generators are contained in an approved pressure vessel. Generally, as with storage and use of gases outdoors, the gas is more likely to be dispersed to the atmosphere without harming people in the surrounding area.

**6005.3.1 Cabinets.** Ozone cabinets shall be constructed of *approved* materials and compatible with ozone. Cabinets shall display an *approved* sign stating: OZONE GAS GENERATOR—HIGHLY TOXIC—OXIDIZER.

Cabinets shall be braced for seismic activity in accordance with the *International Building Code*.

Cabinets shall be mechanically ventilated in accordance with the *International Mechanical Code* with not less than six air changes per hour.

The average velocity of ventilation at makeup air openings with cabinet doors closed shall be not less than 200 feet per minute (1.02 m/s).

- ❖ This section lists criteria for the design and construction of cabinets intended for the ozone gas generators. This includes labeling, ventilation and seismic bracing requirements. For ventilation, it both refers to the *International Mechanical Code*® (IMC®) for requirements and states the following criteria:

- Six air changes per hour.
- Average velocity of 200 feet per minute (1.02 m/s) across the opening of the cabinet.

These criteria result in a negative pressure cabinet with appropriate intake air sizing.

**6005.3.2 Ozone gas generator rooms.** Ozone gas generator rooms shall be mechanically ventilated in accordance with the *International Mechanical Code* with not less than six air changes per hour. Ozone gas generator rooms shall be

equipped with a continuous gas detection system that will shut off the generator and sound a local alarm when concentrations above the permissible exposure limit occur.

Ozone gas generator rooms shall not be normally occupied, and such rooms shall be kept free of combustibles and hazardous material storage. Room access doors shall display an *approved* sign stating: OZONE GAS GENERATOR—HIGHLY TOXIC—OXIDIZER.

- ❖ For larger generators and particular processes, an ozone gas generator room may be more practical than cabinets. This section gives the criteria for design and construction for these rooms. The key construction element is the ventilation requirement of six air changes per hour, which is the same requirement as for cabinets. A gas detection system is also required that will activate a local alarm when the permissible exposure limit has been reached. This limit appears to be 10 parts per million (ppm) in accordance with the information provided by the EPA.

Because ozone is also an oxidizer, combustibles would not be allowed within the room to reduce the potential for an intense fire. In addition, because of the health effects, the rooms are not intended to be normally occupied. These two limitations essentially necessitate a mechanical room-type arrangement. The labeling of the generator room is essential to emergency responders and also to those unfamiliar with the facility.

**6005.4 Piping, valves and fittings.** Piping, valves, fittings and related components used to convey ozone shall be in accordance with Sections 6005.4.1 through 6005.4.3.

- ❖ The requirements found in this section are intended to reduce the weak links in the system that can be found with improper piping connections or fittings.

**6005.4.1 Piping.** Piping shall be welded stainless steel piping or tubing.

**Exceptions:**

1. Double-walled piping.
2. Piping, valves, fittings and related components located in exhausted enclosures.

- ❖ A welded connection is required for piping because it is more reliable than a friction connection or a threaded connection. Additionally, this section requires the piping to be stainless steel to reduce the likelihood of corrosion to which other piping may be susceptible.

There are two exceptions to the welded connection and stainless steel requirement: double wall piping or where all portions of the piping, valves and fittings are located in an exhausted enclosure. Both of these methods reduce the likelihood that a failure in the piping, valves or fittings would result in a release of highly toxic ozone to the atmosphere.

**6005.4.2 Materials.** Materials shall be compatible with ozone and shall be rated for the design operating pressures.

- ❖ It is important that valves or fittings used are compatible with ozone. Section 6005.4.1 requires the piping to be stainless steel unless one of the two exceptions applies. Regardless, the materials used need to be compatible. Essentially, the intent is to avoid leaks or major failures resulting from corrosion.

Also, this section discusses the need for piping to withstand the pressures that are expected, because that could be another potential mode of failure.

**6005.4.3 Identification.** Piping shall be identified with the following: OZONE GAS—HIGHLY TOXIC—OXIDIZER.

- ❖ To alert occupants and emergency responders to the potential dangers of ozone, the piping carrying the ozone must be labeled to list the hazards of this highly toxic and oxidizing gas.

**6005.5 Automatic shutdown.** Ozone gas generators shall be designed to shut down automatically under the following conditions:

1. When the dissolved ozone concentration in the water being treated is above saturation when measured at the point where the water is exposed to the atmosphere.
2. When the process using generated ozone is shut down.
3. When the gas detection system detects ozone.
4. Failure of the ventilation system for the cabinet or ozone-generator room.
5. Failure of the gas detection system.

- ❖ There are several conditions where the ozone generator needs to shut down automatically. These include when dissolved ozone in water being treated in a water purification system is above saturation, when the ozone being generated is not placed directly into use, as in the case of water purification, when ozone is detected or the ventilation and gas detection systems fail. This adds to the levels of redundancies available to enhance personnel safety.

**6005.6 Manual shutdown.** Manual shutdown controls shall be provided at the generator and, where in a room, within 10 feet (3048 mm) of the main *exit* or *exit access* door.

- ❖ A manual shutdown control on the ozone generator is a backup to the automated shutdown system that uses sensors to detect leaks, sound alarms and shut down the system. Because an ozone generator located in a room would almost always be a large-capacity machine, the manual shutdown controls are needed near the main access door to minimize the possibility that any significant quantity of escaping ozone would reach building occupants. Having the controls near the door also minimizes the chance that the person who shuts down the generator in an emergency would be exposed to harmful amounts of ozone. With smaller generators that would more likely be located in a ventilated cabinet or exhausted enclosure, there is no requirement for manual shutdown controls other than those on the generator itself.

## Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

*Code Changes Resource Collection—2015 International Fire Code.* Washington, DC: International Code Council, 2014.

EPA-452/R-96-007, *Review of National Ambient Air Quality Standards for Ozone: Assessment of Scientific and Technical Information.* OAQPS Staff Paper. Research Triangle Park, NC: Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency (U.S. EPA), 1996.

EPA-600/R-95-154, *Ozone Generators in Indoor Air Settings.* Report prepared for the Office of Research and Development by Raymond Steiber. Research Triangle Park, NC: National Risk Management Research Laboratory, U.S. Environmental Protection Agency (U.S. EPA), 1995.



# Chapter 61: Liquefied Petroleum Gases

## General Comments

The use and popularity of liquefied petroleum gas (LP-gas) for domestic purposes varies depending on location. In the United States, propane is the most widely used LP-gas, with butane a distant runner-up. Rural communities, especially those located in cooler climates, tend to use propane as a principal fuel source for domestic cooking, clothes drying, water heating and space heating. This practice tends to be less common in urban and suburban communities served by public utility companies supplying piped natural gas. On the other hand, LP-gas is widely used by industries as a motor fuel for industrial lift trucks; aerosol charging; welding and cutting; auxiliary heating and lighting and, in the agricultural community, as a fuel for drying crops, operating pumps and heating livestock shelters.

Propane is well known as a camping fuel for cooking, lighting, heating and refrigerating. LP-gas also remains a popular standby fuel supply for auxiliary generators. Additionally, utility companies use propane as a substitute for natural gas as a “peak shaving” alternative when supplies run low or prices are high; in this application, propane is usually mixed with air to achieve the same energy content per cubic foot as natural gas.

Propane is widely used as an alternative motor vehi-

cle fuel, and its characteristic as a clean-burning fuel has resulted in the addition of propane dispensers to service stations throughout the country.

Another use for propane, although less popular because it is flammable, is as the working fluid in a refrigeration cycle. In some applications, it is a suitable alternative to R-22 and other chlorofluorocarbon (CFC)-rich refrigerants.

Future uses for LP-gas, and propane in particular, may arise out of an intense interest in independent electrical power generation units, such as fuel cell and microturbine generators. Propane is a leading candidate for these units because of its portability and moderate storage pressures. Additionally, ongoing research on absorption refrigeration cycles may lead to greater interest in propane-powered air conditioners.

## Purpose

Chapter 61 includes requirements for handling, storing and using LP-gas, principally propane, to reduce the possibility of damage to containers, accidental releases of LP-gas and exposure of flammable concentrations of LP-gas to ignition sources.

## SECTION 6101 GENERAL

**6101.1 Scope.** Storage, handling and transportation of liquefied petroleum gas (LP-gas) and the installation of LP-gas equipment pertinent to systems for such uses shall comply with this chapter and NFPA 58. Properties of LP-gases shall be determined in accordance with Appendix B of NFPA 58.

❖ Some of the principal characteristics of LP-gases are shown in Commentary Figure 6101.1(1). They include the limits of flammability, the specific gravity of the gas vapor at 60°F (16°C) and the ignition temperatures of the flammable mixtures.

It is important to recognize that LP-gases exist in both liquid and vapor states at ambient temperatures. When stored in a pressure vessel, the liquid and vapor states of LP-gases will be in equilibrium until the system is called upon to deliver vapor to the appliance it is serving. When this happens, the pressure in the container drops and the liquid begins to boil to produce more vapor and once again reach equilibrium. As vapor is produced through the boiling process, the liquid in the container begins to refrigerate

itself and the entire system cools down. Commentary Figure 6101.1(2) shows the vapor pressure of propane at various temperatures.

LP-gases are heavier than air, and although public perception holds that they will sink to the lowest level of a space, these gases disperse according to the laws of physics just as other gases do. It is not safe to assume that all LP-gases, such as propane, immediately sink to the floor and “pool” there. LP-gases can and will, under ambient conditions, disperse to all parts of a room or space.

LP-gases, such as propane, must be odorized with a warning agent that is detectable at a minimum concentration of one-fifth the lower limit of flammability. The most frequently used odorant for propane is ethyl mercaptan, which is usually added at a pipeline terminal or other supply point before the gas is shipped to a retail bulk storage facility.

LP-gas containers pose the danger of a boiling-liquid expanding-vapor explosion (BLEVE) if they are exposed to a fire. Prolonged flame impingement above the liquid-gas interface, where the heat-absorbing properties of the liquid cannot protect the

container shell from thermal stress, may generate catastrophic failures, expelling tank contents in a fire-ball and propelling container fragments from the site of the accident.

Such violent container failures are extremely dangerous and were much more common in the past, before safety improvements in railcars and cargo transport trucks were introduced. Recently, the propane industry, through the National Propane Gas Association and the Propane Education and Research Council, has developed a program for training emergency response personnel to respond effectively and knowledgeably to threatening incidents involving the transportation, storage or use of propane. The curriculum was made available free of charge to every fire department in the United States.

The requirements of this chapter are intended to address hazards associated with the storage, handling and use of LP-gas. NFPA 58 is supplemented by NFPA 59, which specifically addresses the use of LP-gas at utility gas plants.

The U.S. Department of Transportation (DOT) classifies LP-gas as a hazardous material, and the transportation of LP-gases "in commerce" is regulated by Title 49 of the Code of Federal Regulations. The term

"in commerce" is defined to be transportation by a commercial entity. In other words, transportation of a propane grill cylinder in the passenger compartment of a car is not regulated by the DOT but is by NFPA 58.

**6101.2 Permits.** Permits shall be required as set forth in Sections 105.6 and 105.7.

Distributors shall not fill an LP-gas container for which a permit is required unless a permit for installation has been issued for that location by the *fire code official*.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit, Section 105.6.28 for a discussion of specific quantity-based operational permits for the materials regulated in this chapter and Section 105.7 for a general discussion of activities requiring a construction permit. The permit process also notifies the fire department of the need for prefire planning for hazardous property.

GAS	IGNITION TEMPERATURE (°F)	LOWER FLAMMABLE LIMITATIONS <sup>a</sup>	UPPER FLAMMABLE LIMITATIONS <sup>a</sup>	SPECIFIC GRAVITY OF VAPOR @ 60°F
Butane	550	1.9	8.5	2.0
1-Butene	725	1.6	10.0	1.9
2-Butene (cis)	617	1.7	9.0	1.9
2-Butene (trans)	615	1.8	9.7	1.9
Propane	920	2.1	9.5	1.5
Propylene	851	2.0	11.1	1.5

For SI: °C = [(°F) - 32]/1.8.

a. Lower and upper flammable limitations are percentages of gas in gas-air mixtures. Specific gravity describes the relative weight of a unit of gas compared to air (air = 1.0).

**Source:** NFPA 325M, *Properties of Flammable Solids, Liquids and Gases* (1991).

**Figure 6101.1(1)**  
**PROPERTIES OF COMMON LP-GASES**

TEMP (°F)	PRESS. (psig)	TEMP (°F)	PRESS. (psig)	TEMP (°F)	PRESS. (psig)	TEMP (°F)	PRESS. (psig)
130	257	70	109	20	40	-20	10
120	225	65	100	10	31	-25	8
110	197	60	92	0	23	-30	5
100	172	50	77	-5	20	-35	3
90	149	40	63	-10	16	-40	1
80	128	30	51	-15	13	-44	0

For SI: °C = [(°F) - 32]/1.8.

**Figure 6101.1(2)**  
**VAPOR PRESSURES OF PROPANE**

An operational permit for installations using or storing LP-gas is required except when the installation is a container of 500-gallon (1893 L) water capacity or less and serving a Group R-3 occupancy. In addition, Section 105.7.8 requires that a construction permit be obtained for any installation of or modification to an LP-gas system.

The last sentence of this section is addressing stationary installations of LP-gas and states that for those installations requiring a permit, the container must not be filled unless that permit has been issued.

**6101.3 Construction documents.** Where a single LP-gas container is more than 2,000 gallons (7570 L) in water capacity or the aggregate water capacity of LP-gas containers is more than 4,000 gallons (15 140 L), the installer shall submit *construction documents* for such installation.

❖ This section applies to those installations for which a construction permit is required, namely when a new system is being installed or an existing system is being modified. When container size exceeds the thresholds specified, applicants must submit plans indicating compliance with requirements before approval can be authorized. Plans should be clear, concise, legible, prepared on standard-sized paper and include the following:

- Location and legal identification (address and lot or parcel number) of the lot or site.
- Legal boundaries of the site, including reference to source or survey.
- Location of significant buildings on the lot or site and adjacent lots or sites.
- Location of nearest public roadways and site access.
- Location of all underground and overhead utilities.
- North arrow.
- Topographical features.
- Proposed container location with respect to buildings, building openings, lot lines, public roadways and underground or overhead utilities.
- Container dimensions and capacity.
- Container compliance markings (e.g., ASME, DOT, API).
- Details of container foundation and supports.
- Section through container showing supports and anchors and, if an underground tank, backfill and corrosion protection.
- Arrangement of valves and piping.
- Specifications for containers, valves, piping, tank mounts and pads and other related equipment and appliances.
- Means for protecting valves from tampering.
- Name, address and telephone number of property owner.

- Name, address and telephone number of installer and servicing contractor.

## SECTION 6102 DEFINITIONS

**6102.1 Definitions.** The following terms are defined in Chapter 2:

**LIQUEFIED PETROLEUM GAS (LP-gas).**

**LP-GAS CONTAINER.**

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4).

## SECTION 6103 INSTALLATION OF EQUIPMENT

**6103.1 General.** LP-gas equipment shall be installed in accordance with the *International Fuel Gas Code* and NFPA 58, except as otherwise provided in this chapter.

❖ The *International Fuel Gas Code*<sup>®</sup> (IFGC<sup>®</sup>) addresses the installation of equipment downstream from the final pressure regulator in the system, which typically is the second-stage regulator. The IFGC would, therefore, regulate LP-gas piping typically installed indoors, as well as appliance installations.

The remainder of Chapter 61 is devoted primarily to energy-consuming installations at which fuel-burning appliances are installed. NFPA 58 should be referred to for propane bulk plant installations; refrigerated storage installations; marine shipping and receiving installations and equipment-specific requirements such as for installing vaporizers and dispensers. The more detailed provisions in NFPA 58 should be reviewed by the fire code official before approving any LP-gas installation.

**6103.2 Use of LP-gas containers in buildings.** The use of LP-gas containers in buildings shall be in accordance with Sections 6103.2.1 and 6103.2.2.

❖ In general, storing and using LP-gas inside buildings is limited to relatively small quantities. There are some exceptions, such as the use of LP-gas for temporary heating in buildings under construction.

LP-gas containers are either fabricated to the requirements of the American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code* (BPVC) or the DOT rules contained in Title 49 of the Code of Federal Regulations.

**6103.2.1 Portable containers.** Portable LP-gas containers, as defined in NFPA 58, shall not be used in buildings except as

specified in NFPA 58 and Sections 6103.2.1.1 through 6103.2.1.7.

❖ Portable containers are typically DOT cylinders, which are used in the vertical position. This is not always the case though; some recreational vehicles use DOT cylinders in a horizontal position (see Commentary Figure 6103.2.1).

One of the most common violations involving LP-gas is the storage or use of it inside buildings, particularly residential structures. This is a long-standing requirement that relates to the potential for releasing propane within a building.

In the past, any propane cylinder would release propane simply by opening the service valve; however, advances have been made in the technologies used in the propane industry. Since 1995, propane cylinders shipped with new outdoor cooking equipment (grills, smokers, etc.) must be fitted with valves that will not release propane even if the valve handle is opened, unless a positive, leak-tight connection is made between the cylinder and the cooking equipment. This technology, as well as two others that would stop the flow of gas under fire conditions or if there were a hose line break, are required by ANSI Z21.58.

**6103.2.1.1 Use in basement, pit or similar location.** LP-gas containers shall not be used in a basement, pit or similar location where heavier-than-air gas might collect. LP-gas containers shall not be used in an above-grade underfloor space or basement unless such location is provided with an *approved* means of ventilation.

**Exception:** Use with self-contained torch assemblies in accordance with Section 6103.2.1.6.

❖ Because propane has a specific gravity of 1.52 at 60°F (16°C) (which means it is 1.52 times heavier than air at that temperature), it has been assumed to automatically sink to the ground when it is released to the atmosphere. Even though the laws of physics have proven this concept to be untrue, concerns persist about the ability for propane to disperse in locations where air circulation is restricted. Any ventilation

system design should take into account the expected temperatures at the location and an expected leak rate from the piping system.

Only LP-gas containers are prohibited from being used in basements, pits and similar locations. Hard-piped systems in which the container remains outside the building can serve systems installed in basements, pits and similar locations. The hazard associated with containers in buildings relates to the fact that the pressure in the container is dependent on the temperature of the propane within it and can exceed 100 pounds per square inch gauge (psig) at 70°F (21°C), whereas the pressure in the building piping of a propane service is usually 0.5 psig (3 kPa).

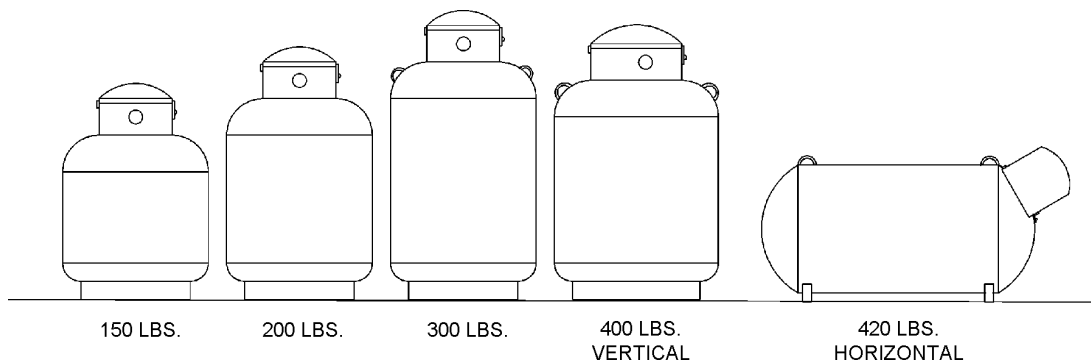
In the past, the model codes prohibited the use of any propane system in spaces below grade. The U.S. Consumer Product Safety Commission (CPSC) staff concluded, however, that the rate of incidents occurring in propane systems used in basements and underground locations is no different than that occurring in above-ground locations.

The exception to this requirement acknowledges the use of self-contained torch assemblies, which are limited to about 1 pound (0.454 kg) (2.5 pounds water) of propane per container.

**6103.2.1.2 Construction and temporary heating.** Portable LP-gas containers are allowed to be used in buildings or areas of buildings undergoing construction or for temporary heating as set forth in Sections 6.19.4, 6.19.5 and 6.19.8 of NFPA 58.

❖ The referenced sections in NFPA 58 address the use of temporary heating in buildings undergoing construction or renovations, or industrial buildings under certain conditions.

**6103.2.1.3 Group F occupancies.** In Group F occupancies, portable LP-gas containers are allowed to be used to supply quantities necessary for processing, research or experimentation. Where manifolded, the aggregate water capacity of such containers shall not exceed 735 pounds (334 kg) per manifold. Where multiple manifolds of such containers are present in the same room, each manifold shall be separated from



For SI: 1 pound = 0.454 kg.

**Figure 6103.2.1**  
**TYPICAL DOT CYLINDERS**

other manifolds by a distance of not less than 20 feet (6096 mm).

❖ The use of manifolds to connect containers increases the overall capacity of the system by increasing its vaporization capacity. The vaporization rate is directly related to the total surface area of the containers. Using manifolds, however, also increases the number of connections made on a system, and, because the connections in a piping system under pressure are where leaks are likely to originate, the total volume of propane in manifolded systems is limited to that shown. The amount of propane in pounds can be calculated from the water capacity in pounds by multiplying by 0.42. In this instance, the amount of propane permitted is about 310 pounds (141 kg).

**6103.2.1.4 Group E and I occupancies.** In Group E and I occupancies, portable LP-gas containers are allowed to be used for research and experimentation. Such containers shall not be used in classrooms. Such containers shall not exceed a 50-pound (23 kg) water capacity in occupancies used for educational purposes and shall not exceed a 12-pound (5 kg) water capacity in occupancies used for institutional purposes. Where more than one such container is present in the same room, each container shall be separated from other containers by a distance of not less than 20 feet (6096 mm).

❖ Further restrictions on the use of propane in educational (schools) and institutional occupancies reflect the likelihood that the occupants of those spaces will be limited in their ability to respond to an emergency.

The minimum distance of 20 feet (6096 mm) is intended to provide a factor of safety so that if one installation becomes a source of an ignited jet plume, any other similar installations would not be directly exposed to the plume.

**6103.2.1.5 Demonstration uses.** Portable LP-gas containers are allowed to be used temporarily for demonstrations and public exhibitions. Such containers shall not exceed a water capacity of 12 pounds (5 kg). Where more than one such container is present in the same room, each container shall be separated from other containers by a distance of not less than 20 feet (6096 mm).

❖ This section restricts the size of LP-gas containers used for demonstrations to roughly 5 pounds (2.3 kg) of propane capacity. There is no restriction on the number of containers, however; only a limitation that they be separated by at least 20 feet (6096 mm) for the same reason as specified in the previous section.

**6103.2.1.6 Use with self-contained torch assemblies.** Portable LP-gas containers are allowed to be used to supply approved self-contained torch assemblies or similar appliances. Such containers shall not exceed a water capacity of 2½ pounds (1 kg).

❖ A common example of the use described in this section is jewelry making using portable LP-gas containers to supply approved self-contained torch assemblies when such containers do not exceed a

2½-pound (1.13 kg) water capacity. This section, which correlates with Section 6.20.9.3 of NFPA 58, is not contingent on the type of operation or whether it is permanent or temporary. Thus, this section allows jewelry manufacturers to use portable LP-gas containers in accordance with the requirements set forth in NFPA 58. NFPA 58 also requires that these LP-gas containers comply with UL 147A, *Nonrefillable (Disposable Type Fuel Gas Cylinder Assemblies)*.

**6103.2.1.7 Use for food preparation.** Where approved, listed LP-gas commercial food service appliances are allowed to be used for food-preparation within restaurants and in attended commercial food-catering operations in accordance with the *International Fuel Gas Code*, the *International Mechanical Code* and NFPA 58.

❖ Although not stated explicitly, this section intends to permit the use of LP-gas containers in buildings with commercial food service cooking appliances. The code requires that those appliances be approved. Typically, this type of appliance will be labeled in accordance with one of the ANSI Z83 series standards for commercial gas cooking equipment.

**6103.2.2 Industrial vehicles and floor maintenance machines.** LP-gas containers on industrial vehicles and floor maintenance machines shall comply with Sections 11.13 and 11.14 of NFPA 58.

❖ This section simply refers to the correct section reference in NFPA 58 for containers serving engines mounted on industrial vehicles and floor maintenance machines.

**6103.3 Location of equipment and piping.** Equipment and piping shall not be installed in locations where such equipment and piping is prohibited by the *International Fuel Gas Code*.

❖ With respect to LP-gas systems, the IFGC addresses equipment and piping downstream of the second-stage regulator, which would typically include all piping and appliances within the building.

## SECTION 6104 LOCATION OF LP-GAS CONTAINERS

**6104.1 General.** The storage and handling of LP-gas and the installation and maintenance of related equipment shall comply with NFPA 58 and be subject to the approval of the *fire code official*, except as provided in this chapter.

❖ This section reinforces the need to review NFPA 58 for detailed provisions before any installation of LP-gas is approved.

**6104.2 Maximum capacity within established limits.** Within the limits established by law restricting the storage of liquefied petroleum gas for the protection of heavily populated or congested areas, the aggregate capacity of any one installation shall not exceed a water capacity of 2,000 gallons

(7570 L) (see Section 3 of the Sample Legislation for Adoption of the *International Fire Code* on page xxi).

**Exception:** In particular installations, this capacity limit shall be determined by the *fire code official*, after consideration of special features such as topographical conditions, nature of occupancy, and proximity to buildings, capacity of proposed LP-gas containers, degree of fire protection to be provided and capabilities of the local fire department.

- ❖ This section originated in NFPA 58 and is intended to establish a limit on ordinary above-ground containers in densely populated areas. The requirement establishes a level of acceptable risk to the general public; however, the scientific basis for the 2,000-gallon (908 kg) limitation is not clear.

The question is often asked, “What is the definition of heavily populated or congested areas?” Heavily populated and congested areas are those areas that are determined by the fire code official to pose a risk of substantial loss from a fire involving large containers of LP-gas and are designated in the jurisdiction’s adopting ordinance. Such areas could be likened to the areas designated as “fire districts” in Appendix D of the IBC. This section refers to “the limits established by law” to cross reference those provisions in the ordinance adopting the code. The model adopting ordinance on page xxi of the *International Fire Code*® (IFC®) includes Section 3 to correlate with this section in defining these limits.

The exception recognizes that consideration of the specific features of the installation, such as fire protection systems, mounding or burying of containers or the capabilities of the local fire-fighting service, should be taken into account before establishing any limit on the system’s capacity.

**6104.3 Container location.** LP-gas containers shall be located with respect to buildings, *public ways* and *lot lines* of adjoining property that can be built upon, in accordance with Table 6104.3.

- ❖ This paragraph references Table 6104.3, which contains the requirements for siting LP-gas containers on a piece of property.

Separating and protecting containers from each other and from buildings and heat-producing appliances are the principal means for preventing container failures and accidental ignitions. Separation serves at least two purposes. Outside a building, separating tanks from structures allows escaping gas to disperse or dilute before it can enter a building or come in contact with an ignition source. Similarly, the container is protected to an extent from a hazardous exposure if escaping gas is ignited, and the tank is protected if the building becomes involved in a fire.

Separating containers from each other or from other groups of containers minimizes the scale of an accident if a tank or group of containers becomes involved in a fire. Though the separation distances do

not result in absolute protection from fire exposures and leaks, they do provide a measure of access for establishing fire-fighting positions to protect tanks and exposures.

**TABLE 6104.3.** See page 61-7.

- ❖ This table has its origins in NFPA 58 and has existed for many years. This establishes reasonable distances that can be used to determine separation requirements between an LP-gas container installation and buildings, lot lines and public ways, as well as between multiple containers installed at the same site. The important factors to consider when establishing suitable distances include the container capacity and whether it is installed above ground, mounded or below ground. See Commentary Figure 6104.3(1) for a graphic depiction of the requirements.

As one would expect, the required distances are reduced for containers that are mounded or installed underground because of the reduced exposure of the container to external sources of heat. Although not defined in the code, the difference between a mounded container and one installed underground is that a mounded container is an ASME container labeled for underground installation but installed above the minimum depth required for underground service. NFPA 58 contains specific provisions for mounding tanks.

Note a to Table 6104.3 defines the endpoint for measuring the separation distance for underground containers as being the relief device, which will release propane to the atmosphere only under abnormal conditions, and the filling connection and liquid-level gauge, both of which release propane during a normal filling operation.

Note b contains a requirement for building overhangs in which the overhang is less than 50 feet (15 240 mm) above the relief device discharge outlet. This dimension represents what is considered a safe distance to prevent the accumulation of LP-gas should the relief device discharge [see Commentary Figure 6104.3(2)].

Note c requires that clearances be provided to allow installation and maintenance, if necessary, for underground tanks, which must be done using a backhoe or some other large piece of equipment.

Note d anticipates an increase in the hazard of those installations made up of at least four containers because of the greater number of joints and connections needed as well as perhaps a greater risk of involvement of the storage system in a building fire.

Note e addresses installing smaller containers and focuses on requirements for locating relief devices and other appurtenances an acceptable distance from potential sources of ignition.

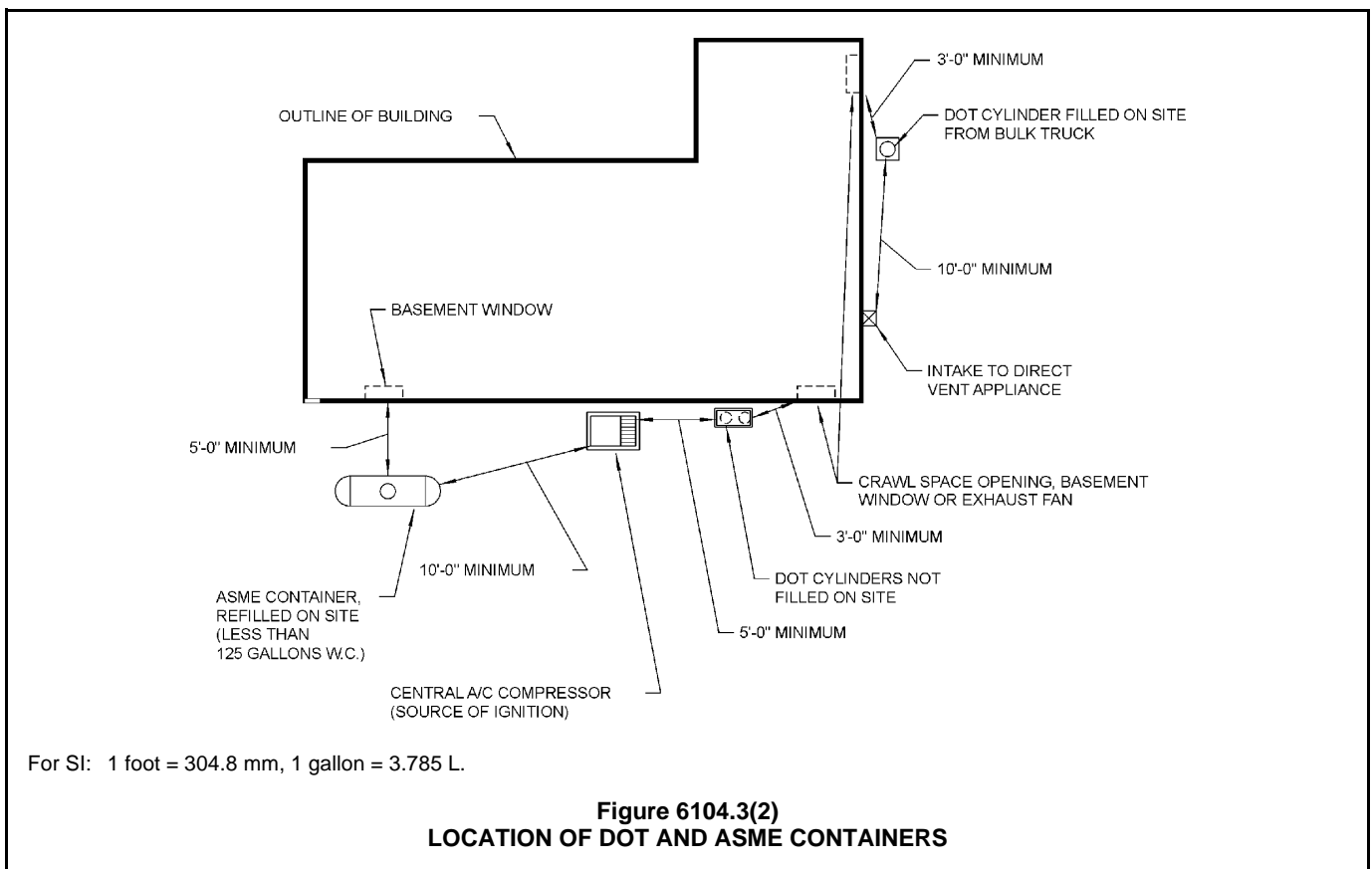
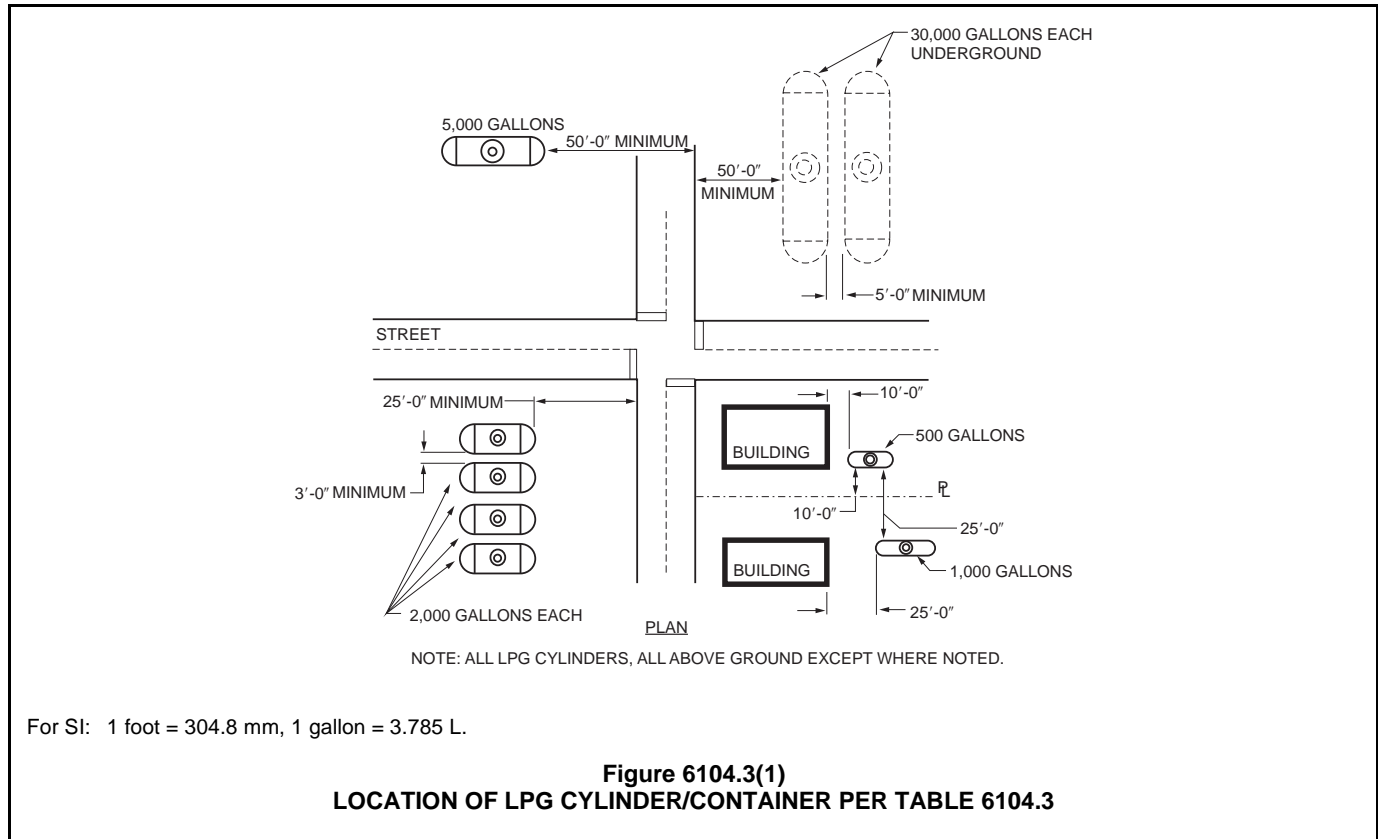
Note f permits a reduction in the required distances for a 1,200-gallon (4,542 L) water capacity container, which is typically the maximum size for a container that would be used for any residential service.

**TABLE 6104.3  
LOCATION OF LP-GAS CONTAINERS**

LP-GAS CONTAINER CAPACITY (water gallons)	MINIMUM SEPARATION BETWEEN LP-GAS CONTAINERS AND BUILDINGS, PUBLIC WAYS OR LOT LINES OF ADJOINING PROPERTY THAT CAN BE BUILT UPON		MINIMUM SEPARATION BETWEEN LP-GAS CONTAINERS <sup>b, c</sup> (feet)
	Mounded or underground LP-gas containers <sup>a</sup> (feet)	Above-ground LP-gas containers <sup>b</sup> (feet)	
Less than 125 <sup>c, d</sup>	10	5 <sup>e</sup>	None
125 to 250	10	10	None
251 to 500	10	10	3
501 to 2,000	10	25 <sup>e, f</sup>	3
2,001 to 30,000	50	50	5
30,001 to 70,000	50	75	(0.25 of sum of diameters of adjacent LP-gas containers)
70,001 to 90,000	50	100	
90,001 to 120,000	50	125	

For SI: 1 foot = 304.8 mm, 1 gallon = 3.785 L.

- a. Minimum distance for underground LP-gas containers shall be measured from the pressure relief device and the filling or liquid-level gauge vent connection at the container, except that all parts of an underground LP-gas container shall be not less than 10 feet from a building or lot line of adjoining property that can be built upon.
- b. For other than installations in which the overhanging structure is 50 feet or more above the relief-valve discharge outlet. In applying the distance between buildings and ASME LP-gas containers with a water capacity of 125 gallons or more, not less than 50 percent of this horizontal distance shall also apply to all portions of the building that project more than 5 feet from the building wall and that are higher than the relief valve discharge outlet. This horizontal distance shall be measured from a point determined by projecting the outside edge of such overhanging structure vertically downward to grade or other level upon which the LP-gas container is installed. Distances to the building wall shall be not less than those prescribed in this table.
- c. Where underground multicontainer installations are composed of individual LP-gas containers having a water capacity of 125 gallons or more, such containers shall be installed so as to provide access at their ends or sides to facilitate working with cranes or hoists.
- d. At a consumer site, if the aggregate water capacity of a multicontainer installation, comprised of individual LP-gas containers having a water capacity of less than 125 gallons, is 500 gallons or more, the minimum distance shall comply with the appropriate portion of Table 6104.3, applying the aggregate capacity rather than the capacity per LP-gas container. If more than one such installation is made, each installation shall be separated from other installations by not less than 25 feet. Minimum distances between LP-gas containers need not be applied.
- e. The following shall apply to above-ground containers installed alongside buildings:
  1. LP-gas containers of less than a 125-gallon water capacity are allowed next to the building they serve where in compliance with Items 2, 3 and 4.
  2. Department of Transportation (DOTn) specification LP-gas containers shall be located and installed so that the discharge from the container pressure relief device is not less than 3 feet horizontally from building openings below the level of such discharge and shall not be beneath buildings unless the space is well ventilated to the outside and is not enclosed for more than 50 percent of its perimeter. The discharge from LP-gas container pressure relief devices shall be located not less than 5 feet from exterior sources of ignition, openings into direct-vent (sealed combustion system) appliances or mechanical ventilation air intakes.
  3. ASME LP-gas containers of less than a 125-gallon water capacity shall be located and installed such that the discharge from pressure relief devices shall not terminate in or beneath buildings and shall be located not less than 5 feet horizontally from building openings below the level of such discharge and not less than 5 feet from exterior sources of ignition, openings into direct vent (sealed combustion system) appliances, or mechanical ventilation air intakes.
  4. The filling connection and the vent from liquid-level gauges on either DOTn or ASME LP-gas containers filled at the point of installation shall be not less than 10 feet from exterior sources of ignition, openings into direct vent (sealed combustion system) appliances or mechanical ventilation air intakes.
- f. This distance is allowed to be reduced to not less than 10 feet for a single LP-gas container of 1,200-gallon water capacity or less, provided such container is not less than 25 feet from other LP-gas containers of more than 125-gallon water capacity.



**6104.3.1 Installation on roof prohibited.** LP-gas containers used in stationary installations shall not be located on the roofs of buildings.

❖ Installation of stationary containers on the roof of buildings is permitted by NFPA 58; however, based on this section, stationary LP-gas containers are not allowed on the roof of any building. This prohibition takes precedence over the NFPA 58 requirements because of Section 102.7 of the code. Note that the use of the word “stationary” is intended to make it clear that this section should not be misinterpreted to include containers used for temporary applications such as applying roofing materials or brazing operations. A stationary LP-gas installation is defined in Chapter 3 of NFPA 58 as “An installation of LP-gas containers, piping and equipment for indefinite use at a particular location; an installation is not normally expected to change in status, condition, or location.” A stationary installation is assembled from approved DOT cylinders or ASME-compliant containers, piping and equipment such as pressure regulators that remain on the site for an indefinite time period. Section 105.7.12 requires a construction permit for any LP-gas system. Temporary operations require an operational permit in accordance with Section 105.6.28 and possibly other operational permits, depending on the specific operation being conducted. For example, LP-gas is commonly used by contractors for soldering water or refrigerant piping systems. Many roof covering systems are applied using LP-gas-fueled torch systems, which constitute hot work and must comply with the requirements in Chapter 35 (see Commentary Figure 6104.3.1). Torch-applied roofing systems also need to comply with the requirements of Section 3317 for hot work. When LP-gas



**Figure 6104.3.1  
TORCH-APPLIED ROOFING APPARATUS**

cylinders are required on a building roof or inside a building for temporary maintenance or construction reasons, their on-site transportation and use should comply with the requirements of Section 6.20 of NFPA 58 for cylinders, equipment, piping and appliances in buildings, building roofs and exterior balconies.

**6104.3.2 Special hazards.** LP-gas containers shall be located with respect to special hazards including, but not limited to, above-ground flammable or *combustible liquid* tanks, oxygen or gaseous hydrogen containers, flooding or electric power lines as specified in Section 6.4.5 of NFPA 58.

❖ Additional requirements may apply when siting an LP-gas container. Other products stored in the vicinity may present specific hazards that must be addressed. Flood hazard areas are defined in Section 202 of the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>).

**6104.4 Multiple LP-gas container installations.** Multiple LP-gas container installations with a total water storage capacity of more than 180,000 gallons (681 300 L) [150,000-gallon (567 750 L) LP-gas capacity] shall be subdivided into groups containing not more than 180,000 gallons (681 300 L) in each group. Such groups shall be separated by a distance of not less than 50 feet (15 240 mm), unless the containers are protected in accordance with one of the following:

1. Mounded in an *approved* manner.
2. Protected with *approved* insulation on areas that are subject to impingement of ignited gas from pipelines or other leakage.
3. Protected by fire walls of *approved* construction.
4. Protected by an *approved* system for application of water as specified in Table 6.4.2 of NFPA 58.
5. Protected by other *approved* means.

Where one of these forms of protection is provided, the separation shall be not less than 25 feet (7620 mm) between LP-gas container groups.

❖ These separation requirements are intended to minimize the exposure of adjacent containers following ignition of a release and to establish access for fire fighting. When used, insulation must be capable of preventing container temperatures from exceeding 800°F (427°C) for at least 50 minutes. Annex H of NFPA 58 details the performance test for LP-gas tank insulation systems.

## SECTION 6105 PROHIBITED USE OF LP-GAS

**6105.1 Nonapproved equipment.** LP-gas shall not be used for the purpose of operating devices or equipment unless such device or equipment is *approved* for use with LP-gas.

❖ Appliances and equipment must be approved for use with LP-gas. For example, appliances should be listed for use with LP-gas; hoses used to serve LP-gas installations should be listed and labeled for that use.

**6105.2 Release to the atmosphere.** LP-gas shall not be released to the atmosphere, except in accordance with Section 7.3 of NFPA 58.

❖ The release of LP-gas to the atmosphere is not recommended, but sometimes cannot be avoided. Prior to the 2015 edition, the code permitted LP-gas to be released to the atmosphere only while the container is being filled, through the fixed maximum liquid level gauge. One such common instance is when filling a container at a residence. The delivery person must rely on the fixed liquid-level gauge to determine when the maximum amount of LP-gas has been reached. This gauge has a very small circular orifice that is connected to a tube that extends into the container to a level consistent with the height of the liquid when the container would be 80-percent full. When the liquid level in the container being filled reaches the bottom of the tube opening, a small amount of liquid escapes from the gauge to the atmosphere, causing it to vaporize. The vaporizing gas cools the surrounding air to the point that the moisture in the air condenses and forms a white cloud. When the delivery person observes this cloud, the filling operation is stopped.

Another instance in which the release of gas to the atmosphere is unavoidable is when the filling hose is disconnected from the container fill valve. The liquid remaining in the hose is released to the atmosphere and vaporizes.

There are many other situations that require the release of LP-gas under controlled conditions. Section 7.3 of NFPA 58 recognizes additional circumstances that necessitate the release of gas to the atmosphere, including the release of gas when the filling hose is disconnected from the filler valve on the container; the release of gas necessary to make cylinders and other containers safe prior to being serviced; and the release of gas that may be necessary in order to properly purge a container of air to make it safe for filling. These are a few of the common occurrences in the propane industry that necessitate the release of LP-gas to the atmosphere.

## SECTION 6106 DISPENSING AND OVERFILLING

**6106.1 Attendants.** Dispensing of LP-gas shall be performed by a qualified attendant.

❖ This section requires that any person transferring LP-gas must be qualified, which means that person must be trained. A number of training materials are available, most notably the *Certified Employees Training Program* published by the National Propane Gas Association (NPGA).

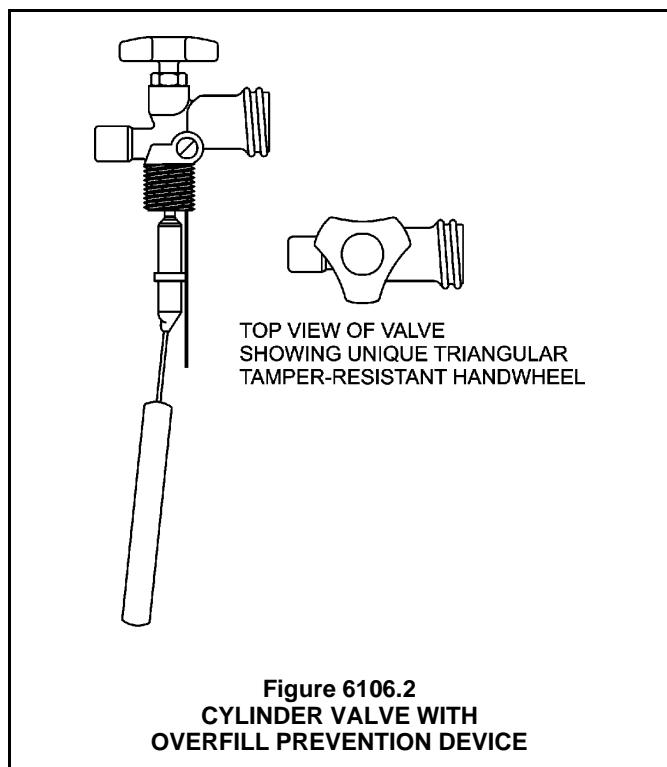
**6106.2 Overfilling.** LP-gas containers shall not be filled or maintained with LP-gas in excess of either the volume determined using the fixed liquid-level gauge installed in accordance with the manufacturer's specifications and in accordance with Section 5.7.5 of NFPA 58 or the weight

determined by the required percentage of the water capacity marked on the container. Portable LP-gas containers shall not be refilled unless equipped with an overfilling prevention device (OPD) where required by Section 5.7.3 of NFPA 58.

❖ Overfilling a container can result in a catastrophic release of LP-gas because of the relatively high coefficient of expansion of liquid LP-gas. Depending on how much a container has been overfilled, a temperature difference of just a few degrees can result in the container becoming "liquid full," which increases the pressure in the container dramatically and leads to the pressure relief device opening, releasing LP-gas to the atmosphere.

Detailed requirements for filling containers are given in NFPA 58. As stated there, the maximum amount of LP-gas permitted in a container may vary between containers filled by weight or by volume because the density of liquid LP-gas varies greatly with different temperatures.

Since 2002, NFPA 58 has not permitted the filling of cylinders for vapor service in the 4- to 40-pound (1.8 kg and 18 kg) range unless the cylinder is equipped with an overfill prevention device (OPD). An OPD is a float-operated mechanism that is designed to act as a backup to the normal filling procedures (using either a scale or the fixed liquid-level gauge) and will automatically close the filler valve when the liquid in the container reaches 80 percent of the container volume. The OPD cannot be seen, but new containers having this safety device are identifiable by the three lobes on the handwheel on the valve (see Commentary Figure 6106.2). Accordingly, all cylinders in a cylinder exchange program must be



equipped with or retrofitted with an OPD. Prior to the introduction of OPDs, overfilled cylinders may have initially held their charge, but later leaked when cylinder pressure increased due to high ambient temperature exposures. This safeguard against overfilling portable containers is found in referenced Section 5.7.3 of NFPA 58.

This section requires the use of a manufacturer-installed liquid level gauge to fill a container. The liquid level gauge is generally an integral part of the service valve which is used to turn the tank on and off. Service valves have rubber or plastic o-rings that can start to leak over time. It is common practice in the industry to field repair and replace valves and gauges on both ASME tanks and DOTn cylinders, as needed. When a service valve becomes faulty, a new valve is installed with a liquid level gauge tube of exactly the same length. In addition, OPD systems on DOT cylinders may also require periodic replacement. The propane industry has procedures and training to successfully perform these replacements and repair.

This section also acknowledges that the service and repair of propane containers in the field does take place and NFPA 58 Section 5.7.5 covers the requirements for proper installation and the use of liquid level gauges.

**6106.3 Dispensing locations.** The point of transfer of LP-gas from one LP-gas container to another shall be separated from exposures as specified in NFPA 58.

- ❖ Because the release of LP-gas to the atmosphere in small quantities may be unavoidable when filling a container, all possible sources of ignition in the vicinity of the point of transfer must be accounted for. NFPA 58 includes detailed requirements for establishing clearances from those sources of ignition.

### SECTION 6107 SAFETY PRECAUTIONS AND DEVICES

**6107.1 Safety devices.** Safety devices on LP-gas containers, equipment and systems shall not be tampered with or made ineffective.

- ❖ The safety devices found on all propane containers include the service valve, the filler valve (part of the service valve on some containers) and the pressure relief device. In addition, small cylinders with a propane capacity between 4 and 40 pounds (1.8 and 18 kg) now may have a separate device called an OPD attached to the service valve inside the container. See the commentary to Section 6106.2 for further discussion of OPDs.

**6107.2 Smoking and other sources of ignition.** “No Smoking” signs complying with Section 310 shall be posted where required by the *fire code official*. Smoking within 25 feet

(7620 mm) of a point of transfer, while filling operations are in progress at LP-gas containers or vehicles, shall be prohibited.

Control of other sources of ignition shall comply with Chapter 3 of this code and Section 6.22 of NFPA 58.

- ❖ Because of the nature of the filling operation, it may be inevitable that some quantity of gas will be released to the atmosphere; therefore, strict observance of the requirement for prohibiting sources of ignition within the limits prescribed here is essential.

**6107.3 Clearance to combustibles.** Weeds, grass, brush, trash and other combustible materials shall be kept not less than 10 feet (3048 mm) from LP-gas tanks or containers.

- ❖ The concern addressed here is the potential threat to a container of LP-gas from the ignition of nearby combustible material. It has been common practice to exempt from this requirement landscaping materials, such as grass and shrubs, that are regularly maintained.

**6107.4 Protecting containers from vehicles.** Where exposed to vehicular damage due to proximity to alleys, driveways or parking areas, LP-gas containers, regulators and piping shall be protected in accordance with NFPA 58.

- ❖ Because NFPA 58 is specific to LP-gas and contains requirements for vehicle impact protection as well as annex guidance on how to accomplish such protection, it makes sense for this section to reference NFPA 58 for this topic to avoid conflicts between the code and the referenced standard.

### SECTION 6108 FIRE PROTECTION

**6108.1 General.** Fire protection shall be provided for installations having LP-gas storage containers with a water capacity of more than 4,000 gallons (15 140 L), as required by Section 6.25 of NFPA 58.

- ❖ This section refers to NFPA 58 for the criteria to establish where fire protection should be installed at any location where the aggregate water capacity of LP-gas containers exceeds 4,000 gallons (15 140 L). The objective is to provide protection to those containers that are exposed to the threat of fire. NFPA 58 should be referred to for exceptions to this requirement.

**6108.2 Portable fire extinguishers.** Portable fire extinguishers complying with Section 906 shall be provided as specified in NFPA 58.

- ❖ Refer to NFPA 58 to determine where fire extinguishers must be provided.

**SECTION 6109**  
**STORAGE OF PORTABLE LP-GAS**  
**CONTAINERS AWAITING USE OR RESALE**

**6109.1 General.** Storage of portable LP-gas containers of 1,000 pounds (454 kg) or less, whether filled, partially filled or empty, at consumer sites or distribution points, and for resale by dealers or resellers shall comply with Sections 6109.2 through 6109.15.1.

**Exceptions:**

1. LP-gas containers that have not previously been in LP-gas service.
  2. LP-gas containers at distribution plants.
  3. LP-gas containers at consumer sites or distribution points, which are connected for use.
- ❖ This section is intended to apply to DOT cylinders, which are distinguishable from ASME containers by their vertical orientation (ASME containers are usually horizontally oriented) and markings on the collar (see Commentary Figure 6103.2.1).
- The container size threshold of 1,000 pounds (454 kg) is the water capacity of the container; therefore, the maximum propane capacity would be 420 pounds (191 kg).
- Exception 1 applies to containers that are brand new and have never contained LP-gas. Such containers would not be subject to this chapter but, rather, would be treated as any other mercantile product. Exceptions 2 and 3 include those containers already in use and those at LP-gas distribution plants, at which employees are trained in the hazards of LP-gas and whose everyday job functions include the handling of the containers.

**6109.2 Exposure hazards.** LP-gas containers in storage shall be located in a manner that minimizes exposure to excessive temperature rise, physical damage or tampering.

- ❖ Because of the relatively high coefficient of expansion for liquid LP-gas, precautions must be taken to prevent overheating of containers that could lead to releases of LP-gas to the atmosphere.

**6109.3 Position.** LP-gas containers in storage having individual water capacity greater than 2½ pounds (1 kg) [nominal 1-pound (0.454 kg) LP-gas capacity] shall be positioned with the pressure relief valve in direct communication with the vapor space of the container.

- ❖ Liquid propane released to the atmosphere through the relief valve will expand to 270 times its original volume after it vaporizes, whereas propane vapor will expand much less. To avoid the release of liquid propane, it is important to keep the pressure relief device in contact with the vapor space. Most cylinders are designed to be oriented vertically, so the relief device is at the top of the cylinder; however, some cylinders used in the recreational vehicle industry are designed for horizontal orientation only, and must be kept in that position for the relief valve to be in contact with the vapor space. Some cylinders are designed for use in either the horizontal or vertical orientation.

**6109.4 Separation from means of egress.** LP-gas containers stored in buildings in accordance with Sections 6109.9 and 6109.11 shall not be located near *exit access* doors, *exits*, *stairways* or in areas normally used, or intended to be used, as a *means of egress*.

- ❖ This section states that LP-gas containers may not be stored where they would block a means of egress in a building. The required means of egress widths and capacities must not be infringed upon by either LP-gas containers or the cabinets in which they may be stored.

**6109.5 Quantity.** Empty LP-gas containers that have been in LP-gas service shall be considered as full containers for the purpose of determining the maximum quantities of LP-gas allowed in Sections 6109.9 and 6109.11.

- ❖ Because the actual quantity of LP-gas in a container cannot always be determined, every container stored at a location must be treated as a full container.

**6109.6 Storage on roofs.** LP-gas containers that are not connected for use shall not be stored on roofs.

- ❖ The roof is a location that is likely to become warmer than atmospheric conditions on a sunny day; therefore, LP-gas containers must not be stored on roofs when they are not connected for use.

**6109.7 Storage in basement, pit or similar location.** LP-gas containers shall not be stored in a basement, pit or similar location where heavier-than-air gas might collect. LP-gas containers shall not be stored in above-grade underfloor spaces or basements unless such location is provided with an *approved* means of ventilation.

**Exception:** Department of Transportation (DOTn) specification cylinders with a maximum water capacity of 2½ pounds (1 kg) for use in completely self-contained hand torches and similar applications. The quantity of LP-gas shall not exceed 20 pounds (9 kg).

- ❖ Because propane has a specific gravity of 1.52 at 60°F (16°C) (which means it is 1.52 times heavier than air at that temperature), it has been assumed to automatically sink to the ground when it is released to the atmosphere. Even though the laws of physics have proven this concept to be untrue, concerns persist about propane dispersing in locations where air circulation is restricted. Any proposed ventilation system should take into account the expected temperatures at the location.

The exception to this section would permit very small, disposable cylinders to be stored in these locations.

**6109.8 Protection of valves on LP-gas containers in storage.** LP-gas container valves shall be protected by screw-on-type caps or collars that shall be securely in place on all containers stored regardless of whether they are full, partially full or empty. Container outlet valves shall be closed or plugged.

- ❖ Valve assemblies must be protected from physical impact. Cylinders having propane capacities up to 60 pounds (27 kg) will usually have collars that extend above the height of the valves. Larger cylinders will

have screw-on caps or domes that serve the same function.

#### 6109.9 Storage within buildings accessible to the public.

Department of Transportation (DOTn) specification cylinders with maximum water capacity of 2½ pounds (1 kg) used in completely self-contained hand torches and similar applications are allowed to be stored or displayed in a building accessible to the public. The quantity of LP-gas shall not exceed 200 pounds (91 kg) except as provided in Section 6109.11.

❖ This section recognizes that retail stores require inventory that is accessible to the public where hand-held torch assemblies are sold. The smaller cylinders in this section are also used as “starters” for charcoal grills and as fuel for insecticidal foggers and camp lanterns. The phrase “accessible to the public” describes circumstances where public exposure to a fire or explosion would be a concern. Where public access to a building is available, such as in Group M occupancies, a fire or explosion involving LP-gas could place nonemployees at risk. By limiting quantities and container sizes in such publicly accessible facilities, the code minimizes this risk.

**6109.10 Storage within buildings not accessible to the public.** The maximum quantity allowed in one storage location in buildings not accessible to the public, such as industrial buildings, shall not exceed a water capacity of 735 pounds (334 kg) [nominal 300 pounds (136 kg) of LP-gas]. Where additional storage locations are required on the same floor within the same building, they shall be separated by not less than 300 feet (91 440 mm). Storage beyond these limitations shall comply with Section 6109.11.

❖ This section is applicable to industrial or storage facilities where LP-gas-powered forklift trucks are frequently operated and maintained by trained personnel. The requirement permits up to 300 pounds (136 kg) of propane to be stored at a single location. Forklift cylinders, which typically have a 33-pound (15 kg) propane capacity, can be stored in small quantities for convenient exchange during a working shift. Where larger quantities of cylinders are needed by the building operations, to reduce the excess storage exposure to a single-fire incident, the excess quantity must be physically separated by space. Where such spatial separation cannot be achieved, the more restrictive provisions of Section 6109.11 must be applied to provide the needed level of safety.

The reference to Section 6109.11 applies where more than 300 pounds (136 kg) must be stored at a location without the required 300-foot (91 440 mm) separation distance.

The phrase “not accessible to the public” describes circumstances where public exposure to a fire or explosion would be a relatively minor concern. Where public access to a building is not available, such as in Group F or S occupancies, a fire or explosion involving LP-gas would not place nonemployees at risk.

**6109.10.1 Quantities on equipment and vehicles.** LP-gas containers carried as part of service equipment on highway mobile vehicles need not be considered in the total storage capacity in Section 6109.10, provided such vehicles are stored in private garages and do not carry more than three LP-gas containers with a total aggregate LP-gas capacity not exceeding 100 pounds (45.4 kg) per vehicle. LP-gas container valves shall be closed.

❖ This section addresses vehicles carrying LP-gas that is ancillary to service equipment on the vehicle. Typically, LP-gas may be found on fabrication trucks and mechanics’ trucks for use with welding equipment, roofing tar trucks for torches used on roofs and plumbers’ trucks for use with lead melting pots.

**6109.11 Storage within rooms used for gas manufacturing.** Storage within buildings or rooms used for gas manufacturing, gas storage, gas-air mixing and vaporization, and compressors not associated with liquid transfer shall comply with Sections 6109.11.1 and 6109.11.2.

❖ The requirements of this section might typically apply to the storage of LP-gas containers used for standby gas systems in which LP-gas is mixed with air to achieve an energy content similar to that of natural gas, thereby permitting gas appliances and equipment to continue operating without a change in burner controls. These systems are commonly found in larger industrial applications.

**6109.11.1 Quantity limits.** The maximum quantity of LP-gas shall be 10,000 pounds (4540 kg).

❖ Limiting LP-gas to 10,000 pounds (4,540 kg) [roughly 3,000-gallon (11 355 L) water capacity container] is considered to be an acceptable threshold for the safe and efficient operation of standby gas systems.

**6109.11.2 Construction.** The construction of such buildings and rooms shall comply with requirements for Group H occupancies in the *International Building Code*, Chapter 10 of NFPA 58 and both of the following:

1. Adequate vents shall be provided to the outside at both top and bottom, located not less than 5 feet (1524 mm) from building openings.
2. The entire area shall be classified for the purposes of ignition source control in accordance with Section 6.2.2 of NFPA 58.

❖ Section 508 of the *International Building Code*® (IBC®) contains specific requirements to address the separation of mixed occupancies to isolate the hazard of storing up to 10,000 pounds (4540 kg) of LP-gas in a room or a building. In addition to those requirements, Item 1 of this section requires adequate ventilation openings to assist in the dilution of gas should a leak occur. Chapter 10 of NFPA 58 contains information on venting as well as other aspects of the design of rooms of this nature. Item 2 refers to NFPA 58, which contains extensive information on establishing the proper hazard classification that

would govern the requirements for electrical wiring systems and limit ignition sources.

**6109.12 Location of storage outside of buildings.** Storage outside of buildings of LP-gas containers awaiting use, resale or part of a cylinder exchange program shall be located in accordance with Table 6109.12.

❖ This section regulates, by reference to Table 6109.12, the placement of cylinders awaiting use or resale and cylinder exchange cabinets, which are increasingly being used to distribute the 20-pound (9 kg) gas grill cylinders to the public. Exchange cabinets are typically constructed of steel and are ventilated to permit the dispersal of gas should a leak occur.

**TABLE 6109.12.** See below.

❖ This table provides correlation with NFPA 58 and allows all code users to quickly identify minimum required separation distances to all regulated exposures. As in Section 6104, this table is based on the quantity of LP-gas stored (not the size of the container) and is intended to limit the two-way exposure between containers and the built environment.

Regarding Column 5 of the table, prior to the introduction of OPDs, overfilled cylinders may have initially held their charge, but later leaked when cylinder pressure increased due to high ambient temperature exposures, a significant source of concern. Today, cylinder exchange operators report that cylinder leaks due to overfill have declined to almost zero based on the use of OPDs and by the widespread use of new grill cylinder valves that will only allow gas to flow if a cylinder valve is mated to an appliance connection device. These measures prevent fugitive releases due to exposure of overfilled cylinders to high ambient temperatures and due to cylinder valves that have not been completely closed. By using cylinders that mitigate the risk of vapor releases based on improved equipment technologies, cylinder exchange stations are now much safer than they were in the early- to mid-1990s when it was necessary to rely on minimum separation distances to prevent fugitive vapors from entering nearby buildings.

Column 6 of the table considers separation from

the doorway or openings in a single-exit building (see Section 1006.2) based on quantity of gas stored. If a fire occurs inside of a building, the presence of a propane exchange station outside is not an egress or life safety concern. Individuals leaving the building could simply exit past the station. If a fire occurs outside, the fire will have to achieve a size that is adequate to raise the temperature of stored propane to the 150°F (66°C) range before a standard cylinder relief vent would be expected to operate. Given the minimum required 10-foot (3048 mm) separation to combustibles in Column 7, it is reasonable to assume that building occupants would have time to evacuate a single-exit building before an exposure fire caused cylinder venting. Scenarios involving a release of gas from an overfilled cylinder and subsequent migration to an ignition source are no longer regarded as plausible based on the mandatory use of OPDs and the likely use of leak-resistant cylinder valves. With regard to Column 7, it should be noted that this prescriptive separation from combustible materials is not consistent with NFPA 58, which uses a more performance-oriented approach. However, the fire service's desire for a specific minimum distance has been clearly expressed in the past; therefore, the distance was retained in the table.

Column 8 contains a required 20-foot (6096 mm) separation to motor fuel dispensers which completes the reference to Chapter 61 made in Section 2307.4. Motor fuel-dispensing facilities are considered Group M occupancies and frequently include convenience stores in addition to motor fuel-dispensing operations. Column 8 specifies a minimum separation distance between the LP-gas container area and any flammable or combustible liquid-dispensing operation or the outdoor storage of combustible materials to reduce the potential fire hazard exposure.

**6109.13 Protection of containers.** LP-gas containers shall be stored within a suitable enclosure or otherwise protected against tampering. Vehicle impact protection shall be provided as required by Section 6107.4.

**Exception:** Vehicle impact protection shall not be required for protection of LP-gas containers where the

**TABLE 6109.12**  
**SEPARATION FROM EXPOSURES OF LP-GAS CONTAINERS AWAITING USE,**  
**RESALE OR EXCHANGE STORED OUTSIDE OF BUILDINGS**

QUANTITY OF LP-GAS STORED (pounds)	MINIMUM SEPARATION DISTANCE FROM STORED LP-GAS CYLINDERS TO (feet):						
	Nearest important building or group of buildings or line of adjoining property that may be built upon	Line of adjoining property occupied by schools, places of religious worship, hospitals, athletic fields or other points of public gathering; busy thoroughfares; or sidewalks	LP-gas dispensing station	Doorway or opening to a building with two or more means of egress	Doorway or opening to a building with one means of egress	Combustible materials	Motor vehicle fuel dispenser
720 or less	0	0	5	5	10	10	20
721 – 2,500	0	10	10	5	10	10	20
2,501 – 6,000	10	10	10	10	10	10	20
6,001 – 10,000	20	20	20	20	20	10	20
Over 10,000	25	25	25	25	25	10	20

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg.

containers are kept in lockable, ventilated cabinets of metal construction.

- ❖ At public facilities, tampering with LP-gas containers may be a problem. For that reason, locked metal cabinets are used to provide not only tamper protection but also substantial protection from vehicular impact (see Commentary Figure 6109.13). See the commentary to Section 6107.4. The exception reflects the results of impact testing done on a variety of cabinet designs, which found that lockable metal cabinet construction provided equivalent protection.

#### 6109.14 Alternative location and protection of storage.

Where the provisions of Sections 6109.12 and 6109.13 are impractical at construction sites, or at buildings or structures undergoing major renovation or repairs, the storage of containers shall be as required by the *fire code official*.

- ❖ These requirements permit the fire code official to approve storage sites for LP-gas even if compliance with Sections 6109.12 and 6109.13 is not practical. This would especially be the case at construction sites and other transient installations in which LP-gas containers may be moved frequently.

**6109.15 LP-gas cylinder exchange for resale.** In addition to other applicable requirements of this chapter, facilities operating LP-gas cylinder exchange stations that are accessible to the public shall comply with the following requirements.

1. Cylinders shall be secured in a lockable, ventilated metal cabinet or other *approved* enclosure.
2. Cylinders shall be accessible only by authorized personnel or by use of an automated exchange system in accordance with Section 6109.15.1.

3. A sign shall be posted on the entry door of the business operating the cylinder exchange stating “DO NOT BRING LP-GAS CYLINDERS INTO THE BUILDING” or similar *approved* wording.

4. An emergency contact information sign shall be posted within 10 feet (3048 mm) of the cylinder storage cabinet. The content, lettering, size, color and location of the required sign shall be as required by the *fire code official*.

- ❖ Cylinder exchange cabinets, such as the one shown in Commentary Figure 6109.13, for 20-pound (9 kg) LP-gas cylinders have been available to consumers for over 15 years and have a very respectable safety record. Cabinets for exchange of industrial cylinders, such as those found on forklift trucks, are also in use. While a limited number of incidents resulting from impact from vehicles have been reported, none of these events has resulted in loss of life or severe injuries. It is estimated that several million sales transactions occur annually at cylinder exchange stations.

This section addresses all LP-gas cylinder exchange stations, whether they are manual or automatic. Item 1 requires that all cylinder exchange cabinets be designed so the cabinet provides ventilation for the stored cylinders and is equipped with a means of securing cylinders against tampering.

Item 2 limits access to cylinders to authorized personnel or to users of automated cylinder exchange stations. At an automated cylinder exchange station, Item 5 of Section 6109.15.1 requires that when a manual override occurs, it must be performed by an authorized person before returning the station to automatic operation. In the absence of a definition for



Figure 6109.13  
INSTALLATION OF LP-GAS CONTAINERS FOR RETAIL SALE OR EXCHANGE

the term “authorized personnel,” fire code officials could apply the requirements in Section 4.4 of NFPA 58 for qualification of personnel who are involved in the operation of cylinder exchange stations. NFPA 58 requires that they receive documented training in proper cylinder-handling procedures with refresher training at least every 3 years. Training can often be provided by the LP-gas supplier and many suppliers offer programs prepared by the Propane Education and Research Council, which offers a Certified Employee Training Program to its members. In Item 3, an approved sign is required to inform consumers that bringing cylinders inside of a building is prohibited, based on the requirement in Section 6109.9, and Item 4 requires a sign that provides emergency contact information in the event of a leaking cylinder or other emergency involving the exchange station.

**6109.15.1 Automated cylinder exchange stations.** Cylinder exchange stations that include an automated vending system for exchanging cylinders shall comply with the following additional requirements:

1. The vending system shall only permit access to a single cylinder per individual transaction.
  2. Cabinets storing cylinders shall be designed such that cylinders can only be placed inside when they are oriented in the upright position.
  3. Devices operating door releases for access to stored cylinders shall be permitted to be pneumatic, mechanical or electrically powered.
  4. Electrical equipment inside of or within 5 feet (1524 mm) of a cabinet storing cylinders, including but not limited to electronics associated with vending operations, shall comply with the requirements for Class I, Division 2 equipment in accordance with NFPA 70.
  5. A manual override control shall be permitted for use by authorized personnel. On newly installed cylinder exchange stations, the vending system shall not be capable of returning to automatic operation after a manual override until the system has been inspected and reset by authorized personnel.
  6. Inspections shall be conducted by authorized personnel to verify that all cylinders are secured, access doors are closed and the station has no visible damage or obvious defects that necessitate placing the station out of service. The frequency of inspections shall be as specified by the *fire code official*.
- ❖ One of the bigger advancements in LP-gas cylinder exchange programs is the use of automation at the point-of-sale (POS). These improvements have allowed exchange stations to become self-service, meaning that retailers can allow their employees to focus on other interests in the store rather than managing the exchange of LP-gas cylinders. Consumers can now use an electronic banking card at automated exchange stations where they receive a properly

filled and code-compliant cylinder of LP-gas while the supplier receives an empty cylinder in return (see Commentary Figure 6109.13).

This section contains provisions for regulating these automated LP-gas cylinder exchange stations. These requirements increase the likelihood that consumers will properly remove filled cylinders and return empty cylinders. Item 1 requires that the vending system be designed to limit the consumer to one cylinder per transaction. Item 2 requires that the system accommodate cylinders placed only in the upright position. As indicated in Item 3, door-release components inside the exchange cabinet can be powered by pneumatic, mechanical or electrical energy. Where door release components or other equipment in the cabinet are electrically operated, Item 4 requires hazardous location electrical equipment in accordance with Article 500 of NFPA 70 and specifies the boundary [within 5 feet (1524 mm)] of the hazardous location to mitigate the risk of igniting fugitive gas. Normally, flammable gases in storage do not require classified hazardous location electrical equipment, but in the case of these automated LP-gas cylinder exchange stations, the possibility exists for a cylinder valve to not be completely closed on a cylinder that has been returned by a consumer. Some cabinet manufacturers provide a remote POS kiosk that is located more than 5 feet (1524 mm) from the exchange station to accommodate this requirement with ordinary electrical equipment. As with any mechanical or electro-mechanical vending device, failures can and do occur and Item 5 provides a means for authorized personnel to deal with such failures by using a manual override control. Item 6 requires that automated cylinder exchange stations be inspected by authorized personnel (see commentary, Section 6109.15, Item 5) at a frequency specified by the fire code official. Factors to consider in establishing a required inspection frequency could include the servicing/refilling interval for the cabinet.

## SECTION 6110 LP-GAS CONTAINERS NOT IN SERVICE

**6110.1 Temporarily out of service.** LP-gas containers whose use has been temporarily discontinued shall comply with all of the following:

1. Be disconnected from appliance piping.
  2. Have LP-gas container outlets, except relief valves, closed or plugged.
  3. Be positioned with the relief valve in direct communication with the LP-gas container vapor space.
- ❖ When a new LP-gas supplier installs a tank at a customer's facility, he or she is responsible for ensuring that the previous supplier's tank is removed from service and safely stored until it can be retrieved.

**6110.2 Permanently out of service.** LP-gas containers to be placed permanently out of service shall be removed from the site.

❖ This provision is an extension of Section 6110.1 and requires that any container placed out of service must be retrieved by its owner.

### SECTION 6111 PARKING AND GARAGING OF LP-GAS TANK VEHICLES

**6111.1 General.** Parking of LP-gas tank vehicles shall comply with Sections 6111.2 and 6111.3.

**Exception:** In cases of accident, breakdown or other emergencies, LP-gas tank vehicles are allowed to be parked and left unattended at any location while the operator is obtaining assistance.

❖ In this context, LP-gas tank vehicles include bulk cargo tank vehicles, either transports (semitruck trailers) or bobtails [usually up to 5,000-gallon (18 925 L) water capacity]. The exception to this section recognizes the possibility of a mechanical breakdown of a vehicle while in service.

**6111.2 Unattended parking.** The unattended parking of LP-gas tank vehicle shall be in accordance with Sections 6111.2.1 and 6111.2.2.

❖ Unattended parking may be defined as the parking of a cargo tank vehicle used to transport LP-gas where either the driver or other responsible person is not able to respond to situations involving the vehicle that may occur.

**6111.2.1 Near residential, educational and institutional occupancies and other high-risk areas.** LP-gas tank vehicles shall not be left unattended at any time on residential streets or within 500 feet (152 m) of a residential area, apartment or hotel complex, educational facility, hospital or care facility. Tank vehicles shall not be left unattended at any other place that would, in the opinion of the *fire code official*, pose an extreme life hazard.

❖ Because of the hazardous cargo involved, operator control must be maintained over cargo tank vehicles used to transport LP-gas. In other words, LP-gas transports must not be left unattended. This is especially true in areas where high occupancy levels exist and the possibility of tampering with the vehicle increases.

**6111.2.2 Durations exceeding 1 hour.** LP-gas tank vehicles parked at any one point for longer than 1 hour shall be located as follows:

1. Off public streets, highways, public avenues or public alleys.
2. Inside of a bulk plant.

3. At other *approved* locations not less than 50 feet (15 240 mm) from buildings other than those *approved* for the storage or servicing of such vehicles.

❖ When a vehicle will be parked for more than 1 hour, it will probably be unattended and, therefore, special conditions are imposed.

The first condition specifies that the vehicle must not be parked on a public way. The second condition permits the vehicle to be parked in an LP-gas bulk plant, which is a plant with containers used for storing LP-gas, until the gas is delivered to the end user. The third condition permits the fire code official to approve alternative locations for parking LP-gas cargo tank vehicles. The fire code official might base approval on the proximity to occupied buildings and spaces as well as the potential for tampering with the vehicle.

**6111.3 Garaging.** Garaging of LP-gas tank vehicles shall be as specified in NFPA 58. Vehicles with LP-gas fuel systems are allowed to be stored or serviced in garages as specified in Section 11.16 of NFPA 58.

❖ This section applies not only to cargo tank vehicles used to transport and deliver LP-gas, but also to motor vehicles fueled by LP-gas. NFPA 58 contains extensive provisions for garaging these vehicles. Section 6.24.9 of NFPA 58 contains parking, service and repair requirements for vehicles equipped with an LP-gas system not used for propulsion, such as a recreational vehicle with an on-board LP-gas cooking system.

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The following resource materials were used in the preparation of the commentary for this chapter.

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# Chapter 62: Organic Peroxides

## General Comments

This chapter addresses the hazards associated with the storage, handling and use of organic peroxides. These chemicals possess the characteristics of flammable or combustible liquids and are also strong oxidizers. Class V organic peroxides pose little fire hazard; therefore, these materials are not regulated by specific storage or use requirements. Some organic peroxides are unstable and become increasingly reactive with age or heating.

Organic peroxides pose the dual hazard of being both oxidizers and flammable or explosive compounds. This unusual combination of properties requires special storage and handling precautions to prevent uncontrolled release, contamination, hazardous chemical reactions, fires or explosions. In addition to these properties, organic peroxides are unusually sensitive to temperature. Heat, whether by fire exposure or environmental, is a major factor in the decomposition of peroxide compounds. Some organic peroxides will decompose uneventfully when subject to a gradual temperature increase but may explode if they undergo the thermal shock of a rapid, uncontrolled temperature rise.

J.S. Townsend (1993) notes that some organic peroxides are just as dangerous when they become too cold as when they are too hot. For example, acetyl peroxide becomes unstable above 122°F (50°C)—its self-accelerating decomposition temperature (SADT). When cooled below 17°F (-8.3°F), acetyl peroxide forms crystals that are shock sensitive. Consequently, special precautions must be taken to transport and store acetyl peroxide between 32°F (0°C) and 90°F (32°C).

Organic peroxides are commonly used in the plastics industry to initiate polymerization. Although the requirements of this chapter pertain to industrial applications in which significant quantities of organic peroxides are stored or used, smaller quantities of organic peroxides still pose a significant hazard. These materials, therefore, must be stored and used in accordance with the applicable provisions of this chapter and Chapter 50.

## Purpose

The provisions of this chapter are intended to manage the fire and oxidation hazards of organic peroxides by preventing their uncontrolled release.

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## SECTION 6201 GENERAL

**6201.1 Scope.** The storage and use of organic peroxides shall be in accordance with this chapter and Chapter 50.

Unclassified detonable organic peroxides that are capable of *detonation* in their normal shipping containers under conditions of fire exposure shall be stored in accordance with Chapter 56.

❖ The specific requirements for the storage, handling and use of organic peroxides in this chapter are intended to complement the general hazardous materials requirements of Chapter 50. Because of the hazards to people and property, organic peroxides capable of being detonated in their usual shipping containers or packages under fire conditions must be stored in accordance with the provisions of Chapter 56 for explosives. Examples of unclassified detonable (UD) materials are organic peroxides classified as Type A by DOTn 49 CFR; 173.128(b)(1) and materials classified as explosives by DOTn 49 CFR; 173, Subpart C. DOTn Type A organic peroxides have an SADT of 122°F (50°C) or less.

**6201.2 Permits.** Permits shall be required for organic peroxides as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit and Section 105.7 for a general discussion of activities requiring a construction permit. The permit process also notifies the fire department of the need for prefire planning for hazardous property.

## SECTION 6202 DEFINITION

**6202.1 Definition.** The following term is defined in Chapter 2:

### ORGANIC PEROXIDE.

Class I.

Class II.

**Class III.**

**Class IV.**

**Class V.**

**Unclassified detonable.**

- ❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated term used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*® as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4).

## SECTION 6203 GENERAL REQUIREMENTS

**6203.1 Quantities not exceeding the maximum allowable quantity per control area.** The storage and use of organic peroxides in amounts not exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Sections 5001, 5003, 6201 and 6203.

- ❖ The provisions of this section complement the requirements of Chapter 50 in structures occupied for the storage, handling or use of organic peroxides. The regulations contained in Sections 6203.1.1 through 6203.1.1.4 assume that the quantity of organic peroxides in a given building is limited to the maximum allowable quantities (MAQs) per control area as established in Section 5003.1; thus, the building is not classified in Occupancy Group H. The general requirements of Sections 5001 and 5003 are fully applicable to the storage and use of organic peroxides, in addition to the provisions of this chapter.

**6203.1.1 Special limitations for indoor storage and use by occupancy.** The indoor storage and use of organic peroxides shall be in accordance with Sections 6203.1.1.1 through 6203.1.1.4.

- ❖ Because certain occupancies may need to have organic peroxides on hand, Sections 6203.1.1.1 through 6203.1.1.4 provide regulations specific to occupancy group classifications and that recognize the relative hazards of both the occupancy and the organic peroxide.

**6203.1.1.1 Group A, E, I or U occupancies.** In Group A, E, I or U occupancies, any amount of unclassified detonable and Class I organic peroxides shall be stored in accordance with the following:

1. Unclassified detonable and Class I organic peroxides shall be stored in hazardous materials storage cabinets complying with Section 5003.8.7.
  2. The hazardous materials storage cabinets shall not contain other storage.
- ❖ Because of their respective explosive or higher deflagration hazard characteristics, even the smallest quantity of UD or Class I organic peroxides present in

Group A, E, I or U occupancies must be stored in an approved hazardous materials storage cabinet constructed and placarded in accordance with Section 5003.8.7 to reduce the exposure of the materials to hazards from the surrounding environment.

In accordance with Note g in Table 5003.1.1(1), storage of UD organic peroxide in any amount is allowed only in buildings equipped throughout with an approved automatic sprinkler system, in accordance with Section 903.3.1. Also, based on Note e in Table 5003.1.1(1), where an approved storage cabinet is used, the MAQ that can be kept in the occupancies can be doubled.

To reduce the likelihood of contamination of the organic peroxide materials or damage to their packaging, Item 2 prohibits the storage of other materials in the approved organic peroxide storage cabinet.

In accordance with Section 6201.1, storage of UD organic peroxides must also comply with the applicable provisions of Chapter 56 for explosives.

**6203.1.1.2 Group R occupancies.** Unclassified detonable and Class I organic peroxides shall not be stored or used within Group R occupancies.

- ❖ Because of their explosive or higher deflagration hazard characteristics, UD and Class I organic peroxide cannot be stored in any residential occupancy within the scope of the code's regulations. Storage would result in an increased danger to the occupants, as well as exposure of the peroxides to the otherwise unregulated environment.

**6203.1.1.3 Group B, F, M or S occupancies.** Unclassified detonable and Class I organic peroxides shall not be stored or used in offices, or retail sales areas of Group B, F, M or S occupancies.

- ❖ Because of their explosive or higher deflagration hazard characteristics, UD and Class I organic peroxide cannot be stored in occupancies in Group B, F, M or S. Storage would result in an increased danger to the occupants, as well as exposure of the peroxides to the higher relative fire loads typically encountered in these occupancies.

**6203.1.1.4 Classrooms.** In classrooms in Group B, F or M occupancies, any amount of unclassified detonable and Class I organic peroxides shall be stored in accordance with the following.

1. Unclassified detonable and Class 1 organic peroxides shall be stored in hazardous materials storage cabinets complying with Section 5003.8.7.
2. The hazardous materials storage cabinets shall not contain other storage.

- ❖ It is the intent of this section to allow for the occasional use of limited amounts of organic peroxides in certain scientific, experimental or demonstration settings; however, this section does not allow storage of any quantity of these materials for any length of time.

The fire code official may limit the amount of organic peroxides brought into a structure for these uses. The quantity actually needed for the experiment should determine the amount allowed into a structure.

Because of their explosive or higher deflagration hazard characteristics, even the smallest quantity of UD or Class I organic peroxides must be stored in an approved hazardous materials storage cabinet constructed and placarded in accordance with Section 5003.8.7 to reduce the exposure of the materials to hazards from the surrounding environment.

In accordance with Note g in Table 5003.1.1(1), storage of UD organic peroxide in any amount is allowed only in buildings equipped throughout with an approved automatic sprinkler system, in accordance with Section 903.3.1. Also, based on Note g in Table 5003.1.1(1), where an approved storage cabinet is used, the MAQ that could be kept in these occupancies can be doubled.

To reduce the likelihood of contaminating organic peroxide materials or damaging their packaging, Item 2 prohibits the storage of other materials in the approved organic peroxide storage cabinet.

Note that in accordance with Section 6201.1, storage of UD organic peroxides must also comply with the applicable provisions of Chapter 56 for explosives.

**6203.2 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of organic peroxides in amounts exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Chapter 50 and this chapter.

- ❖ The provisions of this section complement the requirements of Chapter 50 in structures occupied for the storage, handling or use of organic peroxides. The regulations in this section assume that the quantity of organic peroxides in a given building is in excess of the MAQ as established in Section 5003.1 and, therefore, that the building is classified in Occupancy Group H. The requirements of Chapter 50 apply to the storage and use of organic peroxides in addition to the provisions of this chapter.

## SECTION 6204 STORAGE

**6204.1 Indoor storage.** Indoor storage of organic peroxides in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) shall be in accordance with Sections 5001, 5003, 5004 and this chapter.

Indoor storage of unclassified detonable organic peroxides that are capable of *detonation* in their normal shipping containers under conditions of fire exposure shall be stored in accordance with Chapter 56.

- ❖ This section regulates the indoor storage of organic peroxides when in excess of the MAQ in buildings or portions of buildings classified in Occupancy Group

H. The general and storage provisions of Chapter 50 are applicable in addition to the requirements of this section. Storage of organic peroxides inside of structures must comply with Sections 6204.1.1 through 6204.1.11 to prevent uncontrolled release or exposure to conditions that may result in a fire or explosion.

Because of the explosion hazard, UD organic peroxides must be stored in accordance with the provisions of this section and Chapter 56 for explosives.

**6204.1.1 Detached storage.** Storage of organic peroxides shall be in detached buildings where required by Section 5003.8.2.

- ❖ Detached structures designed and constructed for the sole purpose of organic peroxide storage provide the best protection for people and property from fire and explosions. Detached storage structures should be constructed of noncombustible materials to prevent them from becoming involved in an outside fire that may endanger their contents or a fire stemming from ignited contents in storage.

Section 5003.8.2 and Table 5003.8.2 require detached storage when the indoor storage quantities are more than 2 tons (4 metric tons) of Class I, more than 25 tons (50 metric tons) of Class II and more than 50 tons (100 metric tons) of Class III organic peroxides. See the commentary to Section 5003.8.2 and Table 5003.8.2 for further discussion of detached storage requirements. Commentary Figure 6204.1.1 shows a cross-sectional diagram of a typical detached storage building.

**6204.1.2 Distance from detached buildings to exposures.**

In addition to the requirements of the *International Building Code*, detached storage buildings for Class I, II, III, IV and V organic peroxides shall be located in accordance with Table 6204.1.2. Detached buildings containing quantities of unclassified detonable organic peroxides in excess of those set forth in Table 5003.8.2 shall be located in accordance with Table 5604.5.2(1).

- ❖ The *International Building Code*® (IBC®) prescribes minimum fire-resistance ratings for exterior walls of buildings based on clearances from adjacent structures and lot lines. The separation distances prescribed by this section are minimums notwithstanding the inherent fire-resistance ratings of the exterior wall assemblies. These clearances are intended to reduce the hazard to nearby structures and people in the event of a fire or explosion in a detached storage structure used for the storage of organic peroxides.

**TABLE 6204.1.2.** See page 62-4.

- ❖ The separation distances specified in the table are intended to reduce the effects of radiant heat exposure in the event of a fire in an adjacent storage structure. Separation distances for UD organic peroxides must conform to the requirements of Table 5604.5.2(2).

**ORGANIC PEROXIDES**

**6204.1.3 Liquid-tight floor.** In addition to the requirements of Section 5004.12, floors of storage areas shall be of liquid-tight construction.

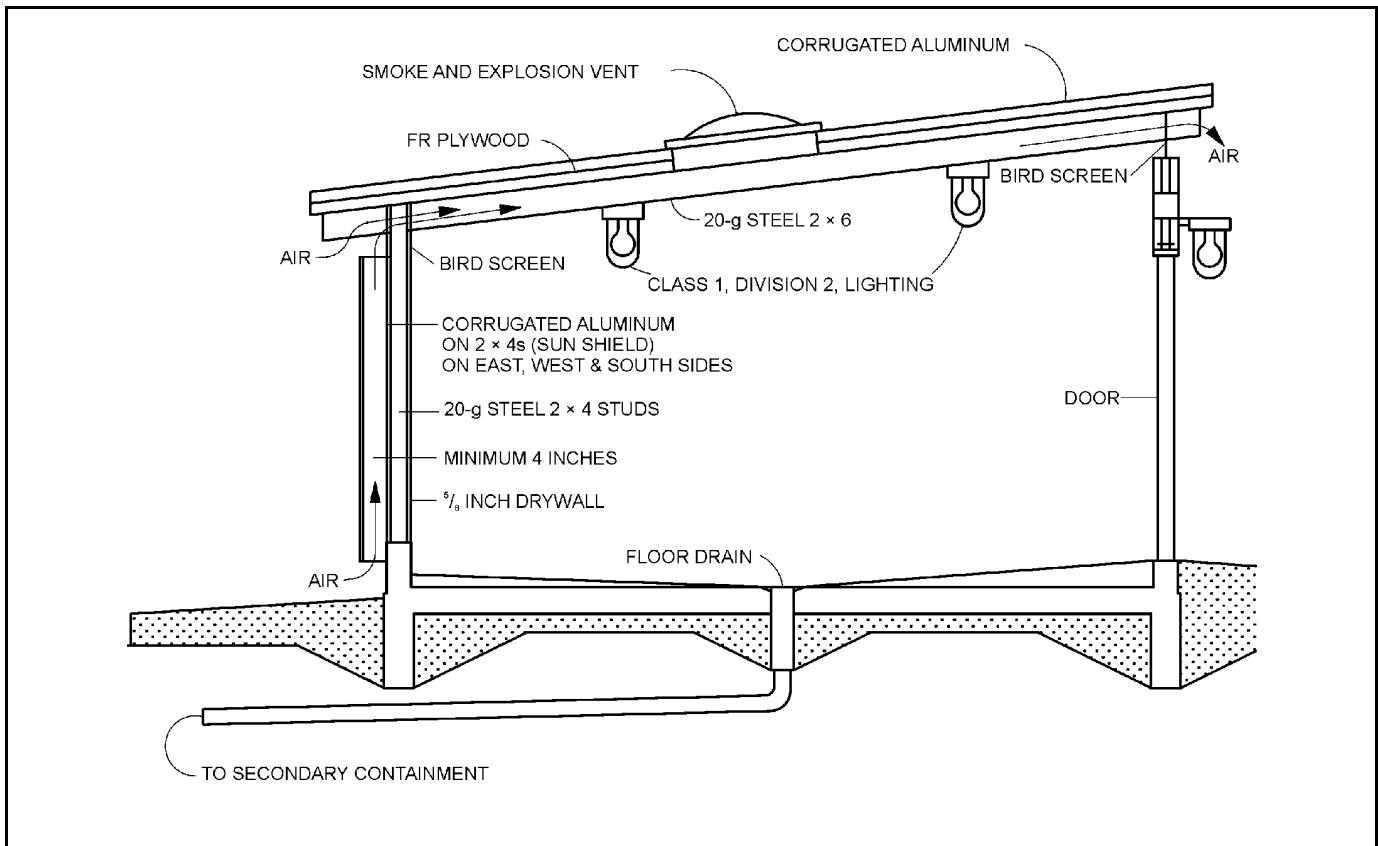
❖ In addition to the requirement of Section 5004.12 that floors be constructed of noncombustible materials, liquid-tight floors are required so as to prevent the passage of liquids to adjacent spaces.

**6204.1.4 Electrical wiring and equipment.** In addition to the requirements of Section 5003.9.4, electrical wiring and equipment in storage areas for Class I or II organic peroxides

shall comply with the requirements for electrical Class I, Division 2 locations.

❖ Because of the danger of ignition by arcs or sparks in the event of an accidental spill or leak, electrical equipment and devices in storage areas for organic peroxides must be classified for use in Class I, Division 2 hazardous locations as described in NFPA 70.

**6204.1.5 Smoke detection.** An *approved* supervised smoke detection system in accordance with Section 907 shall be provided in rooms or areas where Class I, II or III organic perox-



**Figure 6204.1.1**  
**TYPICAL DETACHED STORAGE STRUCTURE**

**TABLE 6204.1.2**  
**ORGANIC PEROXIDES—DISTANCE TO EXPOSURES FROM DETACHED STORAGE BUILDINGS OR OUTDOOR STORAGE AREAS**

ORGANIC PEROXIDE CLASS	MAXIMUM STORAGE QUANTITY (POUNDS) AT MINIMUM SEPARATION DISTANCE					
	Distance to buildings, lot lines, public streets, public alleys, public ways or means of egress			Distance between individual detached storage buildings or individual outdoor storage areas		
	50 feet	100 feet	150 feet	20 feet	75 feet	100 feet
I	2,000	20,000	175,000	2,000	20,000	175,000
II	100,000	200,000	No Limit	100,000 <sup>a</sup>	No Limit	No Limit
III	200,000	No Limit	No Limit	200,000 <sup>a</sup>	No Limit	No Limit
IV	No Limit	No Limit	No Limit	No Limit	No Limit	No Limit
V	No Limit	No Limit	No Limit	No Limit	No Limit	No Limit

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg.

a. Where the amount of organic peroxide stored exceeds this amount, the minimum separation shall be 50 feet.

ides are stored. Activation of the smoke detection system shall sound a local alarm.

**Exception:** A smoke detection system shall not be required in detached storage buildings equipped throughout with an *approved* automatic fire-extinguishing system complying with Chapter 9.

- ❖ An automatic fire detection system with central, remote or proprietary station supervision and a local alarm signal is required to provide early warning of fire to building occupants and fire suppression personnel. Detectors and installation methods in organic peroxide storage areas should be selected for compatibility with the materials stored. Fire alarm equipment and installation methods must comply with Section 907. Materials that give off strong vapors may interfere with fire detection system components or trigger nuisance alarm signals. The required local alarm is intended to alert the occupants in the immediate vicinity of the storage area to a potential hazardous condition. The local alarm is not intended to be part of an evacuation alarm system for the entire structure.

The exception indicates that automatic fire detection is not required in detached storage buildings when an automatic fire suppression system is provided. Automatic sprinklers or other approved fire suppression systems reduce the danger to people and property from fire by detecting the fire, sounding an alarm, transmitting the alarm to the fire department and containing or suppressing the fire. Sprinkler systems in detached storage buildings must be supervised by a connection to a central station, a remote supervising station or a proprietary supervising station, or, when approved by the fire code official, connected to a system that produces an audible and visual signal monitored at a constantly attended on-site location. See the commentary to Section 903.4 for further discussion of sprinkler system supervision and Section 904.3.5 for further discussion of alternative automatic fire-extinguishing system supervision.

**6204.1.6 Maximum quantities.** Maximum allowable quantities per building in a mixed occupancy building shall not

exceed the amounts set forth in Table 5003.8.2. Maximum allowable quantities per building in a detached storage building shall not exceed the amounts specified in Table 6204.1.2.

- ❖ This section establishes the maximum allowable indoor storage quantities of organic peroxide on a per-building basis, as opposed to a per-control area basis, and regulates both mixed occupancy buildings and detached organic peroxide storage buildings.

**6204.1.7 Storage arrangement.** Storage arrangements for organic peroxides shall be in accordance with Table 6204.1.7 and shall comply with all of the following:

1. Containers and packages in storage areas shall be closed.
2. Bulk storage shall not be in piles or bins.
3. A minimum 2-foot (610 mm) clear space shall be maintained between storage and uninsulated metal walls.
4. Fifty-five-gallon (208 L) drums shall not be stored more than one drum high.

- ❖ These provisions detail storage requirements related to the hazards of release or ignition of liquids and vapors of organic peroxide stored in structures. Some of the factors that are considered are as follows:

1. Open containers or packages may permit the release of flammable or oxidizing materials or vapors.
2. Containers in bulk piles or bins may be susceptible to physical damage from stacking or product movement, which could damage the container and lead to an uncontrolled release of product.
3. The required separation distance is intended to minimize the effects of radiant heat exposures to stored materials in the event of a fire outside the structure.
4. The stacking of drums may result in a container being damaged during product movement if a drum is dropped or tipped over.

**TABLE 6204.1.7.** See below.

- ❖ See the commentary to Section 6204.2.4.

**TABLE 6204.1.7  
STORAGE OF ORGANIC PEROXIDES**

ORGANIC PEROXIDE CLASS	PILE CONFIGURATION				MAXIMUM QUANTITY PER BUILDING
	Maximum width (feet)	Maximum height (feet)	Minimum distance to next pile (feet)	Minimum distance to walls (feet)	
I	6	8	4 <sup>a</sup>	4 <sup>b</sup>	Note c
II	10	8	4 <sup>a</sup>	4 <sup>b</sup>	Note c
III	10	8	4 <sup>a</sup>	4 <sup>b</sup>	Note c
IV	16	10	3 <sup>a, d</sup>	4 <sup>b</sup>	No Requirement
V	No Requirement	No Requirement	No Requirement	No Requirement	No Requirement

For SI: 1 foot = 304.8 mm.

- a. Not less than one main aisle with a minimum width of 8 feet shall divide the storage area.
- b. Distance to noncombustible walls is allowed to be reduced to 2 feet.
- c. See Table 6204.1.2 for maximum quantities.
- d. The distance shall be not less than one-half the pile height.

**6204.1.8 Location in building.** The storage of Class I or II organic peroxides shall be on the ground floor. Class III organic peroxides shall not be stored in basements.

❖ Class I and II organic peroxides may not be stored above or below the ground floor because of concerns for fire-fighter access. Because of their lower relative hazard, Class III organic peroxides may be stored on floors above grade; however, they may not be stored on floors below grade because of the difficulty of manual fire suppression operations in below-grade areas.

**6204.1.9 Contamination.** Organic peroxides shall be stored in their original DOTn shipping containers. Organic peroxides shall be stored in a manner to prevent contamination.

❖ Organic peroxides must be kept in original U.S. Department of Transportation (DOT)-approved shipping containers to facilitate identification and to minimize the possibility of accidental spills or ignition. The stability of organic peroxides can be markedly reduced through contamination by various materials, such as strong acids or alkalis, sulfur-based compounds or reducing agents of any type. Storage practices must prevent contamination and the hazards associated with it.

**6204.1.10 Explosion control.** Indoor storage rooms, areas and buildings containing unclassified detonable and Class I organic peroxides shall be provided with explosion control in accordance with Section 911.

❖ Because of the possibility of a deflagration or detonation in the event of ignition of Class I organic peroxides, explosion relief venting must be provided to protect the storage building or structure from collapse. Explosion venting must conform to the requirements in Section 911.

**6204.1.11 Standby power.** Standby power shall be provided in accordance with Section 604 for the following systems used to protect Class I and unclassified detonable organic peroxide:

1. Exhaust ventilation system.
2. Treatment system.
3. Gas detection system.
4. Smoke detection system.
5. Temperature control system.
6. Fire alarm system.
7. Emergency alarm system.

❖ A standby power system complying with Section 604 is required as a backup power supply for the systems listed in this section. These systems may also be connected to an approved emergency power system instead of a separate standby power system (see commentary, Section 604).

**6204.1.11.1 Fail-safe engineered systems.** Standby power shall not be required for mechanical exhaust ventilation,

treatment systems and temperature control systems where *approved* fail-safe engineered systems are installed.

❖ This section recognizes the use of an engineered system designed to always fail in the appropriate design mode without human intervention rather than an emergency power system. The exception is intended to permit alternative systems that are not subject to power interruptions.

**6204.2 Outdoor storage.** Outdoor storage of organic peroxides in amounts exceeding the *maximum allowable quantities per control area* indicated in Table 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5004 and this chapter.

❖ This section regulates the outdoor storage of organic peroxides when in excess of the MAQ per outdoor control area established by Table 5003.1.1(3). The general and storage provisions of Chapter 50 are applicable in addition to the requirements of this section. Storage of organic peroxides in outdoor control areas must comply with Sections 6204.2.1 through 6204.2.5 to prevent uncontrolled release or exposure to conditions that may result in a fire or explosion.

**6204.2.1 Distance from storage to exposures.** Outdoor storage areas for organic peroxides shall be located in accordance with Table 6204.1.2.

❖ The IBC prescribes minimum fire-resistance ratings for exterior walls of buildings based on clearances from adjacent structures and lot lines. The separation distances prescribed by this section are minimums notwithstanding the inherent fire-resistance ratings of the exterior wall assemblies. These clearances are intended to reduce the hazard to nearby structures and people in the event of a fire or explosion in a detached storage structure or outdoor area used for the storage of organic peroxides.

**6204.2.2 Electrical wiring and equipment.** In addition to the requirements of Section 5003.9.4, electrical wiring and equipment in outdoor storage areas containing unclassified detonable, Class I or II organic peroxides shall comply with the requirements for electrical Class I, Division 2 locations.

❖ Because of the danger of ignition by arcs or sparks in the event of an accidental spill or leak, electrical equipment and devices in outdoor organic peroxide storage areas must be classified for use in Class I, Division 2 hazardous locations as described in NFPA 70.

**6204.2.3 Maximum quantities.** Maximum quantities of organic peroxides in outdoor storage shall be in accordance with Table 6204.1.2.

❖ Outdoor storage of organic peroxides must comply with the requirements specified in Table 6204.1.2, which establishes the minimum separation distances required between the outdoor storage area and exposures, including other outdoor storage areas, and the MAQ of organic peroxides being stored.

**6204.2.4 Storage arrangement.** Storage arrangements shall be in accordance with Table 6204.1.7.

- ❖ Similar to Section 6204.1.7 for indoor storage, this section references the provisions of Table 6204.1.7 for organic peroxide storage arrangements. Pile limitations specified in the table are based on the relative hazard of the material when involved in fire. These limits apply to Class I, II, III and IV organic peroxides in combustible and noncombustible containers and packages.

**6204.2.5 Separation.** In addition to the requirements of Section 5003.9.8, outdoor storage areas for organic peroxides in amounts exceeding those specified in Table 5003.8.2 shall be located a minimum distance of 50 feet (15 240 mm) from other hazardous material storage.

- ❖ The required minimum 50-foot (15 240 mm) separation distance from other hazardous materials storage is intended to reduce the hazard of dangerous chemical reactions with other incompatible materials in the event of a spill, fire or explosion.

## SECTION 6205 USE

**6205.1 General.** The use of organic peroxides in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) or 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5005 and this chapter.

- ❖ This section applies to indoor and outdoor dispensing, use and handling of organic peroxides when the amounts being dispensed, used or handled are in excess of the MAQ per indoor or outdoor control area indicated in Table 5003.1.1(1) or 5003.1.1(3), respectively. The administrative, general, use, dispensing and handling provisions of Chapter 50 are applicable, in addition to the requirements of this chapter.

Once the MAQ of organic peroxide per control area has been exceeded, indoor areas where materials are being dispensed, used or handled must be located in a building or portion of a building complying with the IBC for a Group H occupancy because of the increased hazards associated with quantity.

Although no occupancy group is assigned to them, outside organic peroxide use areas require an increased level of regulation when quantities exceed the MAQs per outdoor control area. The MAQs per control area listed in Tables 5003.1.1(1) and 5003.1.1(3) have been divided into closed-use and open-use systems. Corresponding MAQs recognize that an open-use condition is generally more hazardous than a closed-use condition because the organic peroxide is more directly exposed to the surrounding environment and can become more readily involved in an incident than if it is totally confined. The MAQs for use are based on the aggregate quantity in both use and storage, not exceeding the exempt amount listed for storage.

## Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

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*Recommendations on the Transport of Dangerous Goods, Test and Criteria, Parts I, II and III*, 10th rev. ed. New York: United Nations, 1997.

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# Chapter 63: Oxidizers, Oxidizing Gases and Oxidizing Cryogenic Fluids

## General Comments

Solid, liquid and gaseous oxidizers and oxidizing cryogenic fluids are common industrial chemicals. These compounds are often used because of their reactive properties. Common oxidizers include bromates, chlorates, chlorites, dichromates, hypochlorites, nitrates, nitrites, permanganates, inorganic peroxides and inorganic superoxides. Oxidizing cryogenic fluids include liquid oxygen, which is regulated by this chapter in addition to Chapter 55.

Requirements for the storage and use of liquid oxygen for respiratory care in Group I-1, I-4 and R occupancies are now specified in Chapter 63. Section 6306 was developed in response to changes in technology that improve in-home care of patients with respiratory ailments. This section now allows patients to utilize a liquid oxygen ambulatory care container and to be able to refill the container from a liquid oxygen home care container in a home setting.

Although oxidizers themselves do not burn, they pose unique fire hazards because of their ability to support combustion by breaking down and giving off oxygen. The hazard classification system for these materials described in the definition of "Oxidizer" in Section 6302.1 reflects the varying reactivity of oxidizers when they come in contact with combustible materials. The classification system originated in NFPA 430, upon which the provisions of this chapter are based but that is not referenced by the code except for sprinkler design criteria in Section 6304.1.4.

Cryogenic oxygen regulated by this chapter is also known as liquid oxygen (LOX). Oxygen is converted to LOX because it is less bulky and costly to handle when compared to an equivalent volume of compressed oxygen stored in high-pressure cylinders. LOX is defined in Section 6302.1 as an oxidizing gas in the cryogenic state and has a boiling point temperature of  $-297.3^{\circ}\text{F}$  ( $-165^{\circ}\text{C}$ ). LOX, as with other cryogenic fluids, presents a number of hazards.

Because of the extremely low boiling points of cryogenic fluids, containers for cryogenic fluids, piping and pressure relief and control devices must be constructed of materials that are resistant to these temperatures.

Materials like carbon steel and all plastics are not acceptable for cryogenic fluid service.

Cryogenic fluids are gases that have been condensed into a fluid and have extremely large expansion ratios. LOX has a liquid-to-gas expansion ratio [measured from its boiling point temperature to normal temperature and pressure (NTP)] of one to 960. Because of the large expansion ratio, the design of the containers must include a means of pressure relief anywhere in the piping system where LOX can be trapped, such as a pipe located between two valves that are closed.

The physical hazard as an oxidizer remains when oxygen is converted to LOX. As a result, a small release of liquid may produce a sufficient volume of oxygen to create an oxygen-enriched atmosphere. An atmosphere containing 23 percent or more by volume of oxygen is considered to be oxygen enriched. LOX and its cold vapors are capable of causing severe burns to human tissues.

The oxidizer hazard classifications defined in this chapter do not correspond to those given in NFPA 704. The NFPA 704 system indicates whether a given material will support combustion by using the "OXY" symbol in the lower quadrant of the placard. No numerical hazard value is assigned to a material's oxidizing ability in the NFPA 704 system.

When the specific hazard classification of a material is not known, the fire code official must use judgment in approving the assignment of materials to specific hazard classes. The best source of guidance is the information supplied by the Material Safety Data Sheets (MSDS) (see commentary, Section 407).

## Purpose

Chapter 63 addresses the hazards associated with oxidizing materials and establishes criteria for their safe storage and protection in indoor and outdoor storage facilities, minimizing the potential for uncontrolled releases and contact with fuel sources. The chapter also provides reasonable safeguards for the storage and use of medical oxygen in home health care settings.

**SECTION 6301  
GENERAL**

**6301.1 Scope.** The storage and use of oxidizing materials shall be in accordance with this chapter and Chapter 50. Oxidizing gases shall also comply with Chapter 53. Oxidizing *cryogenic fluids* shall also comply with Chapter 55.

**Exceptions:**

1. Display and storage in Group M and storage in Group S occupancies complying with Section 5003.11.
  2. Bulk oxygen systems at industrial and institutional consumer sites shall be in accordance with NFPA 55.
  3. Liquid oxygen stored or used in home health care in Group I-1, I-4 and R occupancies in accordance with Section 6306.
- ❖ This chapter is based in part on former NFPA 430 (now Chapter 15 of NFPA 400), addressing the hazards presented by the storage and use of oxidizers. In addition to the requirements of this chapter, oxidizing compressed gases are subject to Chapter 53 and oxidizing cryogenic fluids to Chapter 55.

Exception 1 states that this chapter does not apply to oxidizers where stored and displayed in Group M occupancies or where stored in Group S occupancies. Instead, they are governed by Section 5003.11 for those occupancy groups. In that section, Class 4 oxidizers are prohibited in Group M mercantile occupancies because of their detonable hazard potential. Quantities of all other oxidizer classes are limited on a per-control-area basis to limit exposure to people and property (see commentary, Section 5003.11). This exception would permit an increase above the maximum allowable quantities per control area (MAQs) indicated in Table 5003.1.1(1) for oxidizers while still maintaining a mercantile or storage occupancy group classification.

Exception 2 makes it clear that bulk oxygen systems, as defined in Section 6302.1, are not within the scope of this chapter but are required to comply with the provisions of NFPA 55.

It is not realistic to apply the MAQ/control area concept set forth in Chapter 50 to the widespread use and distribution of liquid oxygen in home health care settings. Exception 3 clarifies that LOX stored and used for home health care in the indicated occupancies in accordance with Section 6306 is not required to also comply with Chapter 50 or 55 provisions. The concept in Section 6306 is to limit not only the individual container size but also the total number of containers allowed in an individual dwelling unit. Trying to further regulate the quantity in a building is not considered by either industry or the fire service to be a reasonable or enforceable regulatory approach. A

similar statement in Section 5301.1 sends the user to this chapter for regulation of oxidizing gases (including oxygen), which will get the user to Section 6306, as well.

**6301.2 Permits.** Permits shall be required as set forth in Section 105.6.

- ❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit, Section 105.6.21 for a discussion of specific quantity-based operational permits for the materials regulated in this chapter and Section 105.7 for a general discussion of activities requiring a construction permit. The permit process also notifies the fire department of the need for prefire planning for hazardous property.

**SECTION 6302  
DEFINITIONS**

**6302.1 Definitions.** The following terms are defined in Chapter 2:

**BULK OXYGEN SYSTEM.**

**LIQUID OXYGEN AMBULATORY CONTAINER.**

**LIQUID OXYGEN HOME CARE CONTAINER.**

**OXIDIZER.**

**Class 4.**

**Class 3.**

**Class 2.**

**Class 1.**

**OXIDIZING CRYOGENIC FLUID.**

**OXIDIZING GAS.**

- ❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*® as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4).

**SECTION 6303  
GENERAL REQUIREMENTS**

**6303.1 Quantities not exceeding the maximum allowable quantity per control area.** The storage and use of oxidizing materials in amounts not exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be

in accordance with Sections 5001, 5003, 6301 and 6303. Oxidizing gases shall also comply with Chapter 53.

❖ The provisions of this section complement the requirements of Chapter 50 in structures used for the storage, handling or use of oxidizing materials. Unless otherwise indicated in a particular section, the regulations contained in Sections 6303.1.1 through 6303.1.3 assume that the quantity of oxidizers in a given building is limited to the MAQs established in Section 5003.1; thus, the building is not classified in Occupancy Group H. The general requirements of Sections 5001 and 5003 are fully applicable to the storage and use of organic peroxides in addition to the provisions of this chapter. In the event that the oxidizer being stored is a gas, it will also be subject to Chapter 53.

**6303.1.1 Special limitations for indoor storage and use by occupancy.** The indoor storage and use of oxidizing materials shall be in accordance with Sections 6303.1.1.1 through 6303.1.1.3.

❖ Because certain occupancies may need to have oxidizing materials on hand, Sections 6303.1.1.1 through 6303.1.1.3 provide regulations that are specific to occupancy group classifications and recognize the relative hazards of both the occupancy and the oxidizing material.

**6303.1.1.1 Class 4 liquid and solid oxidizers.** The storage and use of Class 4 liquid and solid oxidizers shall comply with Sections 6303.1.1.1.1 through 6303.1.1.1.4.

❖ Because of their explosive or higher deflagration hazard characteristics, Class 4 liquid and solid oxidizers warrant special consideration and limitations when stored or used in certain occupancies, as indicated in Sections 6303.1.1.1.1 through 6303.1.1.1.4.

**6303.1.1.1.1 Group A, E, I or U occupancies.** In Group A, E, I or U occupancies, any amount of Class 4 liquid and solid oxidizers shall be stored in accordance with the following:

1. Class 4 liquid and solid oxidizers shall be stored in hazardous materials storage cabinets complying with Section 5003.8.7.
2. The hazardous materials storage cabinets shall not contain other storage.

❖ Because of their explosive or higher deflagration hazard characteristics, even the smallest quantity of Class 4 liquid and solid oxidizers present in Group A, E, I or U occupancies must be stored in an approved hazardous materials storage cabinet constructed and placarded in accordance with Section 5003.8.6 to reduce the exposure of the materials to hazards from the surrounding environment.

It should also be noted that Note g to Table 5003.1.1(1) limits storage of Class 4 liquid and solid oxidizers in any amount to buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Also, based on Note e to Table 5003.1.1(1), if an approved storage cabinet is used, the MAQ that could be kept

in occupancies equipped with sprinklers can be doubled.

**6303.1.1.1.2 Group R occupancies.** Class 4 liquid and solid oxidizers shall not be stored or used within Group R occupancies.

❖ Because Class 4 liquid and solid oxidizers are a great explosive hazard, they cannot be stored in any residential occupancy within the scope of the code's regulations because of the increased danger to the occupants and the otherwise unregulated environment to which the materials could be exposed.

**6303.1.1.1.3 Offices and retail sales areas.** Class 4 liquid and solid oxidizers shall not be stored or used in offices or retail sales areas of Group B, F, M or S occupancies.

❖ Because Class 4 liquid and solid oxidizers are a great explosive hazard, they cannot be stored in offices or retail sales areas of occupancies in Group B, F, M or S because of the increased danger to the occupants and the higher relative fire loads typically encountered in these occupancies.

**6303.1.1.1.4 Classrooms.** In classrooms of Group B, F or M occupancies, any amount of Class 4 liquid and solid oxidizers shall be stored in accordance with the following:

1. Class 4 liquid and solid oxidizers shall be stored in hazardous materials storage cabinets complying with Section 5003.8.7.
2. Hazardous materials storage cabinets shall not contain other storage.

❖ This section allows the occasional use of limited amounts of Class 4 liquid and solid oxidizers in certain scientific, experimental or demonstration settings; however, storage of any quantity of these materials for any length of time is not allowed. The fire code official may limit the amount of Class 4 liquid and solid oxidizers brought into a structure for these uses. The quantity actually needed for the experiment should determine the amount allowed into a structure.

Because of their explosive hazard characteristics, even the smallest quantity of Class 4 liquid and solid oxidizers must be stored in an approved hazardous materials storage cabinet, constructed and placarded in accordance with Section 5003.8.6, to reduce the exposure of the materials to hazards from the surrounding environment. Based on Note e to Table 5003.1.1(1), where an approved storage cabinet is used, the MAQ that could be kept in such occupancies can be doubled.

Note g to Table 5003.1.1(1) allows storage of Class 4 liquid and solid oxidizers in any amount only in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1.

To reduce the likelihood of contamination of the Class 4 oxidizer materials or damage to their packaging, Item 2 prohibits the storage of other materials in the approved storage cabinet.

**6303.1.1.2 Class 3 liquid and solid oxidizers.** Not more than 200 pounds (91 kg) of solid or 20 gallons (76 L) of liquid Class 3 oxidizer is allowed in storage and use where such materials are necessary for maintenance purposes or operation of equipment. The oxidizers shall be stored in *approved* containers and in an *approved* manner.

❖ The higher amounts of Class 3 liquid and solid oxidizers permitted by this section in storage and use are in recognition of their common use for building maintenance purposes or equipment operation. Proper storage practices and safeguards must still be observed.

**6303.1.1.3 Oxidizing gases.** Except for cylinders of nonliquefied *compressed gases* not exceeding a capacity of 250 cubic feet (7 m<sup>3</sup>) or liquefied *compressed gases* not exceeding a capacity of 46 pounds (21 kg) each used for maintenance purposes, patient care or operation of equipment, oxidizing gases shall not be stored or used in Group A, E, I or R occupancies or in offices in Group B occupancies.

The aggregate quantities of gases used for maintenance purposes and operation of equipment shall not exceed the *maximum allowable quantity per control area* listed in Table 5003.1.1(1).

Medical gas systems and medical gas supply cylinders shall also be in accordance with Section 5306.

❖ In Occupancy Groups A, E, I or R, or offices in Group B occupancies, up to the MAQ of oxidizing gases per control area established in Table 5003.1.1(1) are allowed for maintenance and critical functions, such as patient care and maintenance of equipment.

To limit the amount of gas that could be released in any given incident, no individual cylinder may exceed a capacity of 250 cubic feet (7 m<sup>3</sup>) for nonliquefied compressed gases or 46 pounds (21 kg) for liquefied compressed gases. Consistent with Section 6301.1, the provisions of Chapter 53 are also applicable to oxidizer gases, in addition to the provisions of this section.

The quantity limitation to office spaces in Group B occupancies allows small laboratories, doctor or dental spaces, or other nonoffice uses classified as Group B to store and use quantities up to the MAQs of flammable or oxidizing gases.

**6303.1.2 Emergency shutoff.** *Compressed gas* systems conveying oxidizing gases shall be provided with *approved* manual or automatic emergency shutoff valves that can be activated at each point of use and at each source.

❖ In order to maintain control over the flow of oxidizer gases under emergency conditions, each supply source and point of use of oxidizer compressed gas must have an approved emergency shutoff valve. These valves must be excess flow control valves to

regulate the rate of flow of hazardous materials in the piping system, fail-safe valves or other approved types that will operate automatically, or there must be a manual means of operation to give the fire department or other responsible persons the ability to stop the flow of hazardous materials in an emergency. The valves must be readily accessible and comply with Section 5003.2.2.1. Also see the commentary to the definitions of “Emergency shutoff valve,” “Emergency shutoff valve, manual” and “Emergency shutoff valve, automatic” in Section 202.

**6303.1.2.1 Shutoff at source.** A manual or automatic fail-safe emergency shutoff valve shall be installed on supply piping at the cylinder or bulk source. Manual or automatic cylinder valves are allowed to be used as the required emergency shutoff valve where the source of supply is limited to unmanifolded cylinder sources.

❖ Where the source of the gas is limited to “cylinder sources” that are not manifolded, the shutoff valve can be the cylinder valve itself. If cylinders are manifolded or if the source is other than cylinders, an independent shutoff valve is required to be installed on the piping system.

**6303.1.2.2 Shutoff at point of use.** A manual or automatic emergency shutoff valve shall be installed on the supply piping at the point of use or at a point where the equipment using the gas is connected to the supply system.

❖ Emergency shutoff valves at the point of use are to be installed on the supply piping either at the use point or where equipment is connected. Either manual or automatic valves are allowed to be used. For example, it is common in some installations to have gas piped to a room for use with portable or fixed equipment. Emergency shutoff valves are typically provided at the point where the piping first enters the room. Equipment may not be connected to the valve; however, the valve represents the point of connection for use. When equipment is connected to the supply system, a valve that isolates the equipment is required. It may or may not be the same valve as that used at the point of penetration. Either valve is allowed to be manual or automatic, and either valve serves as an emergency shutoff valve.

**6303.1.3 Ignition source control.** Ignition sources in areas containing oxidizing gases shall be controlled in accordance with Section 5003.7.

❖ Given the fact that oxidizers enhance or accelerate the combustion process, ignition sources, such as smoking and open flames, must be strictly controlled in oxidizer storage or use areas in accordance with the provisions of Section 5003.7 to reduce the likelihood of a fire involving the stored material.

**6303.2 Class 1 oxidizer storage configuration.** The storage configuration of Class I liquid and solid oxidizers shall be as set forth in Table 6303.2.

❖ See the commentary to Table 6303.2.

**TABLE 6303.2  
STORAGE OF CLASS 1 OXIDIZER LIQUIDS AND SOLIDS**

STORAGE CONFIGURATION	LIMITS (feet)
Piles	
Maximum width	24
Maximum height	20
Maximum distance to aisle	12
Minimum distance to next pile <sup>a</sup>	4
Minimum distance to walls <sup>b</sup>	2
Maximum quantity per pile	200 tons
Maximum quantity per building	No Limit

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg, 1 ton = 0.907185 metric ton.

a. The minimum aisle width shall be equal to the pile height, but not less than 4 feet and not greater than 8 feet.

b. There shall be no minimum distance from the pile to a wall for amounts less than 9,000 pounds.

❖ Class 1 oxidizers are the least susceptible to spontaneous reactions at elevated temperatures (such as from exposure fires). The limitations of Table 6303.2 apply to Class 1 oxidizers in containers and packages. Combustible containers such as fiber drums, cardboard or plastic boxes, paper or plastic bags and plastic bottles or jugs are common packaging materials for oxidizers. Expanded polystyrene foam and other plastic and cellulosic combustible materials are also commonly used as packing materials. Noncombustible containers, such as glass jugs and bottles, are common containers but are usually shipped in combustible packing materials and boxes to prevent damage. Occasionally, some materials may be shipped or stored in metal drums. Whenever possible, materials should be kept in original shipping containers to prevent spillage or contamination.

**SECTION 6304  
STORAGE**

**6304.1 Indoor storage.** Indoor storage of oxidizing materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) shall be in accordance with Sections 5001, 5003 and 5004 and this chapter.

❖ This section regulates the indoor storage of oxidizing materials when quantities are in excess of the MAQ and classified in Occupancy Group H. The general and storage provisions of Chapter 50 are applicable in addition to the requirements of this section. Storage of oxidizing materials inside structures must comply with Sections 6304.1.1 through 6304.2.4 to

prevent uncontrolled release or exposure to conditions that may result in a fire or explosion.

**6304.1.1 Explosion control.** Indoor storage rooms, areas and buildings containing Class 4 liquid or solid oxidizers shall be provided with explosion control in accordance with Section 911.

❖ Because of the possibility of a deflagration or detonation in the event of ignition of oxidizers, explosion relief venting meeting the requirements of Section 911 must be installed to protect the storage building or structure from collapse.

**6304.1.2 Automatic sprinkler system.** The *automatic sprinkler system* for oxidizer storage shall be designed in accordance with NFPA 400.

❖ This section, as with all of Section 6304.1, is applicable to oxidizer storage buildings or portions of buildings classified in Occupancy Group H. Section 903.2.5.1 generally requires that sprinklers be installed throughout the Group H occupancy in accordance with Section 903.3.1.1. Because of the unique fire protection challenges presented by the storage of liquid and solid oxidizers, this section mandates that the sprinkler design for oxidizer storage be in accordance with NFPA 400, which includes special sprinkler design densities based on the class of oxidizer being protected and the manner of storage. These requirements are also duplicated in NFPA 13.

Note that only the sprinkler design criteria contained in NFPA 400 may be used because the rest of the standard is not included in the reference and, therefore, would not be applicable. See the commentary to Section 102.7 for further discussion of the limitations on the use of referenced standards.

**6304.1.3 Liquid-tight floor.** In addition to Section 5004.12, floors of storage areas for liquid and solid oxidizers shall be of liquid-tight construction.

❖ Floors and sills of rooms or areas used to contain hazardous material spills must be liquid tight to prevent the flow of liquids to adjoining areas (see commentary, Section 5004.2). The floor surface should be compatible with the oxidizer materials to be retained and must be noncombustible, as required by Section 5004.12.

**6304.1.4 Smoke detection.** An *approved* supervised smoke detection system in accordance with Section 907 shall be installed in liquid and solid oxidizer storage areas. Activation of the smoke detection system shall sound a local alarm.

**Exception:** Detached storage buildings protected by an *approved* automatic fire-extinguishing system.

❖ An automatic fire detection system with central, remote or proprietary station supervision and a local alarm signal is required for early warning of fire to building occupants and fire suppression personnel.

Detectors and installation methods in oxidizer storage areas must be selected for compatibility with the materials stored. Fire alarm equipment and installation methods must comply with Section 907. Materials that emit strong vapors may interfere with fire detection system components or trigger nuisance alarm signals. The required local alarm is intended to alert the occupants in the immediate vicinity of the storage area to a potentially hazardous condition. The alarm is not intended to be part of an evacuation alarm system for the entire structure.

The exception indicates that automatic fire detection is not required in detached storage buildings where there is an automatic fire suppression system. Automatic sprinklers or approved alternative fire-extinguishing systems reduce the danger to people and property from fire by detecting the fire, sounding an alarm, transmitting the alarm to the fire department and suppressing the fire.

Fire-extinguishing systems in detached storage buildings must be supervised by connection to a central station, a remote supervising station or a proprietary supervising station or, when approved by the fire code official, connected to a system that produces an audible and visual signal monitored at a constantly attended on-site location. See the commentary to Section 903.4 for further discussion of sprinkler system supervision, and Section 904.3.5 for further discussion of alternative automatic fire-extinguishing system supervision.

**6304.1.5 Storage conditions.** The maximum quantity of oxidizers per building in storage buildings shall not exceed those quantities set forth in Tables 6304.1.5(1) through 6304.1.5(3).

The storage configuration for liquid and solid oxidizers shall be as set forth in Table 6303.2 and Tables 6304.1.5(1) through 6304.1.5(3).

Class 2 oxidizers shall not be stored in *basements* except where such storage is in stationary tanks.

Class 3 and 4 oxidizers in amounts exceeding the *maximum allowable quantity per control area* set forth in Section 5003.1 shall be stored on the ground floor only.

❖ This section covers storage requirements related to the hazards of oxidizers stored in storage structures. MAQs of oxidizers and their arrangement in the building must comply with Tables 6304.1.5(1) through (3).

Because of the moderate hazard of Class 2 oxidizers, they can be stored in basements, but only when contained in approved stationary tanks that comply with the applicable provisions of Section 5003.2.

Because of their greater relative hazard, storage of Class 3 and 4 oxidizers in excess of the MAQs above or below the ground floor is prohibited. The greater hazard results in more problems associated with manual fire suppression operations in below-grade areas. Ground-floor storage also facilitates fire-fighter access to the storage area.

**TABLE 6304.1.5(1)**  
**STORAGE OF CLASS 2 OXIDIZER LIQUIDS AND SOLIDS**

STORAGE CONFIGURATION	LIMITS		
	Control area storage	Group H occupancy storage	Detached storage
Piles			
Maximum width	16 feet	25 feet	25 feet
Maximum height	Note a	Note a	Note a
Maximum distance to aisle	8 feet	12 feet	12 feet
Minimum distance to next pile	Note b	Note b	Note b
Minimum distance to walls	2 feet	2 feet <sup>c</sup>	2 feet <sup>c</sup>
Maximum quantity per pile	MAQ	100 tons	100 tons
Maximum quantity per building	MAQ	2000 tons	No Limit

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg, 1 ton = 0.907185 metric ton.

- a. Maximum storage height in nonsprinklered buildings is limited to 6 feet. In sprinklered buildings see NFPA 400 for storage heights based on ceiling sprinkler protection.
- b. The minimum aisle width shall be equal to the pile height, but not less than 4 feet and not greater than 8 feet.
- c. For protection level and detached storage under 4,500 pounds, there shall be no minimum separation distance between the pile and any wall.

❖ Table 6304.1.5(1) applies equally to Class 3 oxidizers in combustible and noncombustible containers and packages in control areas, Group H storage rooms and detached storage structures. Aisle widths that are equal to the pile height, as stated in Note b, reduce the fire exposure hazard between piles and, in the event of a fire-related collapse of a pile, reduce the likelihood of a “domino” effect that could not only increase fire intensity but also completely block access to pile areas by fire suppression personnel.

**TABLE 6304.1.5(2)**  
**STORAGE OF CLASS 3 OXIDIZER LIQUIDS AND SOLIDS**

STORAGE CONFIGURATION	LIMITS		
	Control area storage	Group H occupancy storage	Detached storage
Piles			
Maximum width	12 feet	16 feet	20 feet
Maximum height	Note a	Note a	Note a
Maximum distance to aisle	8 feet	10 feet	10 feet
Minimum distance to next pile	Note b	Note b	Note b
Minimum distance to walls	4 feet	4 feet <sup>c</sup>	4 feet <sup>c</sup>
Maximum quantity per pile	NA	30 tons	100 tons
Maximum quantity per building	MAQ	1200 tons	No Limit

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg, 1 ton = 0.907185 metric ton.

- a. Maximum storage height in nonsprinklered buildings is limited to 6 feet. In sprinklered buildings see NFPA 400 for storage heights based on ceiling sprinkler protection.
- b. The minimum aisle width shall be equal to the pile height, but not less than 4 feet and not greater than 8 feet.
- c. For protection level and detached storage under 2,300 pounds, there shall be no minimum separation distance between the pile and any wall.

❖ Table 6304.1.5(2) applies equally to Class 3 oxidizers in combustible and noncombustible containers and

packages in control areas, Group H storage rooms and detached storage structures. Aisle widths that are equal to the pile height, as stated in Note b, reduce the fire exposure hazard between piles and, in the event of a fire-related collapse of a pile, reduce the likelihood of a “domino” effect that could not only increase fire intensity but also completely block access to pile areas by fire suppression personnel.

**TABLE 6304.1.5(3)**  
**STORAGE OF CLASS 4 OXIDIZER LIQUIDS AND SOLIDS**

STORAGE CONFIGURATION	LIMITS (feet)
Piles	
Maximum length	10
Maximum width	4
Maximum height	8
Minimum distance to next pile	8
Maximum quantity per building	No Limit

For SI: 1 foot = 304.8 mm.

❖ Table 6304.1.5(3) applies to the storage of Class 4 oxidizers in quantities greater than the exempt amounts specified in Table 5003.1.1(1). Aisle widths that are equal to the pile height, as required in the table, reduce the fire exposure hazard between piles and, in the event of a fire-related collapse of a pile, reduce the likelihood of a “domino” effect that could not only increase fire intensity but also completely block access to pile areas by fire suppression personnel.

**6304.1.6 Separation of Class 4 oxidizers from other materials.** In addition to the requirements in Section 5003.9.8, Class 4 oxidizer liquids and solids shall be separated from other hazardous materials by not less than a 1-hour *fire barrier* or stored in hazardous materials storage cabinets.

❖ Above all else, oxidizers must be kept away from flammable and combustible liquids and explosive materials. Other chemicals may also react violently with some oxidizers and some oxidizers will react with other oxidizers. For example, triazinetriones (chlorinated isocyanurates) are incompatible with hypochlorites. Materials should be checked for compatibility before storage arrangements are approved. See the MSDS for each product for guidance on compatibility.

Class 4 oxidizers must be stored in separate hazardous materials storage cabinets or in rooms separated from other storage areas by 1-hour fire-resistance-rated construction.

**6304.1.7 Contamination.** Liquid and solid oxidizers shall not be stored on or against combustible surfaces. Liquid and solid oxidizers shall be stored in a manner to prevent contamination.

❖ Combustible surfaces may be ignited in the event of a spill or uncontrolled release of oxidizing material, including its vapors. Protective floor and wall coverings should be checked for compatibility with the oxidizing materials even if the underlying material is

compatible. Noncombustible materials, such as unprotected ferrous metals, may corrode or react violently in the presence of certain oxidizing materials. For example, concentrated hydrogen peroxide (greater than 52-percent solution) may produce a violent decomposition reaction in contact with iron, copper, chromium, brass, bronze, lead, silver and manganese. The corrosive effects of many oxidizers may also damage concrete surfaces.

**6304.1.8 Detached storage.** Storage of liquid and solid oxidizers shall be in detached buildings where required by Section 5003.8.2.

❖ Section 5003.8.2 and Table 5003.8.2 require detached storage for Class 4 oxidizer solids and liquids when the MAQ is exceeded. See the commentary to Section 5003.8.2 and Table 5003.8.2.

**6304.1.8.1 Separation distance.** Detached storage buildings for Class 4 oxidizer liquids and solids shall be located not less than 50 feet (15 240 mm) from other hazardous materials storage.

❖ When the MAQ is exceeded for Class 4 oxidizer liquids and solids, the occupancy group is Group H-1, the same as for explosives. The minimum separation distance specified is intended to reduce the effects of radiant heat or physical damage exposure in the event of a fire or explosion in a detached storage building.

**6304.2 Outdoor storage.** Outdoor storage of oxidizing materials in amounts exceeding the *maximum allowable quantities per control area* set forth in Table 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5004 and this chapter. Oxidizing gases shall also comply with Chapter 53.

❖ This section regulates the outdoor storage of oxidizing materials when in excess of the MAQ established by Table 5003.1.1(3). The general and storage provisions of Chapter 50 are applicable in addition to the requirements of this section. Storage of oxidizing materials in outdoor control areas must comply with Sections 6304.2.1 through 6304.2.4 to prevent uncontrolled release or exposure to conditions that may result in a fire or explosion. In addition to the requirements of this chapter, oxidizing compressed gases are subject to the requirements of Chapter 53.

**6304.2.1 Distance from storage to exposures for oxidizing gases.** Outdoor storage areas for oxidizing gases shall be located in accordance with Table 6304.2.2.

❖ Table 6304.2.1 contains separation distances for outdoor storage of oxidizing gases that are intended to minimize radiant heat transfer and fire spread between exposures.

**TABLE 6304.2.1.** See page 63-8.

❖ Table 6304.2.1 establishes spatial separation (or alternative) safeguards required for the outside storage of oxidizing compressed gases when in excess of the outside storage MAQ shown in Table 5003.1.1(3).

The required separation distance is intended to minimize radiant heat transfer between exposures. Separation distances provide a measure of protection against the possibility of fire spread in the event of a fire involving the stored material or an incident involving another exposure, such as a building on the same or an adjacent lot, or a vehicle in the public right-of-way. IBC Section 414.6 contains additional protection requirements for outside storage conditions in areas that are provided with an overhead roof structure or canopy to protect the materials from the weather.

Note a allows encroachment on property lines, public streets, public ways, etc., through the use of a protective 2-hour fire barrier (constructed as required by IBC Section 707, which acts as a shield between the storage and the exposure. The note recognizes that a 2-hour fire-barrier wall provides an equivalent means of achieving the objective of spatial separation. Where a separation assembly is used instead of a physical separation distance, the wall must extend vertically beyond the roof or wall opening of the larger structure on each side (top and sides) to prevent a fire from lapping over or extending around the wall and must be arranged to prevent hazardous accumulation of gas.

**6304.2.1.1 Oxidizing cryogenic fluids.** Outdoor storage areas for oxidizing *cryogenic fluids* shall be located in accordance with Chapter 55.

❖ This section indicates that outdoor storage areas for oxidizing cryogenic fluids are subject to the outdoor storage requirements found in Section 5504.3.

**6304.2.2 Storage configuration for liquid and solid oxidizers.** Storage configuration for liquid and solid oxidizers shall be in accordance with Table 6303.2 and Tables 6304.1.5(1) through 6304.1.5(3).

❖ The outside storage arrangements for liquid and solid oxidizers are the same as for inside storage arrangements contained in Section 6304.1.8 and its referenced tables (see commentary, Section 6304.1.8).

**6304.2.3 Storage configuration for oxidizing gases.** Storage configuration for oxidizing gases shall be in accordance with Table 6304.2.2.

❖ To minimize radiant heat transfer and fire spread between exposures, Table 6304.2.2 contains separa-

tion distances for the outdoor storage of oxidizer gases when in excess of the outside storage MAQ shown in Table 5001.1.1(3).

**SECTION 6305  
USE**

**6305.1 Scope.** The use of oxidizers in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) or 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5005 and this chapter. Oxidizing gases shall also comply with Chapter 53.

❖ This section applies to all indoor and outdoor dispensing, use and handling of oxidizers when these amounts are in excess of the MAQ per indoor or outdoor control area indicated in Table 5003.1.1(1) or 5003.1.1(3), respectively. The administrative, general use, handling and dispensing provisions of Chapter 50 are applicable in addition to the requirements of this chapter.

Once the MAQs of oxidizers per control area have been exceeded, indoor areas where materials are being dispensed, used or handled must be located in a building or portion of a building complying with the IBC for a Group H occupancy as a result of the increased hazards associated with quantity.

Although no occupancy group is assigned to them, outside oxidizer use areas must have an increased level of regulation when quantities exceed the MAQs per outdoor control area listed in Table 5003.1.1(3). Corresponding MAQs recognize that an open-use condition is generally more hazardous than a closed-use condition because the oxidizer is more directly exposed to the surrounding environment and can become more readily involved in an incident than if totally confined. The MAQs for use are based on the aggregate quantity in both use and storage being within the MAQs listed for storage.

**SECTION 6306  
LIQUID OXYGEN IN HOME HEALTH CARE**

**6306.1 General.** The storage and use of liquid oxygen (LOX) in home health care in Group I-1, I-4 and R occupancies shall

**TABLE 6304.2.1  
OXIDIZER GASES—DISTANCE FROM STORAGE TO EXPOSURES<sup>a</sup>**

QUANTITY OF GAS STORED (cubic feet at NTP)	DISTANCE TO A BUILDING NOT ASSOCIATED WITH THE MANUFACTURE OR DISTRIBUTION OF OXIDIZING GASES OR PUBLIC WAY OR LOT LINE THAT CAN BE BUILT UPON (feet)	DISTANCE BETWEEN STORAGE AREAS (feet)
0 – 50,000	5	5
50,001 – 100,000	10	10
100,001 or greater	15	10

For SI: 1 foot = 304.8 mm, 1 cubic foot = 0.02832 m<sup>3</sup>.

a. The minimum required distances shall not apply where fire barriers without openings or penetrations having a minimum fire-resistance rating of 2 hours interrupt the line of sight between the storage and the exposure. The configuration of the fire barrier shall be designed to allow natural ventilation to prevent the accumulation of hazardous gas concentrations.

comply with Sections 6306.2 through 6306.6, or shall be stored and used accordance with Chapter 50.

❖ As the population ages, the use of LOX in home health care settings is expected to increase. Section 6306 was developed in response to changes in technology that improve the care of patients with respiratory ailments in their own homes allowing them to utilize a LOX ambulatory care container and to be able to refill it from a LOX home care container. Section 6306 will enhance public safety by establishing minimum requirements for LOX storage and use in the occupancies where the material is most frequently encountered. In addition, Section 6306 requires that the suppliers provide a reasonable level of information regarding safeguards to be supplied by the users, and fills a void in the code that has been characterized by a growing concern and “need to know” expressed by the code enforcement community. There may be certain circumstances that make compliance with the provisions of Section 6306 impractical or impossible, in which case, the provisions of Chapters 50 and 55 of the code would be applicable.

**6306.2 Information and instructions to be provided.** The seller of liquid oxygen shall provide the user with information in written form that includes, but is not limited to, the following:

1. Manufacturer’s instructions and labeling for safe storage and use of the containers.
2. Locating containers away from ignition sources, *exits*, electrical hazards and high-temperature devices in accordance with Section 6306.3.3.
3. Restraint of containers to prevent falling in accordance with Section 6306.3.4.
4. Requirements for handling containers in accordance with Section 6306.3.5.
5. Safeguards for refilling containers in accordance with Section 6306.3.6.
6. Signage requirements in accordance with Section 6306.6.

❖ This section requires that the LOX purveyor provide the customer with written, basic instructions on the safe storage, use, handling and refilling of LOX containers.

**6306.3 Liquid oxygen home care containers.** Containers of liquid oxygen in home health care shall be in accordance with Sections 6306.3.1 through 6306.3.6.

❖ This section introduces the requirements applicable to home health care LOX containers. See the commentary to the Chapter 2 definitions of “Liquid oxygen home care container” and “Liquid oxygen ambulatory container.”

**6306.3.1 Maximum individual container capacity.** Liquid oxygen home care containers shall not exceed an individual

capacity of 15.8 gallons (60 L) in Group I-1, I-4 and R occupancies. Liquid oxygen ambulatory containers are allowed in Group I-1, I-4 and R occupancies. Containers of liquid oxygen in home health care shall also be stored, used and filled in accordance with Section 6306 and Sections 5503.1 and 5503.2.

❖ The sizes of LOX ambulatory and health care containers in Group I-1, I-4 and R occupancies are limited to 0.396 gallons (0.75 L) and 15.8 gallons (60 L), respectively, as established in the definitions in Section 6302.1 and by this section. It is necessary to establish container size limits because there has been a trend to increase the size of the containers delivered to the user, in some cases, simply in order to avoid more frequent deliveries. If it is necessary to have individual containers larger than the limits established here, then the MAQ and control area concept set forth in Chapter 50 will apply. The general requirements of Chapter 55 for containers and their pressure relief devices are also applicable to these containers.

**6306.3.2 Manufacturer’s instructions and labeling.** Containers shall be stored, used and operated in accordance with the manufacturer’s instructions and labeling.

❖ Compliance with the LOX container manufacturer’s storage, use and operating instructions is a fundamental requirement consistent with all *International Codes*® and those instructions are considered an enforceable extension of the code. Federal, state, county or municipal laws might supercede part of or be applied in addition to the requirements in the instructions.

**6306.3.3 Locating containers.** Containers shall not be located in areas where any of the following conditions exist:

1. They can be overturned due to operation of a door.
2. They are in the direct path of egress.
3. They are subject to falling objects.
4. They can become part of an electrical circuit.
5. Open flames and high-temperature devices can cause a hazard.

❖ The requirements in this section ensure that LOX home care and ambulatory containers are not located in areas where they can be damaged, near sources of ignition or in the direct path of egress. Home care and ambulatory containers must be located so that they are protected from being overturned resulting from the impact of a door or from falling objects, such as a bookshelf. Containers are not allowed to be located in the direct path of a means of egress to avoid damage to containers or injury to occupants egressing the area. Containers also must be located so they cannot become part of an electrical circuit or near open flames or high-temperature devices.

**6306.3.4 Restraining containers.** Liquid oxygen home care containers shall be restrained while in storage or use to prevent falling caused by contact, vibration or seismic activity. Containers shall be restrained by one of the following methods:

1. Restraining containers to a fixed object with one or more restraints.
  2. Restraining containers within a framework, stand or assembly designed to secure the container.
  3. Restraining containers by locating a container against two points of contact such as the walls of a corner of a room or a wall and a secure furnishing or object such as a desk.
- ❖ To avoid physical damage to the containers and to protect the user from injury due to falling containers, LOX home care containers are required to be restrained. This section specifies three approved methods of restraint to prevent a home care container from being overturned due to mechanical impact or a seismic event.

**6306.3.5 Container handling.** Containers shall be handled by use of a cart or hand truck designed for such use.

**Exceptions:**

1. Liquid oxygen home care containers equipped with a roller base.
  2. Liquid oxygen ambulatory containers are allowed to be hand carried.
- ❖ This section requires that if containers are moved, to avoid damage due to dropping or upset, they must be transported using a cart or hand truck suitable for the purpose. Because the level of stability and efficiency in container moving is provided by roller bases that are made for the container, Exception 1 exempts LOX home care containers equipped with rollers or caster wheels in their bases. Exception 2 recognizes that some ambulatory containers are made for portability and are hand carried.

**6306.3.6 Filling of containers.** The filling of containers shall be in accordance with Sections 6306.3.6.1 through 6306.3.6.3.

❖ This section introduces the following requirements applicable to the filling of home health care LOX containers.

**6306.3.6.1 Filling location.** Liquid oxygen home care containers and ambulatory containers shall be filled outdoors.

**Exception:** Liquid oxygen ambulatory containers are allowed to be filled indoors where the supply container is specifically designed for filling such containers and written instructions are provided by the container manufacturer.

❖ A requirement for filling LOX home care and ambulatory containers outdoors is specified in this section. The exception allows ambulatory LOX containers to be filled indoors, provided the supply container is designed for the filling of such containers by the

patient or other individuals and written instructions for the proper filling of these containers are provided by the home care container manufacturer.

**6306.3.6.2 Incompatible surfaces.** A drip pan compatible with liquid oxygen shall be provided under home care container fill and vent connections during the filling process in order to protect against liquid oxygen spillage from coming into contact with combustible surfaces, including asphalt.

❖ This section requires the use of a LOX-compatible drip pan located beneath the container to prevent any spilled LOX from contacting surfaces whose combustibility would be greatly enhanced by contact with the LOX. Asphalt surfaces are especially problematic because LOX that contacts asphalt can act as a contact explosive, resulting in a low-pressure explosion.

**6306.3.6.3 Open flames and high-temperature devices.** The use of open flames and high-temperature devices shall be in accordance with Section 5003.7.2.

❖ During LOX container filling operations, open flame sources and high-temperature devices must be separated from home care and ambulatory containers in accordance with Section 5003.7.2 (see commentary, Section 5003.7.2).

**6306.4 Maximum aggregate quantity.** The maximum aggregate quantity of liquid oxygen allowed in storage and in use in each *dwelling unit* shall be 31.6 gallons (120 L).

**Exceptions:**

1. The maximum aggregate quantity of liquid oxygen allowed in Group I-4 occupancies shall be limited by the maximum allowable quantity set forth in Table 5003.1.1(1).
  2. Where individual sleeping rooms are separated from the remainder of the *dwelling unit* by *fire barriers* constructed in accordance with Section 707 of the *International Building Code*, and *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both, having a minimum *fire-resistance rating* of 1 hour, the maximum aggregate quantity per *dwelling unit* shall be increased to allow not more than 31.6 gallons (120 L) of liquid oxygen per sleeping room.
- ❖ This section establishes a maximum aggregate amount of 31.6 gallons (120 L) inside of each dwelling unit. This allows for one container to be in use and an additional cylinder in storage.
- Exception 1 further requires that the total amount of LOX stored indoors in Group I-4 occupancies not exceed the MAQ for cryogenic oxidizing liquids specified in Table 5003.1.1(1). That table establishes an MAQ for LOX of 45 gallons (170.3 L) in a one-story, Group I-4 occupancy constructed as a single control area and allows the quantity to be increased by 100 percent if the building is protected throughout by an approved automatic sprinkler system complying with NFPA 13. Additional amounts of LOX are permitted if it is stored in approved hazardous materials storage cabinets or if a Group I-4 occupancy is constructed

with additional control areas. Keep in mind that even though these occupancies may be equipped with automatic sprinklers, the ability to increase the MAQ by 100 percent in Table 5003.1.1(1) is only applicable when the sprinkler system is designed in accordance with NFPA 13. Designs in accordance with NFPA 13D or 13R would not qualify for an increase.

Exception 2 permits a maximum of 31.6 gallons (120 L) of LOX in an individual sleeping room when the room is separated from the remainder of the dwelling unit by 1-hour fire-resistance-rated fire barriers and horizontal assemblies constructed in accordance with the requirements in IBC Chapter 7.

**6306.5 Smoking prohibited.** Smoking shall be prohibited in rooms or areas where liquid oxygen is in use.

❖ Smoking is a significant ignition source and LOX is a hazardous material that can enhance the burning rate of combustible materials. Smoking is therefore prohibited in all areas where LOX is in use (also see commentary, Sections 310 and 6306.6.1).

**6306.6 Signs.** Warning signs for occupancies using home health care liquid oxygen shall be in accordance with Sections 6306.6.1 and 6306.6.2.

❖ This section introduces the requirements for warning signs applicable to home health care LOX storage, use or transfer.

**6306.6.1 No smoking sign.** A sign stating “OXYGEN—NO SMOKING” shall be posted in each room or area where liquid oxygen containers are stored, used or filled.

❖ Since smoking is prohibited by Section 6306.5, it is reasonable to provide appropriate warning signs in each room where LOX is stored, used or transferred stating that smoking is banned (see Section 310 for additional requirements for these signs).

**6306.6.2 Premises signage.** Where required by the *fire code official*, each *dwelling unit* or *sleeping unit* shall have an *approved* sign indicating that the unit contains liquid oxygen home care containers.

❖ When the fire code official deems it necessary, this section authorizes him or her to require a sign for each sleeping or dwelling unit to identify the presence of LOX to fire fighters. During the development of Section 6306, concern was expressed that there could be privacy and personal safety issues in placing such signage in public spaces. Accordingly, this section should be applied judiciously and sparingly, and only when absolutely essential to fire-fighter safety.

**6306.7 Fire department notification.** Where required by the *fire code official*, the liquid oxygen seller shall notify the fire department of the locations of liquid oxygen home care containers.

❖ This section requires the seller of the LOX to notify the fire code official of the locations where LOX is being used for home health care. Note that this section is only applicable when it is required by the fire

code official. Some jurisdictions may not want this information due to the potentially large volume of information involved or the lack of resources to process it.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

21 USC Chapter 9, *Federal Food, Drug and Cosmetic Act*. Washington, DC: U.S. Government Printing Office, 2007.

*Code Changes Resource Collection—2015 International Fire Code*. Washington, DC: International Code Council, 2014.

DOTn 49 CFR; 100-178-94, *Hazardous Materials Regulations*. Washington, DC: U.S. Department of Transportation, 1994.

Holtzclaw, H.F and W.R. Robinson. *General Chemistry*, 8th ed. Lexington, MA: DC Heath and Co., 1988.



# Chapter 64: Pyrophoric Materials

## General Comments

Because of their capacity to ignite spontaneously at low temperatures, pyrophoric materials pose unusual deflagration and detonation hazards to building occupants and fire-fighting personnel. Advance knowledge of the materials present in the building through the issuance of permits and the submittal of Material Safety Data Sheets (MSDS), as noted in Section 407, are essential for effective preplanning by the fire department. The ability to fight fires involving pyrophoric materials may be somewhat limited since many pyrophoric materials are also highly reactive with water. Interior fire fighting may not be an option unless adequate alternative extinguishing agents are available.

Some flammable liquids may also be considered pyrophoric liquids. Diethylzinc, for example, is considered a pyrophoric liquid in accordance with NFPA 49 (found in the NFPA *Fire Protection Guide to Hazardous Materials*), but has a U.S. Department of Transportation (DOT) classification as a flammable liquid. Since this material is known to ignite spontaneously when exposed to air, the multiple hazards of being both pyrophoric and flammable must be addressed.

Alkali metals, such as sodium, potassium and lithium, are examples of pyrophoric solids. Most of these reactive metals are not found free in nature, but are combined with other elements. Sodium, for example, burns violently and ignites spontaneously when exposed to moist air. Sodium that comes in contact with water may be accompanied by hydrogen explosions.

Diborane and phosphine are pyrophoric gases that must comply with the provisions of this chapter as well as those of Chapter 53.

The proper classification of materials as pyrophoric is essential to providing adequate means of hazard mitigation. Pyrophoric materials, as indicated earlier, may also pose multiple hazards similar to flammable liquids, flammable solids and water-reactive materials.

In previous editions of the code, there were extensive regulations in Section 6406 for silane gas tetrahydride ( $\text{SiH}_4$ ); CAS No. 7803-62-5], a common but dangerous pyrophoric gas that is also classified as unstable (reactive)(see commentary, Chapter 66). Due to the development of a standard for its storage and handling, this chapter now regulates silane by reference to the applicable Compressed Gas Association (CGA) standard, G-13. Silane gas or mixtures of silane gas are commonly found in the semiconductor and photovoltaic cell manufacturing processes and allied industries. Silane gas is distributed at 100-percent concentration or it can be distributed as a mixture with other gases, such as various concentrations of silane mixed with nitrogen or hydro-

gen. This chapter only addresses silane gas or mixtures of silane gas that behave as a pyrophoric and flammable gas.

Silane is classified as a pyrophoric material and a Class 1 Unstable (reactive) compressed gas. It can autoignite or spontaneously ignite when it is exposed to air without any source of ignition. Silane has a lower flammable limit of 1.37 percent by volume in air. It begins to exhibit pyrophoric characteristics at about 4.5 percent volume in air. Silane is a unique hazardous material in that it is also metastable, meaning that it can have delayed ignition. This metastable characteristic is dangerous because it allows a volume of gas to accumulate inside of a building. In such cases, a deflagration can occur, which can cause structural damage to buildings, injure or kill individuals located close to the release, and complicate the emergency response due to its potential energy. It is for this reason that Section 911.1 and Table 911.1 require deflagration venting when the amount of silane stored inside of buildings exceeds its maximum allowable quantity.

Because of silane's importance in the manufacturing of semiconductors and photovoltaic products and its increased use, manufacturers of silane in conjunction with its users have performed extensive testing of this hazardous material. These tests, along with incident experiences and peer-reviewed scientific data, resulted in the development of the 2006 edition of ANSI/CGA Standard G-13, *Storage and Handling of Silane and Silane Mixtures*.

Excluding the introduction, scope, definitions and references, CGA G-13 is divided into 14 sections. These sections address the following:

- Physical and chemical properties of silane.
- Requirements for its proper indoor and outdoor storage.
- Configuration of the piping, valves and fitting.
- Packaging of silane, gas and flame detection systems.
- Fire protection.
- Ventilation.
  - Purge gas systems.
  - Electrical installation requirements.
  - Supervisory controls of mechanical ventilation, gas monitoring and flame detection systems.

The standard also contains four informational appendices that address protective equipment required for personnel working on silane systems, the compressibility of silane, minimum separation distances from silane

storage to certain thermal flux (e.g., radiant energy) exposures and blast overpressure.

The requirements for outdoor storage are based on a series of silane release tests and the development of a mathematic model that were sponsored by the CGA. During these tests silane was released from DOT tube trailers, International Standards Organization (ISO) module packs (which are another form of bulk compressed packaging), and containers with a volume of more than 16 cubic feet (450 L). The testing results were used in the development of requirements for separation distances of cylinders and large bulk sources of silane.

For cylinders with a volume of less than 16 cubic feet (450 L), CGA G-13 requires the outdoor separation distance to be established based on the volume of silane gas in each nest of compressed gas cylinders (see Chapter 2 for the definition of "Nesting"). The separation distances are intended to limit the thermal flux of the radiation produced by a silane jet fire and are limited based on the volume of each cylinder in each nest and if the cylinder is constructed of steel, fiber overwrapped aluminum or aluminum.

For bulk storage containers including silane tube trailers, ISO modules and containers greater than 450 liters (16 cubic feet) in volume, the CGA standard establishes minimum separation distances to protect exposures from the energy of a 0.5 psig (3.44 kPa) blast overpressure. Blast overpressure is the pressure above the ambient pressure that is manifested in the shock wave of a deflagration or a detonation. The threshold of 0.5 psig (3.44 kPa) value was chosen as the acceptable level of blast overpressure for both buildings and occu-

pants because a frame structure can normally withstand that level of external force with no serious structural damage, and it is unlikely that human beings inside the building would normally suffer any serious injury.

The separation distances from the exposures are based on the stored pressure within the bulk containers or cylinders and the diameter of the pressure relief device. CGA G-13 limits the maximum pressure in the bulk containers or cylinders to 1,600 psig (11 032 kPa) and requires minimum separation distances from a bulk silane source and exposures.

CGA G-13 also contains extensive requirements for the indoor storage and use of silane. It is important to note that some of the requirements of CGA G-13 exceed the requirements of former Section 4106, which was deleted in the 2012 edition of the code.

### Purpose

This chapter regulates the hazards associated with pyrophoric materials, which are capable of spontaneously igniting in the air at or below a temperature of 130°F (54°C). Many pyrophoric materials also pose severe flammability or reactivity hazards. This chapter addresses only the hazards associated with pyrophoric materials. Other materials that pose multiple hazards must conform to the requirements of the code with respect to all hazards (see Section 5001.1). Strict compliance with the provisions of this chapter, along with proper housekeeping and storage arrangements, can reduce the exposure hazards associated with the involvement of pyrophoric materials in a fire or other emergency.

## SECTION 6401 GENERAL

**6401.1 Scope.** The storage and use of pyrophoric materials shall be in accordance with this chapter. *Compressed gases* shall also comply with Chapter 53.

❖ This chapter details specific requirements for the storage of pyrophoric materials. The requirements of this chapter are intended to complement the general requirements for hazardous materials in Chapter 50. Pyrophoric gases are also regulated by Chapter 53. The classification of pyrophoric materials is based on the definition indicated in Section 202, which is derived from DOL 29 CFR; Part 1910.1200.

**6401.2 Permits.** Permits shall be required as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is

issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit, Section 105.6.21 for discussion of specific quantity-based operational permits for the materials regulated in this chapter and Section 105.7 for a general discussion of activities requiring a construction permit.

The permit process also notifies the fire department of the need for prefire planning for hazardous property.

## SECTION 6402 DEFINITION

**6402.1 Definition.** The following term is defined in Chapter 2:

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❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper

application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*® as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4).

## SECTION 6403 GENERAL REQUIREMENTS

**6403.1 Quantities not exceeding the maximum allowable quantity per control area.** The storage and use of pyrophoric materials in amounts not exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Sections 5001, 5003, 6401 and 6403.

❖ The provisions of this section complement the requirements of Chapter 50 for structures occupied for the storage, handling or use of pyrophoric materials. The general requirements of Sections 5001 and 5003, in addition to the provisions of this chapter, are fully applicable to the storage and use of organic peroxides.

**6403.1.1 Emergency shutoff.** *Compressed gas* systems conveying pyrophoric gases shall be provided with *approved* manual or automatic emergency shutoff valves that can be activated at each point of use and at each source.

❖ To provide control over the flow of pyrophoric gases under emergency conditions, each supply source as well as each point of use of pyrophoric compressed gas must be equipped with an approved emergency shutoff valve. These are excess flow control valves that regulate the rate of flow of hazardous materials in the piping system, fail-safe valves or other approved types that will operate automatically or manually to give the fire department or other responsible persons the ability to stop the flow of hazardous material in an emergency. The valves must be readily accessible and comply with Section 5003.2.2.1. See also the commentary to the definitions of “Emergency shutoff valve,” “Emergency shutoff valve, manual” and “Emergency shutoff valve, automatic” in Section 202.

**6403.1.1.1 Shutoff at source.** An automatic emergency shutoff valve shall be installed on supply piping at the cylinder or bulk source. The shutoff valve shall be operated by a remotely located manually activated shutdown control located not less than 15 feet (4572 mm) from the source of supply. Manual or automatic cylinder valves are allowed to be used as the required emergency shutoff valve where the source of supply is limited to unmanifolded cylinder sources.

❖ This section requires that an automatic emergency shutoff valve be provided on pyrophoric compressed gas systems activated by a remotely located, manually activated control. A minimum distance of 15 feet (4572 mm) has been specified to provide reasonable separation distance between the control and the source as a means to protect persons using the con-

trol from radiant heat in a fire event. When the source of supply is limited to unmanifolded cylinders, the cylinder valve is allowed to be either manual or automatic.

**6403.1.1.2 Shutoff at point of use.** A manual or automatic emergency shutoff valve shall be installed on the supply piping at the point of use or at a point where the equipment using the gas is connected to the supply system.

❖ Emergency shutoff valves at the point of use are to be installed on the supply piping either at the use point or where equipment is connected. Either manual or automatic valves are allowed to be used. For example, it is common in some installations to have gas piped to a room for use with portable or fixed equipment. Emergency shutoff valves are typically provided at the point where the piping first enters the room. Equipment may not be connected to the valve; however, the valve represents the point of connection for use. When equipment is connected to the supply system, a valve that isolates the equipment is required. It may or may not be the same valve as that used at the point of penetration. Either valve is allowed to be manual or automatic, and either valve serves as an emergency shutoff valve.

**6403.2 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of pyrophoric materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Chapter 50 and this chapter.

❖ This section complements the requirements of Chapter 50 for structures used for the storage, handling or use of pyrophoric materials. The regulations contained in this section assume that the quantity of pyrophoric materials in a given building is in excess of the maximum allowable quantities per control area (MAQ) as established in Section 5003.1, thus classifying the building as a Group H occupancy. The requirements of Chapter 50 apply to the storage and use of pyrophoric materials, in addition to the provisions of this chapter.

## SECTION 6404 STORAGE

**6404.1 Indoor storage.** Indoor storage of pyrophoric materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1), shall be in accordance with Sections 5001, 5003 and 5004 and this chapter.

The storage of silane gas, and gas mixtures with a silane concentration of 1.37 percent or more by volume, shall be in accordance with CGA G-13.

❖ This section regulates the indoor storage of pyrophoric materials when they exceed the MAQ in buildings or portions of buildings classified as a Group H occupancy. The general and storage provisions of Chapter 50 are applicable, in addition to the require-

ments of this section. Storage of pyrophoric materials inside of structures must comply with Sections 6404.1.1 through 6404.1.4 to prevent uncontrolled release or exposure to conditions that may result in a fire or explosion. Section 6405.3 covers silane gas use. See the commentary introduction to this chapter for a detailed discussion of silane.

**6404.1.1 Liquid-tight floor.** In addition to the requirements of Section 5004.12, floors of storage areas containing pyrophoric liquids shall be of liquid-tight construction.

❖ Floors and sills of rooms or areas used to contain hazardous material spills must be liquid tight to prevent the flow of liquids to adjoining areas (see commentary, Section 5004.2). The floor surface should be compatible with the pyrophoric materials to be retained and must be noncombustible, as required by Section 5004.12.

**6404.1.2 Pyrophoric solids and liquids.** Storage of pyrophoric solids and liquids shall be limited to a maximum area of 100 square feet (9.3 m<sup>2</sup>) per pile. Storage shall not exceed 5 feet (1524 mm) in height. Individual containers shall not be stacked.

Aisles between storage piles shall be not less than 10 feet (3048 mm) in width.

Individual tanks or containers shall not exceed 500 gallons (1893 L) in capacity.

❖ Inside storage restrictions, including pile height, container arrangement and aisle width, are intended to reduce the potential involvement of multiple piles, reduce the exposure hazard to occupants and facilitate fire department access to the storage areas. Inside storage of pyrophoric liquids in tanks or containers is limited to an individual capacity of 500 gallons (1893 L) to reduce the exposure hazard in the event of a single container failure. Prohibiting the stacking of individual containers reduces the likelihood of container failure from stacking stresses. Wide aisles reduce the fire exposure hazard between piles and, in the event of a fire-related collapse of a pile, reduce the likelihood of a “domino” effect that could not only increase fire intensity but also completely block access to pile areas by fire suppression personnel. While not specifically mentioned in this section, inside storage must also be protected as required by Chapter 50, which includes provisions for incompatible material storage, security, signage, control of ignition sources and submittal of a storage plan.

**6404.1.3 Pyrophoric gases.** Storage of pyrophoric gases shall be in detached buildings where required by Section 5003.8.2.

❖ This section is an important cross reference to Section 5004.14 and Table 5004.14. The table requires that storage of more than 2,000 cubic feet (57 m<sup>3</sup>) of pyrophoric gas must be in a detached building complying with Section 5004.14.

Detached structures designed and constructed for the sole purpose of pyrophoric material storage provide the best protection for people and property from fire and explosion. Detached storage structures should be constructed of noncombustible materials to prevent them from becoming involved in an outside fire that may endanger their contents or a fire stemming from ignited contents in storage (see the commentary to Section 5004.14 and Table 5004.14 for further discussion of detached storage requirements).

**6404.1.4 Separation from incompatible materials.** In addition to the requirements of Section 5003.9.8, indoor storage of pyrophoric materials shall be isolated from incompatible hazardous materials by 1-hour *fire barriers* with openings protected in accordance with the *International Building Code*.

**Exception:** Storage in *approved* hazardous materials storage cabinets constructed in accordance with Section 5003.8.7.

❖ This section is intended to separate all incompatible, flammable, explosive or other highly reactive materials from the inside storage areas of pyrophoric materials. A 1-hour fire barrier assembly or, as allowed by the exception, an approved hazardous materials storage cabinet can reduce the potential involvement of pyrophoric materials in a fire involving other incompatible hazardous materials. Note that the provisions of Section 6404.1.4 are to be applied in addition to the requirements of Section 5003.9.8.

**6404.2 Outdoor storage.** Outdoor storage of pyrophoric materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(3) shall be in accordance with Sections 5001, 5003 and 5004, and this chapter.

The storage of silane gas, and gas mixtures with a silane concentration of 1.37 percent or more by volume, shall be in accordance with CGA G-13.

❖ Sections 6404.2.1 and 6404.2.2 are applicable for the outdoor storage of pyrophoric materials in excess of the MAQ listed in Table 5003.1.1(3). The provisions of this section, in addition to the provisions of Sections 5001, 5003 and 5004, are applicable to outdoor areas used for the storage of pyrophoric materials because of the severity of the hazards posed by these materials. Regardless of quantity, silane gas and certain silane gas mixtures must also comply with the provisions of CGA G-13. See the commentary introduction to this chapter for a detailed discussion of silane.

**6404.2.1 Distance from storage to exposures.** The separation of pyrophoric solids, liquids and gases from buildings, *lot lines*, public streets, public alleys, *public ways* or *means of egress* shall be in accordance with the following:

1. Solids and liquids. Two times the separation required by Chapter 57 for Class IB flammable liquids.

2. Gases. The location and maximum amount of pyrophoric gas per storage area shall be in accordance with Table 6404.2.1.

- ❖ To minimize radiant heat transfer and fire spread between stored pyrophoric solid and liquid materials and the listed exposures, the values shown for Class IB flammable liquids in Table 5704.4.2 are applied and then doubled. Similarly, Table 6404.2.1 is referenced for the outdoor storage of pyrophoric gases.

**TABLE 6404.2.1.** See below.

- ❖ Table 6404.2.1 establishes the spatial separation distance (or alternative safeguards) required for the outside storage of pyrophoric compressed gases when in excess of the outside storage MAQ shown in Table 5003.1.1(3).

The required separation distance is intended to minimize radiant heat transfer between storage and exposures. Separation distances provide a measure of protection against the possibility of fire spread in the event of a fire involving either the stored material or another exposure, such as a building on the same or an adjacent lot or a vehicle in the public right-of-way. Section 414.6 of the *International Building Code*® (IBC)® contains additional protection requirements for outside storage in areas that have an overhead roof structure or canopy to protect the materials from the weather.

Note a recognizes that a 2-hour fire barrier wall (constructed in accordance with IBC Section 707), provides an equivalent means of achieving the objectives of spatial separation. Where a separation assembly is used instead of the tabular separation distance, the wall must be arranged to prevent a hazardous accumulation of gas.

**6404.2.2 Weather protection.** Where overhead construction is provided for sheltering outdoor storage areas of pyrophoric materials, the storage areas shall be provided with *approved* automatic fire-extinguishing system protection.

- ❖ The general requirements for construction of weather protection roofs over outdoor storage areas are contained in Section 5004.13 of the code and IBC Section 414.6; however, due to the hazards of pyrophoric

materials, this section is a specific provision applicable to pyrophoric materials that requires roofed-over outdoor storage areas to be sprinklered.

**SECTION 6405  
USE**

**6405.1 General.** The use of pyrophoric materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) or 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5005 and this chapter.

- ❖ This section applies to all indoor and outdoor dispensing, use and handling of pyrophoric material when the amounts being dispensed, used or handled are in excess of the MAQs per indoor or outdoor control area as indicated in Table 5003.1.1(1) or 5003.1.1(3), respectively. The administrative, general use, handling and dispensing provisions of Chapter 50 are applicable, in addition to the requirements of this chapter.

Once the MAQ of pyrophoric material has been exceeded, indoor areas where materials are being dispensed, used or handled must be located in a building or portion of a building complying with the IBC for a Group H occupancy because of the increased hazards associated with quantity.

Although no occupancy group is assigned to them, outside pyrophoric material use areas require an increased level of regulation when quantities exceed the MAQs per outdoor control area listed in Table 5003.1.1(3). Corresponding MAQs recognize that an open-use condition is generally more hazardous than a closed-use condition because the pyrophoric material is more directly exposed to the surrounding environment and can become more readily involved in an incident than if it is totally confined. The maximum allowable quantities per control area for use are based on the aggregate quantity in both use and storage not exceeding the maximum allowable quantities per control area listed for storage.

**6405.2 Weather protection.** Where overhead construction is provided for sheltering of outdoor use areas of pyrophoric

**TABLE 6404.2.1  
PYROPHORIC GASES—DISTANCE FROM STORAGE TO EXPOSURES<sup>a</sup>**

MAXIMUM AMOUNT PER STORAGE AREA (cubic feet)	MINIMUM DISTANCE BETWEEN STORAGE AREAS (feet)	MINIMUM DISTANCE TO LOT LINES OF PROPERTY THAT CAN BE BUILT UPON (feet)	MINIMUM DISTANCE TO PUBLIC STREETS, PUBLIC ALLEYS OR PUBLIC WAYS (feet)	MINIMUM DISTANCE TO BUILDINGS ON THE SAME PROPERTY		
				Nonrated construction or openings within 25 feet	Two-hour construction and no openings within 25 feet	Four-hour construction and no openings within 25 feet
250	5	25	5	5	0	0
2,500	10	50	10	10	5	0
7,500	20	100	20	20	10	0

For SI: 1 foot = 304.8 mm, 1 cubic foot = 0.02832 m<sup>3</sup>.

- a. The minimum required distances shall be reduced to 5 feet when protective structures having a minimum fire resistance of 2 hours interrupt the line of sight between the container and the exposure. The protective structure shall be at least 5 feet from the exposure. The configuration of the protective structure shall allow natural ventilation to prevent the accumulation of hazardous gas concentrations.

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materials, the use areas shall be provided with *approved* automatic fire-extinguishing system protection.

❖ The general requirements for the construction of weather protection roofs over outdoor use areas are contained in Section 5005.3.9 of the code and IBC Section 414.6; however, due to the hazards of pyrophoric materials, this section is a specific provision applicable to pyrophoric materials that requires roofed-over outdoor use areas to be sprinklered.

**6405.3 Silane gas.** The use of silane gas, and gas mixtures with a silane concentration of 1.37 percent or more by volume, shall be in accordance with CGA G-13.

❖ Regardless of quantity, the use of silane gas and certain silane gas mixtures must comply with the provisions of CGA G-13. See the commentary introduction to this chapter for a discussion of silane.

### Bibliography

The following resource material was used in the preparation of the commentary for this chapter of the code:

*Fire Protection Guide to Hazardous Materials*, 13th ed.  
Quincy, MA: National Fire Protection Association,  
2001.

# Chapter 65: Pyroxylin (Cellulose Nitrate) Plastics

## General Comments

Pyroxylin (cellulose nitrate) plastic is formulated from a combination of cellulose, nitric acid and sulfuric acid. The resulting compound, also known as pyroxylin or nitrocellulose, is an unstable and extremely combustible plastic. Once exposed to elevated temperatures, pyroxylin (cellulose nitrate) plastic is subject to spontaneous ignition. The products of combustion of pyroxylin (cellulose nitrate) plastic are extremely toxic because nitrogen oxides are produced at the elevated temperatures reached when this material burns rapidly.

Pyroxylin (cellulose nitrate) plastic, also called “gun cotton,” was discovered to be a powerful explosive and replaced common gunpowder as the explosive charge in the ammunition for rifles and artillery in World War I. Other early uses included being a replacement material for elephant tusk ivory in billiard balls (which had a tendency to explode on a hard break), as casino dice and as the laminating adhesive in early forms of automotive safety glass. It has also been used as a film base for photographic film, as well as to encase documents, book leaves, etc.; however, its flammability and the fact that it causes severe deterioration of the materials it supposedly protects has prevented its widespread use in preservation work.

Many of these products are no longer manufactured from pyroxylin (cellulose nitrate) plastic. Although it has been replaced in many applications by safer plastics, it is still used in many industrial applications such as shoe heels, housewares and lacquers.

Raw pyroxylin (cellulose nitrate) plastic is usually shipped in drums and covered with water or another solvent, usually alcohol.

Water-wet pyroxylin plastic presents the least hazard, while alcohol-wet and other types of solvent-wet pyroxy-

lin plastic possess hazards similar to those of the solvent involved. Because nitrocellulose becomes increasingly unstable as temperatures increase and may ignite easily from frictional heat, drums must never be pushed, rolled or dragged across the floor. Pyroxylin (cellulose nitrate) plastic is especially susceptible to ignition, burns vigorously once ignited (at a rate approximately 15 times that of a comparable mass of paper), produces toxic nitrogen oxides and will burn in the absence of oxygen.

## Purpose

This chapter addresses the significant hazards associated with pyroxylin (cellulose nitrate) plastics, which are the most dangerous and unstable of all plastic compounds. The chemically bound oxygen in their structure permits them to burn vigorously in the absence of atmospheric oxygen. Although these compounds produce approximately the same amount of energy when they burn as paper, pyroxylin (cellulose nitrate) plastics burn at a rate 15 times greater than comparable common combustibles. When burning, these materials release highly flammable and toxic combustion byproducts. Consequently, pyroxylin (cellulose nitrate) plastic fires are very difficult to control and must be virtually flooded to extinguish them. Even storage cabinets, which may be used only for temporary (e.g., overnight) storage of pyroxylin (cellulose nitrate) plastic films, must be sprinklered. Strict compliance with the provisions of this chapter, along with proper housekeeping and storage arrangements, help to reduce the hazards associated with pyroxylin (cellulose nitrate) plastics in a fire or other emergencies.

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## SECTION 6501 GENERAL

**6501.1 Scope.** This chapter shall apply to the storage and handling of plastic substances, materials or compounds with cellulose nitrate as a base, by whatever name known, in the form of blocks, sheets, tubes or fabricated shapes.

Cellulose nitrate motion picture film shall comply with the requirements of Section 306.

❖ This section establishes that any raw materials or finished products containing any amount of pyroxylin

(cellulose nitrate) plastic are subject to the regulations of this chapter. This is true even if the materials are called something other than pyroxylin (cellulose nitrate) plastic, such as xyloidin, collodion, photocotton, pyrocollodion, guncotton or smokeless powder. Compliance with the applicable provisions of Section 407 and Chapter 50, which include, but are not limited to, Material Safety Data Sheets (MSDS) submittal, hazard identification signs and labeling provisions, is also required. Pyroxylin (cellulose nitrate) plastic in the form of motion picture film is regulated by Section 306, as noted in this section.

**6501.2 Permits.** Permits shall be required as set forth in Section 105.6.

- ❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit; Section 105.6.39 for discussion of specific operational permits for the storage, handling or use of pyroxylin plastics; and Section 105.7 for a general discussion of activities requiring a construction permit. The permit process also notifies the fire department of the need for prefire planning for hazardous property.

## SECTION 6502 DEFINITIONS

**6502.1 Terms defined in Chapter 2.** Words and terms used in this chapter and defined in Chapter 2 shall have the meanings ascribed to them as defined therein.

- ❖ This section directs the code user to Chapter 2 of the code for the proper application of the terms used in this chapter. These terms may be defined in Chapter 2 of the code or in another *International Code*<sup>®</sup> as indicated in Section 201.3, or may retain their ordinary (dictionary) meaning (see also commentary, Sections 201.1 through 201.4).

## SECTION 6503 GENERAL REQUIREMENTS

**6503.1 Displays.** Cellulose nitrate (pyroxylin) plastic articles are allowed to be placed on tables not more than 3 feet (914 mm) wide and 10 feet (3048 mm) long. Tables shall be spaced at least 3 feet (914 mm) apart. Where articles are displayed on counters, they shall be arranged in a like manner.

- ❖ Because of pyroxylin (cellulose nitrate) plastic's hazardous instability and easily ignitable composition, its exposure to the ambient environment in public venues must be strictly controlled to minimize the amount of material exposed to potential ignition sources and the number of persons exposed to its hazards, should it be ignited. This section places strict limits on the size of an individual display surface and requires that multiple display surfaces be separated from one another by minimum 3-foot (914 mm) aisles to not only limit the number of tables involved in a single incident but also to provide free egress circulation in the event of an emergency.

**6503.2 Space under tables.** Spaces underneath tables shall be kept free from storage of any kind and accumulation of paper, refuse and other combustible material.

- ❖ The importance of good housekeeping in reducing the exposure of pyroxylin (cellulose nitrate) plastic display objects to fire exposure cannot be overstated.

Prohibiting the storage or accumulation of any combustible material beneath tables on which pyroxylin (cellulose nitrate) plastic display objects are arrayed will reduce the display's exposure to fire in the event such stored materials were to be ignited.

**6503.3 Location.** Sales or display tables shall be so located that in the event of a fire at the table, the table will not interfere with free *means of egress* from the room in not less than one direction.

- ❖ Display tables placed in corridors or aisles may unduly expose egressing persons to rapidly burning pyroxylin (cellulose nitrate) plastic objects, reduce required egress capacity or require substantial effort to remove the tables or negotiate the reduced egress path quickly. Anything that slows egress may also impede access, particularly to fire fighters who may be called to rescue occupants or fight the fire.

**6503.4 Lighting.** Lighting shall not be located directly above cellulose nitrate (pyroxylin) plastic material, unless provided with a suitable guard to prevent heated particles from falling.

- ❖ Because it is pyroxylin (cellulose nitrate) plastic's nature to rapidly deteriorate and ignite when exposed to heat, the hazard posed by light fixtures located over display tables must be reduced in an approved manner. Ideally, the display tables should be located where hot particles from a broken light bulb cannot fall on the pyroxylin (cellulose nitrate) plastic materials. When that is not possible, fixtures must be enclosed to prevent debris from a broken bulb from falling out of the fixture.

## SECTION 6504 STORAGE AND HANDLING

**6504.1 Raw material.** Raw cellulose nitrate (pyroxylin) plastic material in a Group F building shall be stored and handled in accordance with Sections 6504.1.1 through 6504.1.7.

- ❖ Raw pyroxylin (cellulose nitrate) plastic materials present increased hazards when they are involved in manufacturing processes. To reduce those increased hazards, the provisions of Sections 6504.1.1 through 6504.1.7 are applicable to buildings used for the fabrication of items containing pyroxylin (cellulose nitrate) plastic.

**6504.1.1 Storage of incoming material.** Where raw material in excess of 25 pounds (11 kg) is received in a building or *fire area*, an *approved* vented cabinet or *approved* vented vault equipped with an *approved automatic sprinkler system* shall be provided for the storage of material.

- ❖ The amount of heat liberated by pyroxylin (cellulose nitrate) plastic when burning and the speed with which it burns make conventional extinguishment virtually impossible. This, coupled with the poisonous combustion gases, produce conditions that require material confinement and rapid fire suppression. This section requires that quantities of pyroxylin (cellulose nitrate) plastic in excess of 25 pounds (11 kg) be con-

finished to an approved storage cabinet complying with Section 5003.8.7 or an approved vault constructed in accordance with the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>). While typical pyroxylin (cellulose nitrate) plastic storage cabinets are limited to a 30-cubic-foot (0.8 m<sup>3</sup>) volume, typical pyroxylin (cellulose nitrate) plastic vault construction has a fire-resistance rating of 4 hours because of the violent nature of the stored material. Cabinets and vaults must be vented to the outdoors to relieve the pressure buildup resulting from the rapid decomposition of the stored material and equipped with automatic sprinklers designed in accordance with Section 903.3.1.1.

**6504.1.2 Capacity limitations.** Cabinets in any one workroom shall not contain more than 1,000 pounds (454 kg) of raw material. Each cabinet shall not contain more than 500 pounds (227 kg). Each compartment shall not contain more than 250 pounds (114 kg).

❖ To provide a reasonable quantity of material to work with in the manufacturing process while minimizing the quantity of pyroxylin (cellulose nitrate) plastic exposed to a single fire, this section limits the aggregate and per-cabinet and cabinet compartment quantities.

**6504.1.3 Storage of additional material.** Raw material in excess of that allowed by Section 6504.1.2 shall be kept in vented vaults not exceeding 1,500-cubic-foot capacity (43 m<sup>3</sup>) of total vault space, and with *approved* construction, venting and sprinkler protection.

❖ Quantities of pyroxylin (cellulose nitrate) plastic in excess of the 1,000 pounds (454 kg) allowed by Section 6504.1.2 to be readily accessible in cabinets in work spaces must be stored in approved sprinklered and vented vaults no larger than 1,500 cubic feet each in volume [approximately 10 feet by 15 feet by 10 feet (3048 mm by 4572 mm by 3048 mm) high] to limit the amount of material involved in a fire.

**6504.1.4 Heat sources.** Cellulose nitrate (pyroxylin) plastic shall not be stored within 2 feet (610 mm) of heat-producing appliances, steam pipes, radiators or chimneys.

❖ Because pyroxylin (cellulose nitrate) plastic rapidly decomposes and will spontaneously burst into flame when in contact with heated objects in the presence of sufficient oxygen, it is extremely important to reduce the hazard by keeping stored materials well away from the common sources of heat noted in this section. Storing pyroxylin (cellulose nitrate) plastic in an unheated room would be an ideal strategy for this hazard.

**6504.1.5 Accumulation of material.** In factories manufacturing articles of cellulose nitrate (pyroxylin) plastics, *approved* sprinklered and vented cabinets, vaults or storage rooms shall be provided to prevent the accumulation in workrooms of raw stock in process or finished articles.

❖ This section reinforces the provisions of Sections 6504.1.1, 6504.1.2 and 6504.1.3 and intends to limit the amount of raw pyroxylin (cellulose nitrate) plastic

stock or finished product exposed to the hazards of manufacturing operations by mandating that all pyroxylin (cellulose nitrate) plastic materials, whether raw stock or finished product, be stored in sprinklered, vented vaults or cabinets.

**6504.1.6 Operators.** In workrooms of cellulose nitrate (pyroxylin) plastic factories, operators shall not be stationed closer together than 3 feet (914 mm), and the amount of material per operator shall not exceed one shift's supply and shall be limited to the capacity of three tote boxes, including material awaiting removal or use.

❖ To isolate the manufacturing hazard of labor (i.e., the hazards involved in the manipulation of materials in the manufacturing, packing or shipping of finished products), as well as the in-process quantity of pyroxylin (cellulose nitrate) plastic (either raw or finished product), this section requires that workstations in the factory have a clearance from one another of no less than 3 feet (914 mm). Depending on the specific articles being manufactured, the quantity of pyroxylin raw material or finished product allowed at any workstation may vary but cannot exceed the amount needed for a single work shift or three tote boxes, whichever is the greater amount. The term "tote box," although not defined in the code, describes portable containers used to transport raw pyroxylin (cellulose nitrate) plastic or finished pyroxylin (cellulose nitrate) plastic products between a central storage vault and a workstation.

**6504.1.7 Waste material.** Waste cellulose nitrate (pyroxylin) plastic materials such as shavings, chips, turnings, sawdust, edgings and trimmings shall be kept under water in metal receptacles until removed from the premises.

❖ The manufacturing process may involve shaving, scraping, sanding or cutting of pyroxylin (cellulose nitrate) plastic, all of which produce finely divided scrap material that presents much more surface area susceptible to the hazards of ignition than the larger, more dense work pieces from which they came. To reduce the measurable increase in the hazard, this section requires extraordinary collection and storage safeguards for such scrap material in water-filled metal containers. These containers should be removed from the work area at the end of each shift for disposal.

**6504.2 Fire protection.** The manufacture or storage of articles of cellulose nitrate (pyroxylin) plastic in quantities exceeding 100 pounds (45 kg) shall be located in a building or portion thereof equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1.

❖ Because pyroxylin (cellulose nitrate) plastics pose unusual and substantial fire risks, burn at a rate 15 times greater than comparable common combustibles and, when burning, release highly flammable and toxic combustion byproducts, fires involving these materials are very difficult to control. This section mirrors the provisions of Section 1103.5.1 and

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specifies a sprinkler threshold quantity of 100 pounds (45 kg); however, the need for additional fire protection should be considered for pyroxylin (cellulose nitrate) plastics in any amount.

**6504.3 Sources of ignition.** Sources of ignition shall not be located in rooms in which cellulose nitrate (pyroxylin) plastic in excess of 25 pounds (11 kg) is handled or stored.

❖ Consistent with the hazards presented by pyroxylin (cellulose nitrate) plastic, this section prohibits the presence of recognized ignition sources in storage and manufacturing areas where more than 25 pounds (11 kg) of material are present to minimize the amount of material exposed.

**6504.4 Heating.** Rooms in which cellulose nitrate (pyroxylin) plastic is handled or stored shall be heated by low-pressure steam or hot water radiators.

❖ This section reinforces the provisions of Sections 6504.1.4 and 6504.3 by mandating indirect heat only by either low-pressure steam or hot water in rooms where pyroxylin (cellulose nitrate) plastic is stored or processed. In this way, the hazards of open-flame, fuel-fired heat sources do not exist and cannot expose the pyroxylin (cellulose nitrate) plastic to ignition.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

Barrow, William J. *Manuscripts and Documents: Their Deterioration and Restoration*, 2nd ed. Charlottesville, VA: University of Virginia Press, 1972.

*Cellulose Nitrate*, FM Global Property Loss Prevention Data Sheet 7-86; Johnson, RI: Factory Mutual Global Research, 2000.

"Pyroxylin (cellulose nitrate) Plastic." *Special Interest Bulletin No. 49*. New York: American Insurance Association, 1971.

# Chapter 66: Unstable (Reactive) Materials

## General Comments

This chapter regulates the storage of unstable (reactive) materials. Unstable (reactive) materials may react spontaneously with themselves, other chemicals or when exposed to light, heat, cold, moisture, air or physical shock. These materials may burn, explode, polymerize or decompose to form toxic materials. Unstable (reactive) materials are used in a variety of industrial applications, including food processing and the manufacture of plastics, textiles, fireworks, explosives, rocket propellants, special fuel systems and dyes. These hazardous materials may also be found in the preparation of certain medicines or fumigants. They pose unusual and substantial risks to the general public, fire fighters and emergency response personnel under a variety of conditions.

Advance knowledge of the materials being stored in structures through the permit process and the submittal of Material Safety Data Sheets (MSDS), in accordance with Section 407, is essential for adequate control of the hazard and for prefire planning by the fire department. This is especially important for unstable (reactive) liquid and solid materials because of their unpredictable and violent nature.

During a mishap, a variety of hazards can be created by these materials, including explosions, violent decomposition, toxic products of combustion, toxic vapors, corrosion injuries, poisoning or violent polymerization.

Spills or leaks of unstable materials may be handled by absorbing them with inert materials and then removal

or, in cases of larger spills, flushing with large volumes of water if no additional hazard will be created.

Fires in structures or vehicles storing or carrying unstable chemicals should be approached with extreme caution to avoid injury from an explosion, such as a tank boiling liquid expanding vapor explosion (BLEVE). Unless and until specific and reliable information on the stored materials is available to fire command personnel, the scene should be treated as though the incident involves explosives, and personnel and apparatus should be kept well away.

## Purpose

This chapter addresses the hazards of unstable (reactive) liquid and solid materials, as well as unstable (reactive) compressed gas materials. In addition to their unstable reactivity, these materials may pose other hazards, such as toxicity, corrosivity, explosivity, flammability or oxidizing potential. This chapter, however, is intended to address those materials whose primary hazard is unstable reactivity. Materials that pose multiple hazards must conform to the requirements of the code with respect to all hazards (see commentary, Section 5001.1). Strict compliance with the provisions of this chapter, along with proper housekeeping and storage arrangements, help to reduce the exposure hazards associated with unstable (reactive) materials in a fire or other emergency.

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## SECTION 6601 GENERAL

**6601.1 Scope.** The storage and use of unstable (reactive) materials shall be in accordance with this chapter. *Compressed gases* shall also comply with Chapter 53.

### Exceptions:

1. Display and storage in Group M and storage in Group S occupancies complying with Section 5003.11.
  2. Detonable unstable (reactive) materials shall be stored in accordance with Chapter 56.
- ❖ This chapter details specific requirements for the storage of unstable (reactive) materials. The requirements of this chapter are intended to complement the hazardous materials general storage requirements of

Chapter 50. Hazardous gases are also regulated by Chapter 53. The chemicals classified as unstable (reactive) are based on the definition in Section 6602.1, which is derived from NFPA 704.

Exception 1 makes it clear that this chapter does not apply to unstable (reactive) materials stored and displayed in Group M occupancies or stored in Group S occupancies; Section 5003.11 covers those occupancy groups. Also in that section, Class 4 unstable (reactive) materials are prohibited in Group M (mercantile) occupancies because of their detonable hazard potential. Quantities of all other classes are limited on a per-control area basis to limit exposure to people and property (see commentary, Section 5003.11). This exception would permit an increase above the maximum allowable quantity per control area (MAQ) indicated in Table 5003.1.1(1) for unsta-

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ble (reactive) materials while still maintaining a mercantile or storage occupancy group classification.

Exception 2 recognizes the violent, explosive nature of detonable unstable (reactive) materials and directs that they be stored in accordance with the requirements for explosives and blasting agents in Chapter 56 to provide the safeguards commensurate with their hazards.

**6601.2 Permits.** Permits shall be required as set forth in Section 105.6.

❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit; Section 105.6.21 for discussion of specific quantity-based operational permits for the materials regulated in this chapter; and Section 105.7 for a general discussion of activities requiring a construction permit. The permit process also notifies the fire department of the need for prefire planning for hazardous property.

### SECTION 6602 DEFINITION

**6602.1 Definition.** The following term is defined in Chapter 2:

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- Class 4.
- Class 3.
- Class 2.
- Class 1.

❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated term used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*<sup>®</sup> as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4).

### SECTION 6603 GENERAL REQUIREMENTS

**6603.1 Quantities not exceeding the maximum allowable quantity per control area.** Quantities of unstable (reactive) materials not exceeding the *maximum allowable quantity per control area* shall be in accordance with Sections 6603.1.1 through 6603.1.2.5.

❖ The regulations contained in Sections 6603.1.1 through 6603.1.2.5 assume that the quantity of unstable (reactive) materials in a given building is limited to the MAQs as established in Section 5003.1; thus, the building is not classified in Occupancy Group H.

**6603.1.1 General.** The storage and use of unstable (reactive) materials in amounts not exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Sections 5001, 5003, 6601 and 6603.

❖ This section complements the requirements of Chapter 50 in structures occupied for the storage, handling or use of unstable (reactive) materials. Unless otherwise indicated in a particular section, the regulations contained in Sections 6603.1.2 through 6603.1.2.5 assume that the quantity of unstable (reactive) materials in a given building is limited to the MAQs as established in Section 5003.1. The general requirements of Sections 5001 and 5003 are fully applicable to the storage and use of unstable (reactive) materials, in addition to the provisions of this chapter.

**6603.1.2 Limitations for indoor storage and use by occupancy.** The indoor storage of unstable (reactive) materials shall be in accordance with Sections 6603.1.2.1 through 6603.1.2.5.

❖ Because unstable (reactive) materials may be needed in certain occupancies, Sections 6603.1.2.1 through 6603.1.2.5 provide regulations that are specific to occupancy group classifications and that recognize the relative hazards of both the occupancy and the unstable (reactive) materials.

**6603.1.2.1 Group A, E, I or U occupancies.** In Group A, E, I or U occupancies, any amount of Class 3 and 4 unstable (reactive) materials shall be stored in accordance with the following:

1. Class 3 and 4 unstable (reactive) materials shall be stored in hazardous material storage cabinets complying with Section 5003.8.7.
2. The hazardous material storage cabinets shall not contain other storage.

❖ Because of their explosive or higher deflagration hazard characteristics, even the smallest quantity of Class 3 and 4 unstable (reactive) materials present in Group A, E, I or U occupancies must be stored in an approved hazardous material storage cabinet constructed and placarded in accordance with Section 5003.8.6 to reduce the exposure of the materials to hazards from the surrounding environment.

In accordance with Table 5003.1.1(1), Note g, storage of Class 4 unstable (reactive) materials in any amount is allowed only in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Also, based on Table 5003.1.1(1), Note e, where an approved storage cabinet is used, the MAQ of unstable (reactive) materials that could be kept in those occupancies can be doubled.

To reduce the likelihood of contamination of the organic peroxide materials or damage to their packaging, Item 2 prohibits the storage of other materials in the approved unstable (reactive) materials storage cabinet.

**6603.1.2.2 Group R occupancies.** Class 3 and 4 unstable (reactive) materials shall not be stored or used within Group R occupancies.

❖ Because of their respective explosive or higher deflagration hazard characteristics, Class 3 and 4 unstable (reactive) materials storage in any residential occupancy within the scope of the code's regulations is prohibited because of the increased danger to the occupants and the otherwise unregulated environment to which those materials could be exposed.

**6603.1.2.3 Group M occupancies.** Class 4 unstable (reactive) materials shall not be stored or used in retail sales portions of Group M occupancies.

❖ Because of their explosive hazard characteristics, Class 4 unstable (reactive) materials storage in occupancies in Group M is prohibited because of the increased danger to the occupants and the higher relative fire loads typically encountered in these occupancies to which the materials could be exposed.

**6603.1.2.4 Offices.** Class 3 and 4 unstable (reactive) materials shall not be stored or used in offices of Group B, F, M or S occupancies.

❖ Because of their explosive hazard characteristics, Class 3 and 4 unstable (reactive) materials storage in office areas of occupancies in Group B, F, M or S is prohibited because of the increased danger to the occupants and the higher relative fire loads typically encountered in these occupancies.

**6603.1.2.5 Classrooms.** In classrooms in Group B, F or M occupancies, any amount of Class 3 and 4 unstable (reactive) materials shall be stored in accordance with the following:

1. Class 3 and 4 unstable (reactive) materials shall be stored in hazardous material storage cabinets complying with Section 5003.8.7.
2. The hazardous material storage cabinets shall not contain other storage.

❖ This section is intended to allow for the occasional use of limited amounts of Class 3 and 4 unstable (reactive) materials in certain scientific, experimental or demonstration settings; however, it is not the intent to allow storage of any quantity of these materials for any length of time. The fire code official may limit the amount of unstable (reactive) materials brought into a structure for these uses. The quantity actually needed for the experiment or demonstration should determine the amount allowed into a structure.

Because of its respective explosive or higher deflagration hazard characteristics, even the smallest quantity of Class 3 or 4 unstable (reactive) materials must be stored in an approved hazardous material storage cabinet constructed and placarded in accordance with Section 5003.8.6 to reduce the exposure of the materials to hazards from the surrounding environment.

In accordance with Table 5003.1.1(1), Note g, stor-

age of Class 4 unstable (reactive) materials in any amount is allowed only in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Also, based on Table 5003.1.1(1), Note e, where an approved storage cabinet is used, the MAQ that could be kept in such occupancies can be doubled. To reduce the likelihood of contamination of the unstable (reactive) materials or damage to their packaging, Item 2 prohibits the storage of other materials in the approved unstable (reactive) material storage cabinet.

**6603.2 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of unstable (reactive) materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Chapter 50 and this chapter.

❖ This section complements the requirements of Chapter 50 in structures occupied for the storage, handling or use of unstable (reactive) materials. The regulations contained in this section assume that the quantity of unstable (reactive) material in a given building or portion of a building is in excess of the MAQs as established in Section 5003.1; thus, the building or portion of the building is classified in Occupancy Group H. The requirements of Chapter 50 apply to the storage and use of unstable (reactive) material, in addition to the provisions of this chapter.

## SECTION 6604 STORAGE

**6604.1 Indoor storage.** Indoor storage of unstable (reactive) materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) shall be in accordance with Sections 5001, 5003, 5004 and this chapter.

In addition, Class 3 and 4 unstable (reactive) detonable materials shall be stored in accordance with the *International Building Code* requirements for *explosives*.

❖ This section regulates the indoor storage of unstable (reactive) materials when in excess of the MAQ in buildings or portions of buildings classified in Occupancy Group H. The general and storage provisions of Chapter 50 are applicable in addition to the requirements of this section. Storage of unstable (reactive) materials inside structures must comply with Sections 6604.1.1 through 6604.1.5 to prevent uncontrolled release or exposure to conditions that may result in a fire or explosion.

Because of the explosion hazard, Class 3 and 4 detonable unstable (reactive) materials must be stored as required by this section, Chapter 56 and the *International Building Code*® (IBC®) requirements for explosives.

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**6604.1.1 Detached storage.** Storage of unstable (reactive) materials shall be in detached buildings when required in Section 5003.8.2.

❖ Detached structures designed and constructed for the sole purpose of unstable (reactive) materials storage are the best protection for people and property from fire and explosion. Detached storage structures should be constructed of noncombustible materials to prevent them from becoming involved in either an outside fire that may endanger their contents or an indoor fire due to the structure's contents igniting.

Section 5003.8.2 and Table 5003.8.2 require detached storage when the indoor storage quantities are more than 1 ton (908 kg) of Class 3 unstable (reactive) solid or liquid materials, more than 25 tons (22 700 kg) of Class 2 unstable (reactive) solid or liquid material, more than 2,000 cubic feet (57 m<sup>3</sup>) of Class 3 gaseous unstable (reactive) material or more than 10,000 cubic feet (283 m<sup>3</sup>) of Class 2 unstable (reactive) gaseous material. See the commentaries to Section 5003.8.2 and Table 5003.8.2 for further discussion of detached storage requirements.

**6604.1.2 Explosion control.** Indoor storage rooms, areas and buildings containing Class 3 or 4 unstable (reactive) materials shall be provided with explosion control in accordance with Section 911.

❖ Because of the possibility of a deflagration or detonation in the event of ignition of Class 3 or 4 unstable (reactive) materials, explosion relief venting must be installed to protect the storage building or structure from collapse. Explosion venting must conform to the requirements of Section 911.

**6604.1.3 Liquid-tight floor.** In addition to Section 5004.12, floors of storage areas for liquids and solids shall be of liquid-tight construction.

❖ Floors and sills of rooms or areas used to contain hazardous material spills must be liquid tight to prevent the flow of liquids to adjoining areas (see commentary, Section 5004.2). The floor surface should be compatible with the unstable (reactive) materials to be retained and must be noncombustible, as required by Section 5004.12.

**6604.1.4 Storage configuration.** Unstable (reactive) materials stored in quantities greater than 500 cubic feet (14 m<sup>3</sup>) shall be separated into piles, each not larger than 500 cubic feet (14 m<sup>3</sup>). Aisle width shall not be less than the height of the piles or 4 feet (1219 mm), whichever is greater.

**Exception:** Materials stored in tanks.

❖ These provisions detail storage requirements related to the hazards of release or ignition of unstable (reactive) materials stored in structures and are intended to reduce the amount of material exposed in a single incident by managing pile sizes and their separation. Aisle widths that are equal to the pile height or are 4 feet (3048 mm), whichever is greater, reduce the fire exposure hazard between piles and, in the event of a fire-related collapse of a pile, reduce the likelihood of

a “domino” effect that could not only increase fire intensity but also completely block access to pile areas by fire suppression personnel.

Although not specifically mentioned in this section, inside storage must also be protected in accordance with Chapter 50, which includes provisions for incompatible material storage, security, signage, control of ignition sources and submittal of a storage plan.

**6604.1.5 Location in building.** Unstable (reactive) materials shall not be stored in *basements*.

❖ Storage of unstable (reactive) material below the ground floor is prohibited to facilitate fire-fighter access and also because of the inherent difficulty associated with manual fire suppression operations in below-grade areas.

**6604.2 Outdoor storage.** Outdoor storage of unstable (reactive) materials in amounts exceeding the *maximum allowable quantities per control area* indicated in Table 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5004 and this chapter.

❖ This section regulates the outdoor storage of unstable (reactive) materials when in excess of the MAQ established by Table 5003.1.1(3). The general and storage provisions of Chapter 50 are applicable in addition to the requirements of this section. Storage of unstable (reactive) materials in outdoor control areas must comply with Sections 6604.2.1 and 6604.2.2 to prevent uncontrolled release or exposure to conditions that could result in a fire or explosion.

**6604.2.1 Distance from storage to exposures Class 4 and 3 (detonable) materials.** Outdoor storage of Class 4 or 3 (detonable) unstable (reactive) material shall be in accordance with Table 5604.5.2(2). The number of pounds of material listed in the table shall be the net weight of the material present. Alternatively, the number of pounds of material shall be based on a trinitrotoluene (TNT) equivalent weight.

❖ The distance requirements are divided into three subsections to address the different natures of unstable (reactive) materials. As previously drafted, suitable locations for Class 4 and 3 (detonable) unstable reactive materials had not been addressed. The tabular distances listed in Table 5604.5.2(2) provided by the Institute of Makers of Explosives have been developed based on pounds of trinitrotoluene (TNT) or a TNT weight. A TNT equivalent weight is comparable to the net explosive weight as used by the table (also see the commentary to the definition of “Net explosive weight” in Section 202).

**6604.2.2 Distance from storage to exposures Class 3 (deflagratable) materials.** Outdoor storage of deflagratable Class 3 unstable (reactive) materials shall be in accordance with Table 5604.5.2(3). The number of pounds of material listed shall be the net weight of the material present.

❖ This section addresses Class 3 (deflagrating) unstable (reactive) materials and relies on Table 5604.5.2(3) for the quantity-distance regulations. Note that the use of TNT equivalent weights are not

applied but, rather, the net weight of stored material is used.

**6604.2.3 Distance from storage to exposures Class 2 and 1 materials.** Outdoor storage of Class 2 or 1 unstable (reactive) materials shall not be located within 20 feet (6096 mm) of buildings not associated with the manufacture or distribution of such materials, *lot lines*, public streets, public alleys, *public ways* or *means of egress*. The minimum required distance shall not apply when *fire barriers* without openings or penetrations having a minimum fire-resistance rating of 2 hours interrupt the line of sight between the storage and the exposure. The *fire barrier* shall either be an independent structure or the exterior wall of the building adjacent to the storage area.

❖ This section addresses Class 2 unstable (reactive) materials. The provisions of this section from the previous edition have been retained with a modification that exempts buildings associated with the manufacture or distribution of Class 2 and 1 materials. The exemption is similar to that provided for the manufacture and distribution of toxic or highly toxic compressed gases found in Section 6004.3.2.1.2 or for oxidizing gases found in Table 6304.2.2. The exemption has been broadened to include solids, liquids and gases based on the fact that manufacturing buildings processing these materials typically stage or store materials inside and immediately outside of the building where processing is conducted, while materials that have explosive effects are (or should be) located at distances comparable to those used for explosive materials. Line of sight protection is used in lieu of a 30-inch (762 mm) requirement for the protection from radiant flux.

**6604.2.4 Storage configuration.** Piles of unstable (reactive) materials shall not exceed 1,000 cubic feet (28 m<sup>3</sup>).

❖ The size of storage piles of unstable (reactive) materials is regulated by this section based on the hazards of the unstable (reactive) materials being stored. To limit the amount of material involved in a single fire, unstable (reactive) materials are limited to piles no larger than 10 feet by 10 feet by 10 feet (3048 mm by 3048 mm) high.

**6604.2.5 Aisle widths.** Aisle widths between piles shall not be less than one-half the height of the pile or 10 feet (3048 mm), whichever is greater.

❖ Minimum 10-foot-wide (3048 mm) aisles provide access to the storage area for emergency personnel and reduce the likelihood of a “domino” effect that could not only increase fire intensity but also completely block access to pile areas by fire suppression personnel should a pile topple over.

## SECTION 6605 USE

**6605.1 General.** The use of unstable (reactive) materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) or 5003.1.1(3) shall

be in accordance with Sections 5001, 5003, 5005 and this chapter.

❖ This section applies to all indoor and outdoor dispensing, use and handling of unstable (reactive) materials when the amounts being dispensed, used or handled are in excess of the MAQs per indoor or outdoor control area indicated in Table 5003.1.1(1) or 5003.1.1(3), respectively. The administrative general, use, handling and dispensing provisions of Chapter 50 are applicable, in addition to the requirements of this chapter.

Once the MAQ of unstable (reactive) materials has been exceeded, indoor areas where materials are being dispensed, used or handled must be located in a building or portion of a building complying with the IBC for a Group H occupancy because of the increased hazards associated with quantity. Although no occupancy group is assigned to them, outside unstable (reactive) materials use areas must be regulated more closely when quantities exceed the MAQs per outdoor control area.

The MAQs listed in Table 5003.1.1(1) or 5003.1.1(3) have been divided into closed-use and open-use systems. Corresponding MAQs recognize that an open-use system is generally more hazardous than a closed-use system because the unstable (reactive) materials are more directly exposed to the surrounding environment and can become more readily involved in an incident than if they are totally confined. The MAQs for use are based on the aggregate quantity in both use and storage not exceeding the MAQ listed for storage.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

*Fire Protection Guide on Hazardous Materials*, 13th ed. Quincy, MA: National Fire Protection Association, 2001.

Isman, W.E. and G.P. Carlson. *Hazardous Materials*. Encino, CA: Glencoe Publishing Co., Inc., 1980.

NFPA 704-12, *Identification of the Fire Hazards of Materials for Emergency Response*. Quincy, MA: National Fire Protection Association, 2011.

*Police and Fire Interest Bulletin No 7, Unstable (Reactive) Chemicals*. New York: American Insurance Association, 1973.



# Chapter 67: Water-Reactive Solids and Liquids

## General Comments

Water-reactive materials are used in a variety of industrial applications for the processing of other materials, such as descaling (salt) baths in the metal processing industry, dehydrating agents in sulfonation processes (the addition of fuming sulfuric acid to a product being treated) and a variety of other complex chemical industrial processes. They also may be found in the manufacture of a variety of consumer products, such as soaps and detergents, rodenticides, fertilizers, silicone rubber and pharmaceutical products.

Advance knowledge of the materials stored in structures through permits and the submittal of Material Safety Data Sheets (MSDS) are essential for effective prefire planning by the fire department. This is especially important in prefire planning for water-reactive materials, because the presence of these materials severely limits the fire department's ability to use water as the primary fire suppression tool.

Water-reactive materials may react to water in a variety of ways, including explosion, violent splattering, production of toxic gases, rapid decomposition with the evolution of large volumes of heat that may ignite nearby combustibles or any combination of these reactions. Alternative fire suppression protocols must be developed well in advance of an incident and the requisite alternative suppression medium obtained, rather than having to go searching for it at the time of an emergency. Depending on the specific water-reactive material involved in an incident, the alternative extinguishing media could include dry graphite, soda ash, sodium chloride, dry sand or specialized dry powder agents,

such as Lith-X or Met-L-X, both manufactured by the Ansul Fire Protection Company.

If a manageable spill occurs without a fire, the material can be confined by a dam of dry sand and then covered with an absorbent material, such as vermiculite, dolomite or more dry sand. Once absorbed, the material must be moved outside with care for disposal. Water-reactive materials that are spilled outdoors are sometimes best handled by allowing them to react and hastening that process by applying water. Large volumes of water are required for this procedure and they must be applied from a safe distance by personnel wearing full protective clothing and breathing apparatus. This method will not only accelerate the reaction, but also disperse and dilute the fumes generated.

## Purpose

This chapter addresses the hazards associated with water-reactive materials that are solid or liquid at normal temperatures and pressures. In addition to their water reactivity, these materials may pose a wide range of other hazards, such as toxicity, flammability, corrosiveness or oxidizing potential. This chapter addresses only those materials whose primary hazard is water reactivity. Materials that pose multiple hazards must conform to the requirements of the code with respect to all hazards (see commentary, Section 5001.1). Strict compliance with the requirements of this chapter, along with proper housekeeping and storage arrangements, helps to reduce the exposure hazards associated with water-reactive materials in a fire or other emergency.

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## SECTION 6701 GENERAL

**6701.1 Scope.** The storage and use of water-reactive solids and liquids shall be in accordance with this chapter.

### Exceptions:

1. Display and storage in Group M and storage in Group S occupancies complying with Section 5003.11.
  2. Detonable water-reactive solids and liquids shall be stored in accordance with Chapter 56.
- ❖ This chapter contains specific requirements for the storage of water-reactive materials. The requirements of this chapter are intended to complement the

hazardous materials general storage requirements of Chapter 50. Classification of solids and liquids as being water reactive is based on their relative degree of hazard as described in the definition in Section 6502.

Exception 1 makes it clear that this chapter does not apply to water-reactive materials stored and displayed in Group M occupancies or stored in Group S occupancies, and defers to the requirements of Section 5003.11 for those occupancy groups. In that section, quantities are limited on a per-control-area basis to limit exposure to people and property (see commentary, Section 5003.11). This exception would permit an increase above the maximum allowable quantities per control area (MAQ) indicated in Table

5003.1.1(1) for water-reactive materials while still maintaining a mercantile or storage occupancy group classification.

Exception 2 recognizes the violent, explosive nature of detonable water-reactive materials and directs that they be stored in accordance with the requirements for explosives and blasting agents (see Chapter 56) to provide the safeguards commensurate with their hazards.

**6701.2 Permits.** Permits shall be required as set forth in Section 105.6.

- ❖ The process of issuing permits gives the fire code official an opportunity to carefully evaluate and regulate hazardous operations. Permit applicants should be required to demonstrate that their operations comply with the intent of the code before the permit is issued. See the commentary to Section 105.6 for a general discussion of operations requiring an operational permit; Section 105.6.21 for a discussion of specific quantity-based operational permits for the materials regulated in this chapter; and Section 105.7 for a general discussion of activities requiring a construction permit. The permit process also notifies the fire department of the need for prefire planning for hazardous property.

### SECTION 6702 DEFINITION

**6702.1 Definition.** The following term is defined in Chapter 2:

#### WATER-REACTIVE MATERIAL.

- Class 3.
- Class 2.
- Class 1.

- ❖ Definitions of terms can help in the understanding and application of the code requirements. This section directs the code user to Chapter 2 for the proper application of the indicated terms used in this chapter. Terms may be defined in Chapter 2 or in another *International Code*® as indicated in Section 201.3, or the dictionary meaning may be all that is needed (see also commentary, Sections 201.1 through 201.4).

### SECTION 6703 GENERAL REQUIREMENTS

**6703.1 Quantities not exceeding the maximum allowable quantity per control area.** The storage and use of water-reactive solids and liquids in amounts not exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Sections 5001, 5003, 6701 and 6703.

- ❖ This section complements the requirements of Chapter 50 in structures occupied for the storage, handling or use of water-reactive materials limited to the MAQs as established in Section 5003.1. The general

requirements of Sections 5001 and 5003 are fully applicable to the storage and use of water-reactive materials, in addition to the requirements of this chapter.

**6703.2 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of water-reactive solids and liquids in amounts exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Chapter 50 and this chapter.

- ❖ This section complements the requirements of Chapter 50 in structures occupied for the storage, handling or use of water-reactive materials. The regulations contained in this section assume that the quantity of water-reactive materials in a given building is in excess of the MAQs as established in Section 5003.1; thus, the building is classified in Occupancy Group H. The requirements of Chapter 50 apply to the storage and use of water-reactive material, in addition to the requirements of this chapter.

### SECTION 6704 STORAGE

**6704.1 Indoor storage.** Indoor storage of water-reactive solids and liquids in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1), shall be in accordance with Sections 5001, 5003, 5004 and this chapter.

- ❖ This section regulates the indoor storage of water-reactive materials when in excess of the MAQ in buildings or portions of buildings classified in Occupancy Group H. The general and storage requirements of Chapter 50 are applicable in addition to the requirements of this section. Storage of water-reactive materials inside structures must comply with Sections 6701.1 through 6704.1.7 to prevent uncontrolled release or exposure to conditions that may result in a fire or explosion.

**6704.1.1 Detached storage.** Storage of water-reactive solids and liquids shall be in detached buildings where required by Section 5003.8.2.

- ❖ This section regulates the indoor storage of water-reactive materials when in excess of the MAQ in buildings or portions of buildings classified in Occupancy Group H. The general and storage requirements of Chapter 50 are applicable in addition to the requirements of this section. Storage of water-reactive materials inside structures must comply with Sections 6701.1 through 6704.1.7 to prevent uncontrolled release or exposure to conditions that may result in a fire or explosion.

**6704.1.2 Liquid-tight floor.** In addition to the provisions of Section 5004.12, floors in storage areas for water-reactive solids and liquids shall be of liquid-tight construction.

- ❖ Floors and sills of rooms or areas used to contain hazardous material spills must be liquid tight to pre-

vent the flow of liquids to adjoining areas (see commentary, Section 5004.2). The floor surface should be compatible with the water-reactive materials to be retained and must be noncombustible, as required by Section 5004.12.

**6704.1.3 Waterproof room.** Rooms or areas used for the storage of water-reactive solids and liquids shall be constructed in a manner which resists the penetration of water through the use of waterproof materials. Piping carrying water for other than *approved automatic sprinkler systems* shall not be within such rooms or areas.

❖ The design and construction of rooms used for storing water-reactive materials must prevent water from coming into contact with the stored materials. The building materials should be noncombustible so they do not contribute fuel to a fire or reaction and should be designed to resist the passage of flowing water.

A major safeguard is planning the design of the room and locating it to minimize water hazards. For example, in a two-story building it would not be appropriate to put a water-reactive materials storage room directly below a locker room with showers or a bathroom located on the second floor.

Similarly, the enclosure walls of a storage room should not contain plumbing piping. Though water piping may not be run into or through storage rooms, the code recognizes that automatic sprinkler systems are a more regulated type of water piping system and have a low leakage and failure rate when properly installed and maintained.

**6704.1.4 Water-tight containers.** Where Class 3 water-reactive solids and liquids are stored in areas equipped with an *automatic sprinkler system*, the materials shall be stored in closed water-tight containers.

❖ In the event of a sprinkler discharge in response to a fire, the application of water should not aggravate the fire by causing a violent exothermic reaction with the water-reactive materials in storage that might not otherwise become involved. To reduce this hazard and to complement the provisions of Section 6704.1.4, water-reactive materials must be stored in water-tight containers of 60 gallons (227 L) or less than capacity that comply with Section 5003.2 (see the commentary to the Section 202 definition of "Container").

**6704.1.5 Storage configuration.** Water-reactive solids and liquids stored in quantities greater than 500 cubic feet (14 m<sup>3</sup>) shall be separated into piles, each not larger than 500 cubic feet (14 m<sup>3</sup>). Aisle widths between piles shall not be less than the height of the pile or 4 feet (1219 mm), whichever is greater.

**Exception:** Water-reactive solids and liquids stored in tanks.

Class 2 water-reactive solids and liquids shall not be stored in *basements* unless such materials are stored in closed water-tight containers or tanks.

Class 3 water-reactive solids and liquids shall not be stored in *basements*.

Class 2 or 3 water-reactive solids and liquids shall not be stored with flammable liquids.

❖ This section details storage requirements related to the hazards of release or ignition of water-reactive materials stored in structures and is intended to reduce the amount of material exposed in a single incident by managing pile sizes and their separation. Water-reactive materials are limited to piles no larger than 500 cubic feet (14 m<sup>3</sup>) in volume [approximately 8 feet by 8 feet by 8 feet high (2438 mm by 2438 mm by 2438 mm)]. Aisle widths that are equal to the pile height or 4 feet (1219 mm), whichever is greater, reduce the fire exposure hazard between piles and, in the event of a fire-related collapse of a pile, reduce the likelihood of a "domino" effect that could not only increase fire intensity but also completely block access to pile areas by fire suppression personnel. Although not specifically mentioned in this section, inside storage must also comply with Chapter 50, which includes provisions for incompatible material storage, security, signage, control of ignition sources and submittal of a storage plan.

The exception exempts tank storage from the requirements of this section; however, the tanks must conform to the requirements of Section 5003.2.

Because Class 2 oxidizers are potentially explosive, they may be stored in basements only when contained in approved stationary tanks or containers that comply with the applicable requirements of Section 5003.2 and this section.

Because Class 3 water-reactive materials are violently reactive, they may not be stored in a basement because of the limited access for fire suppression operations, the potential for increased damage to the structure and exposure of the occupants to danger.

Class 2 and 3 water-reactive materials may not be stored in the same room or area as flammable liquids because of their violent reactivity and their incompatibility. See the commentary to Section 5003.9.8 for a discussion of precautions to be taken with incompatible materials.

**6704.1.6 Explosion control.** Indoor storage rooms, areas and buildings containing Class 2 or 3 water-reactive solids and liquids shall be provided with explosion control in accordance with Section 911.

❖ The violently reactive nature of Class 2 and 3 water-reactive materials can seriously damage or destroy a storage room or structure. To prevent damage or destruction in storage rooms or structures where Class 2 or 3 water-reactive materials are stored, an explosion control system must be installed as required in Section 911.

**6704.2 Outdoor storage.** Outdoor storage of water-reactive solids and liquids in quantities exceeding the *maximum*

allowable quantity per control area indicated in Table 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5004 and this chapter.

❖ This section regulates the outdoor storage of water-reactive material when in excess of the MAQ established by Table 5003.1.1(3). The general and storage provisions of Chapter 50 are applicable, in addition to the requirements of this section.

**6704.2.1 General.** Outdoor storage of water-reactive solids and liquids shall be within tanks or closed water-tight containers and shall be in accordance with Sections 6704.2.2 through 6704.2.5.

❖ Similar to Sections 6704.1.3 and 6704.1.5, which require waterproof rooms and water-tight containers for the storage of water-reactive materials, this section carries the protection of the material one step further by requiring that water-reactive materials stored outdoors be in closed, water-tight containers or tanks to reduce the likelihood that rain or snow will come into contact with them. Storage of water-reactive material in outdoor control areas must comply with Sections 6704.2.1 through 6704.2.5 to prevent uncontrolled release or exposure to conditions that could result in a fire or explosion.

**6704.2.2 Class 3 distance to exposures.** Outdoor storage of Class 3 water-reactive solids and liquids shall not be within 75 feet (22 860 mm) of buildings, *lot lines*, public streets, public alleys, *public ways* or *means of egress*.

❖ The required separation distances are based on the class of water-reactive material and are intended to reduce the hazard of radiant heat transfer to nearby structures, public streets or alleys or egress elements from buildings. The distances also protect the property in question from heat exposure from incidents on or off the property.

**6704.2.3 Class 2 distance to exposures.** Outdoor storage of Class 2 water-reactive solids and liquids shall not be within 20 feet (6096 mm) of buildings, *lot lines*, public streets, public alleys, *public ways* or *means of egress*. A 2-hour fire barrier without openings or penetrations, and extending not less than 30 inches (762 mm) above and to the sides of the storage area, is allowed in lieu of such distance. The wall shall either be an independent structure, or the exterior wall of the building adjacent to the storage area.

❖ The required separation distances in this section are based on the less violently reactive Class 1 and 2 water-reactive materials and are intended to reduce the hazard of radiant heat transfer to nearby structures, public streets or alleys or egress elements from buildings. The distances also protect the property in question from heat exposure from incidents on or off the property.

This section also recognizes that, for these less violently reactive water-reactive materials, a minimum separation distance of 20 feet (6096 mm) provides adequate protection and that a solid, 2-hour fire bar-

rier, constructed in accordance with Section 707 of the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>), is an equivalent way to meet the objectives of spatial separation. Where a separation assembly is installed instead of having the separation distance, the wall must extend vertically beyond the roof or wall of the larger structure on each side (top and sides) to prevent a fire from lapping over or extending around the wall.

**6704.2.4 Storage conditions.** Class 3 water-reactive solids and liquids shall be limited to piles not greater than 500 cubic feet (14 m<sup>3</sup>).

Class 2 water-reactive solids and liquids shall be limited to piles not greater than 1,000 cubic feet (28 m<sup>3</sup>).

Aisle widths between piles shall not be less than one-half the height of the pile or 10 feet (3048 mm), whichever is greater.

❖ The size of storage piles of water-reactive materials is regulated by this section based on the hazards of the water-reactive materials being stored. To limit the amount of material involved in a single fire, water-reactive materials are limited to piles no larger than approximately 8 feet by 8 feet by 8 feet high (2438 mm by 2438 mm by 2438 mm) for Class 3 or 10 feet by 10 feet by 10 feet high (3048 mm by 3048 mm by 3048 mm) for Class 2 materials. The required aisle width ensures access to the storage area for emergency personnel and reduces the likelihood of a “domino” effect that could not only increase fire intensity, but also completely block access to pile areas by fire suppression personnel should a pile topple over.

**6704.2.5 Containment.** Secondary containment shall be provided in accordance with the provisions of Section 5004.2.2.

❖ To prevent the flow of water-reactive liquids to adjoining rooms or spaces, secondary containment complying with Section 5004.2.2 is required by this section. The design of drainage and secondary containment systems must take into consideration automatic sprinkler design discharge flow rates and fire suppression hand line [typically 1½- or 1¾-inch (38 or 44 mm) hose] flows.

Note that secondary containment requirements do not provide for control of the flammable, irritating or toxic vapors given off by reacted materials, and care must be taken to minimize exposure to hazardous vapors.

Runoff from spills or manual fire suppression activities may result in environmental contamination if not properly controlled (see commentary, Section 5004.2).

## SECTION 6705 USE

**6705.1 General.** The use of water-reactive solids and liquids in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) or 5003.1.1(3)

shall be in accordance with Sections 5001, 5003, 5005 and this chapter.

- ❖ This section applies to all indoor and outdoor dispensing, use and handling operations of water-reactive materials when the amounts being dispensed, used or handled are in excess of the MAQs in accordance with indoor or outdoor areas indicated in Table 5003.1.1(1) or 5003.1.1(3), respectively. The administrative, general use, handling and dispensing provisions of Chapter 50 are applicable, in addition to the requirements of this chapter.

Once the MAQ per control area of water-reactive materials has been exceeded, indoor areas where materials are being dispensed, used or handled must be located in a building or portion of a building complying with the IBC for a Group H occupancy because of the increased hazards associated with quantity. Although no occupancy group is assigned to them, outside water-reactive materials use areas must be regulated more heavily when quantities exceed the MAQs.

The MAQs listed in Table 5003.1.1(1) or 5003.1.1(3) have been divided into closed-use and open-use systems. Corresponding MAQs recognize that an open-use system is generally more hazardous than a closed-use system because the water-reactive materials are more directly exposed to the surrounding environment and can become more readily involved in an incident than if they are totally confined. The MAQs for use are based on the aggregate quantity in both use and storage not exceeding the MAQ listed for storage.

### Bibliography

The following resource materials were used in the preparation of the commentary for this chapter of the code:

“Cellar Fires.” *Special Interest Bulletin No. 67*. New York: National Board of Fire Underwriters, 1953.

Davenport, John A. Section 6.23, “Storage and Handling of Chemicals.” *Fire Protection Handbook*. Quincy, MA: National Fire Protection Association, 2003.

*Fire Protection Guide on Hazardous Materials*, 13th ed. Quincy, MA: National Fire Protection Association, 2001.

Isman, W.E. and G.P. Carlson. *Hazardous Materials*. Encino, CA: Glencoe Publishing Co., Inc., 1980.

“Sodium.” *Special Interest Bulletin No. 208*. New York: National Board of Fire Underwriters, 1956.

“Sodium Hydride Descaling.” *Special Interest Bulletin No. 209*. New York: National Board of Fire Underwriters, 1956.



**CHAPTERS 68 through 79  
RESERVED**



## Part VI—Referenced Standards

# Chapter 80: Referenced Standards

### General Comments

Not every document related to fire safety system design, installation and construction is qualified to be a referenced standard. The International Code Council® (ICC®) has adopted a criterion that referenced standards in the *International Codes*® and standards intended for adoption into the *International Codes* must meet to qualify as a referenced standard. The policy is as follows:

**Referenced Standards:** In order for a standard to be considered for reference or to continue to be referenced by the codes, a standard shall meet the following criteria:

#### Code References:

1. The standard and the manner in which it is to be utilized shall be specifically referenced in the code text.
2. The need for the standard to be referenced shall be established.

#### Standard Content:

1. A standard or portions of a standard intended to be enforced shall be written in mandatory language.
2. The standard shall be appropriate for the subject covered.
3. All terms shall be defined when they deviate from an ordinarily accepted meaning or a dictionary definition.
4. The scope or application of a standard shall be clearly described.
5. The standard shall not have the effect of requiring proprietary materials.
6. The standard shall not prescribe a proprietary agency for quality control or testing.
7. The test standard shall describe, in detail, preparation of the test sample, sample selection or both.
8. The test standard shall prescribe the reporting format for the test results. The format shall identify the key performance criteria of the element(s) tested.
9. The measure of performance for which the test is conducted shall be clearly defined in either the test standard or in code text.

10. The standard shall not state that its provisions shall govern whenever the referenced standard is in conflict with the requirements of the referencing code.
11. The preface to the standard shall announce that the standard is promulgated according to a consensus procedure.

#### Standard Promulgation:

1. The standard shall be completed and readily available prior to final action consideration. In order for a new standard to be considered for reference by the code, two copies of such a standard shall be submitted in at least a consensus draft form.
2. The standard shall be developed and maintained through a consensus process, such as ASTM or ANSI.

Once a standard is incorporated into the code through the code development process, it becomes an enforceable part of the code, subject to the limitations of the text reference in accordance with Section 102.7. When the code is adopted by a jurisdiction, the referenced portion (only the referenced portion) of the standard is also part of that jurisdiction's adopted code. It is for this reason that the criteria were developed.

Compliance with this policy means that documents or portions of documents incorporated into the code by reference are, among others, developed through the use of a consensus process, written in mandatory language and do not mandate the use of proprietary materials or agencies. The requirement that a standard be developed through a consensus process is vital, because it means that the standard will be representative of the most current body of available knowledge on the subject as determined by a broad range of interested or affected parties without dominance by any single interest group. A true consensus process has many attributes, including, but not limited to:

- An open process that has formal (published) procedures allowing for the consideration of all viewpoints.
- A definitive review period that allows for the standard to be updated or revised.
- A process of notification to all interested parties.
- An appeals process.

**REFERENCED STANDARDS**

Many available documents related to fire safety system design, installation and construction, though useful, are not “standards” and are not appropriate for reference in the code. Often, these documents are developed or written with the intention of being used for regulatory purposes and are unsuitable for use as a regulation because of extensive use of recommendations, advisory comments and nonmandatory terms. Typical examples of such documents include installation instructions, guidelines and practices.

The ICC standards policy results in regulations that are clear, concise and enforceable; thus the requirement that standards be written in mandatory language. This requirement is not intended to mean that a standard cannot contain informational or explanatory material that will aid the user of the standard in its application. When it is the desire of the standard’s promulgating agency for such material to be included, however, the information must appear in a nonmandatory location, such as an annex or appendix, and be clearly identified as not being part of the standard.

Overall, standards referenced by the code must be authoritative, relevant, up to date and, most important, reasonable and enforceable. Standards that comply with ICC’s standards policy fulfill these expectations.

**Purpose**

As a performance-based code, the *International Fire Code*® (IFC®) contains numerous references to documents that are used to regulate materials and methods of construction. The references to these documents within the code text consist of the promulgating agency’s acronym and its publication designation (for example, ASME A17.1), as well as a further indication that the document being referenced is the one that is listed in Chapter 80. Chapter 80 contains all of the information that is necessary to identify the specific referenced document. Included is the following information

on a document’s promulgating agency (see Commentary Figure 80):

- The promulgating agency (the agency’s title).
- The promulgating agency’s acronym.
- The promulgating agency’s address.

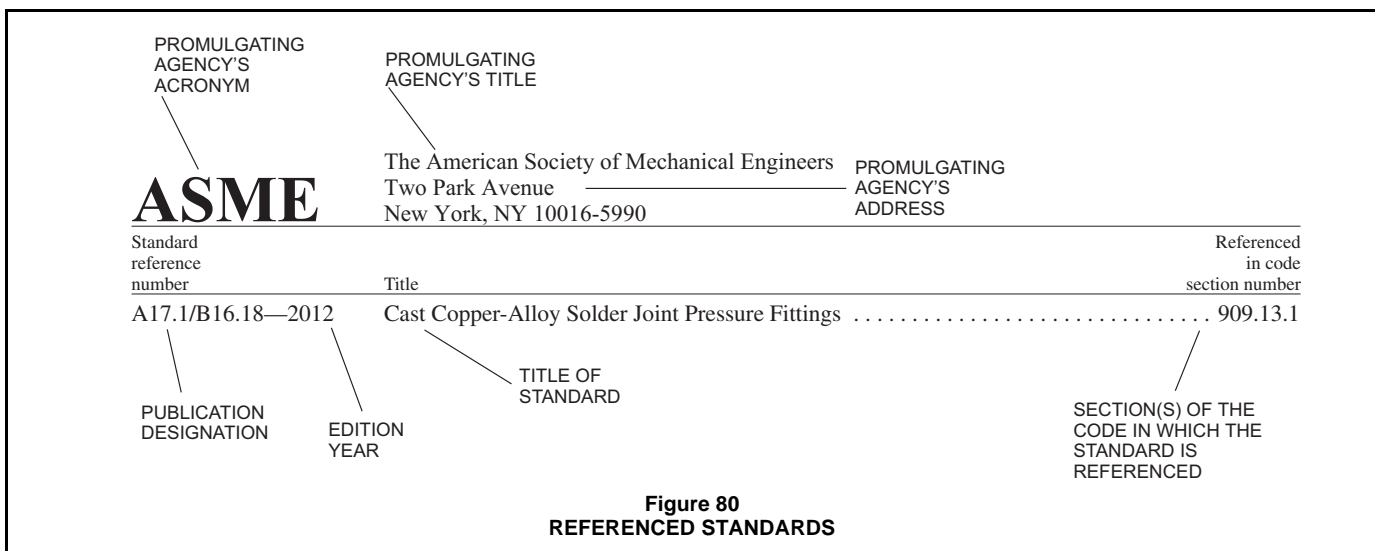
For example, a reference to an ASME standard within the code indicates that the document is promulgated by the American Society of Mechanical Engineers (ASME), which is located in New York City. Chapter 80 lists the standards’ agencies alphabetically for ease of identification.

Chapter 80 also includes the following information on the referenced document itself (see Commentary Figure 80):

- The document’s publication designation.
- The document’s edition year.
- The document’s title.
- Any addenda or revisions to the document known at the time of the code’s publication.
- Every section of the code in which the document is referenced.

For example, a reference to ASME B16.18 indicates that this document can be found in Chapter 80 under the heading ASME. The specific standards designation is B16.18. For convenience, these designations are listed in alphanumeric order. Chapter 80 identifies that: ASME 16.18 is titled *Cast Copper-Alloy Solder Joint Pressure Fittings*, the applicable edition (its year of publication) is 2001, and it is referenced in one specifically identified section of the code.

Using the system established for the family of *International Codes*, the specific edition of a specific standard is clearly identified and the requirements necessary for compliance can be readily determined. The basis for code compliance is, therefore, established and available on an equal basis to the fire code official, builder, designer and owner.



**Figure 80  
REFERENCED STANDARDS**

This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section 102.7.

**AASHTO** American Association of State Highway and Transportation Officials  
444 North Capitol Street, Northwest, #249  
Washington, DC 20001

Standard reference number	Title	Referenced in code section number
HB-17—2002	Specification for Highway Bridges, 17th Edition 2002 . . . . .	503.2.6

**AFSI** Architectural Fabric Structures Institute  
c/o Industrial Fabric Association International  
1801 County Road B West  
Roseville, MN 55113

Standard reference number	Title	Referenced in code section number
ASI—77	Design and Standard Manual . . . . .	3103.10.2

**ANSI** American National Standards Institute  
25 West 43rd Street, Fourth Floor  
New York, NY 10036

Standard reference number	Title	Referenced in code section number
ANSI E1.21—2006	Entertainment Technology: Temporary Ground Supported Overhead Structures Used to Cover the Stage Areas and Support Equipment in the Production of Outdoor Entertainment Events . . . . .	3105.1
ANSI Z21.69/ CSA 6.16—09	Connectors for Movable Gas Appliances . . . . .	.609.4

**API** American Petroleum Institute  
1220 L Street, Northwest  
Washington, DC 20005

Standard reference number	Title	Referenced in code section number
Spec 12P— <sup>3rd</sup> Edition (Reaffirmed 2008)	Specification for Fiberglass Reinforced Plastic Tanks . . . . .	5704.2.13.1.5
RP 651 <sup>3rd</sup> Edition (2007)	Cathodic Protection of Aboveground Petroleum Storage Tanks . . . . .	5706.7, 5706.7.1
Std 653— <sup>4th</sup> Edition (2009)	Tank Inspection, Repair, Alteration and Reconstruction . . . . .	5706.7
RP 752— <sup>3rd</sup> Edition (2009)	Management of Hazards Associated with Location of Process Plant Buildings, CMA Managers Guide . . . . .	5706.7
RP 1604— <sup>3rd</sup> Edition (1996 R2010)	Closure of Underground Petroleum Storage Tanks . . . . .	5704.2.13
RP 1615—(1996) <sup>6th</sup> Edition (2011)	Installation of Underground-petroleum Storage Systems . . . . .	5704.2.13.1.5, 5706.7
Std 2000— <sup>6th</sup> Edition (2009)	Venting Atmosphere and Low-pressure Storage Tanks: Nonrefrigerated and Refrigerated . . . . .	5704.2.7.3.2

**REFERENCED STANDARDS**

**API—continued**

RP 2001— <sup>9th</sup> Edition (2012)	Fire Protection in Refineries, 8th Edition . . . . .	5706.7
RP 2003— <sup>7th</sup> Edition (2008)	Protection Against Ignitions Arising out of Static, Lightning and Stray Currents . . . . .	5706.7
Publ 2009 <sup>7th</sup> Edition— (2002, R2012)	Safe Welding and Cutting Practices in Refineries, Gas Plants and Petrochemical Plants . . . . .	5706.7
Std 2015— <sup>6th</sup> Edition 2001 (R2006)	Safe Entry and Clearing of Petroleum Storage Tanks . . . . .	5706.7, 5706.7.2
RP 2023 <sup>3rd</sup> Edition— (2001, R2006)	Guide for Safe Storage and Handling of Heated Petroleum-derived Asphalt Products and Crude-oil Residue . . . . .	5706.7, 5706.7.3
Publ 2028 <sup>3rd</sup> Edition— (2002, R2012)	Flame Arrestors in Piping Systems . . . . .	5704.2.7.3.2
Publ 2201 <sup>5th</sup> Edition— (2003, R2010)	Procedures for Welding or Hot Tapping on Equipment in Service . . . . .	5706.7
RP 2350— <sup>4th</sup> Edition (2012)	Overfill Protection for Storage Tanks in Petroleum Facilities, 3rd Edition . . . . .	5704.2.7.5.8, 5706.4.6, 5706.7

**ASCE/SEI** American Society of Civil Engineers  
Structural Engineering Institute  
1801 Alexander Bell Drive  
Reston, VA 20191

Standard reference number	Title	Referenced in code section number
ASCE/SEI 24—13	Flood Resistant Design and Construction . . . . .	604.1.7

**ASHRAE** American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.  
1791 Tullie Circle, NE  
Atlanta, GA 30329

Standard reference number	Title	Referenced in code section number
15—2013	Safety Standard for Refrigeration Systems . . . . .	606.12.1

**ASME** The American Society of Mechanical Engineers  
Two Park Avenue  
New York, NY 10016-5990

Standard reference number	Title	Referenced in code section number
A 13.1—2007	Scheme for the Identification of Piping Systems . . . . .	3509.3, 5003.2.2.1, 5303.4.3, 5503.4.5, 5703.5.2
ASME A17.1/CSA B44—2013	Safety Code for Elevators and Escalators . . . . .	508.1.6, 607.1, 907.3.3, 1009.4
A17.3—2008	Safety Code for Existing Elevators and Escalators . . . . .	1103.3.1, 1103.3.2
B16.18—2012	Cast Copper-Alloy Solder Joint Pressure Fittings . . . . .	909.13.1
B16.22—2001 (R2010)	Wrought Copper and Copper-Alloy Solder-joint Pressure Fittings . . . . .	909.13.1
B31.1—2012	Power Piping . . . . .	5003.2.2, Table 5703.6.2
B31.3—2012	Process Piping . . . . .	5003.2.2.2, Table 5703.6.2
B31.4—2012	Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids . . . . .	Table 5703.6.2
B31.9—2011	Building Services Piping . . . . .	Table 5703.6.2, 5703.6.3, 5703.6.11
BPVC— 2010/2011 addenda	ASME Boiler and Pressure Vessel Code (Sections I, II, IV, V & VI, VIII) . . . . .	5003.2.1, 5303.2, 5303.3.2, 5503.2.6, 5503.4.3, 5503.7, 5704.2.13.1.5, 5806.3.1, 5806.4.1, 5806.4.8

# ASSE

American Society of Safety Engineers  
1800 East Oakton Street  
Des Plaines, IL 60018

Standard reference number	Title	Referenced in code section number
ANSI/ASSE Z359.1-2007	Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components, Part of the Fall Protection Code . . . . .	1015.6, 1015.7

# ASTM

ASTM International  
100 Barr Harbor Drive  
West Conshohocken, PA 19428-2959

Standard reference number	Title	Referenced in code section number
B42—10	Specification for Seamless Copper Pipe, Standard Sizes . . . . .	909.13.1
B43—09	Specification for Seamless Red Brass Pipe, Standard Sizes . . . . .	909.13.1
B68—11	Specification for Seamless Copper Tube, Bright Annealed. . . . .	909.13.1
B88—09	Specification for Seamless Copper Water Tube . . . . .	909.13.1
B251—10	Specification for General Requirements for Wrought Seamless Copper and Copper-alloy Tube . . . . .	909.13.1
B280—08	Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service . . . . .	909.13.1
D56—05(2010)	Test Method for Flash Point by Tag Closed Tester . . . . .	202
D86—2012	Test Method for Distillation of Petroleum Products at Atmospheric Pressure . . . . .	202
D92—12b	Test Method for Flash and Fire Points by Cleveland Open Cup . . . . .	202, 2401.2, 5104.1.1, 5701.2
D93—12	Test Method for Flash Point by Pensky-Martens Closed Up Tester . . . . .	202
D323—08	Test Method for Vapor Pressure of Petroleum Products (Reid Method). . . . .	202
D2859—06(2011)	Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials . . . . .	804.3.3.1, 804.3.3.2
D3278—96(2011)	Test Methods for Flash Point of Liquids by Small Scale Closed-cup Apparatus . . . . .	202
E84—2013A	Test Method for Surface Burning Characteristics of Building Materials . . . . .	202, 803.1, 803.1.1, 803.1.2, 803.5.1, 803.5.2, 803.6, 803.7, 803.10, 804.1, 804.1.1, 804.2.4
E108—2011	Test Methods for Fire Tests of Roof Coverings. . . . .	317.3
E681—2009	Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases). . . . .	202
E1354—2013	Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter . . . . .	304.3.2, 304.3.4, 318.1, 808.1, 808.2, 2310.5.3, 3304.2.3, 3603.4
E1529—13	Test Method for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies . . . . .	5704.2.9.2.3
E1537—13	Test Method for Fire Testing of Upholstered Furniture. . . . .	805.1.1.2, 805.2.1.2, 805.3.1.2, 805.4.1.2
E1590—13	Test Method for Fire Testing of Mattresses . . . . .	805.1.2.2, 805.2.2.2, 805.3.2.2.1, 805.4.2.2
E1966—2012A	Test Method for Fire-resistant Joint Systems. . . . .	202
E2072—10	Standard Specification for Pholuminescent (Phosphorescent) Safety Markings. . . . .	1025.4
E2404—2013E1	Standard Practice for Specimen Preparation and Mounting of Textile, Paper or Vinyl Wall or Ceiling Coverings to Assess Surface Burning Characteristics. . . . .	803.5.2, 803.6, 803.7
E2573—12	Standard Practice for Specimen Preparation and Mounting of Site-fabricated Stretch Systems to Assess Surface Burning Characteristics . . . . .	803.10
F1085—10	Standard Specification for Mattress and Box Springs for Use in Berths in Marine Vessels. . . . .	805.3.2.2.2
F2006—10	Standard/Safety Specification for Window Fall Prevention Devices for Non-Emergency Escape (Egress) and Rescue (Ingress) Windows . . . . .	1015.8
F2090—10	Specification for Window Fall Prevention Devices with Emergency Escape (Egress) Release Mechanisms . . . . .	1015.8, 1015.8.1
F2200—13	Standard Specification for Automated Vehicular Gate Construction . . . . .	503.5, 503.6

**REFERENCED STANDARDS**

**BHMA**

Builders Hardware Manufacturers' Association  
355 Lexington Avenue, 15th Floor  
New York, NY 10017

Standard reference number	Title	Referenced in code section number
A156.10—2011	American National Standard for Power-operated Pedestrian Doors . . . . .	1010.1.4.2
A156.19—2013	American National Standard for Power Assist and Low-energy Power-operated Doors. . . . .	1010.1.4.2
A156.27—2011	Power and Manual Operated Revolving Pedestrian Doors. . . . .	1010.1.4.1, 1010.1.4.3.1

**CA**

State of California Department of Consumer Affairs  
Bureau of Electronics and Appliance Repair, Home Furnishings and Thermal Insulation  
4244 South Market Court, Suite D  
Sacramento, CA 95834-1243

Standard reference number	Title	Referenced in code section number
California Technical Bulletin 129—1992	Flammability Test Procedure for Mattresses for Use in Public Buildings . . . . .	805.1.1.2, 805.2.2.2, 805.3.2.2.1, 805.4.2.2
California Technical Bulletin 133—1991	Flammability Test Procedure for Seating Furniture for Use in Public Occupancies . . . . .	805.1.1.2, 805.2.1.2, 805.4.1.2

**CGA**

Compressed Gas Association  
14501 George Carter Way, Suite 103  
Chantilly, VA 20151

Standard reference number	Title	Referenced in code section number
C-7—(2011)	Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers . . . . .	5303.4.2, 5503.4.2
G-13—(2006)	Storage and Handling of Silane and Silane Mixtures (an American National Standard) . . . . .	6404.1, 6404.2, 6405.3
P-1—(2000)	Safe Handling of Compressed Gases in Containers . . . . .	5305.7
ANSI/P-18—(2006)	Standard for Bulk Inert Gas Systems . . . . .	5501.1
S-1.1—(2011)	Relief Device Standards—Part 1—Cylinders for Compressed Gases . . . . .	5303.3.2, 5503.2
S-1.2—(2005)	Pressure Relief Device Standards—Part 2—Cargo and Portable Tanks for Compressed Gases . . . . .	5303.3.2, 5503.2
S-1.3—(2008)	Pressure Relief Device Standards—Part 3—Stationary Storage Containers for Compressed Gases . . . . .	5303.3.2, 5503.2
V-1—(2005)	Standard for Gas Cylinder Valve Outlet and Inlet Connections. . . . .	3505.2.1

**CGR**

Coast Guard Regulations  
c/o Superintendent of Documents  
U.S. Government Printing Office  
Washington, DC 20402-9325

Standard reference number	Title	Referenced in code section number
46 CFR Parts 30, 32, 35 & 39—1999	Shipping . . . . .	5706.8

# CPSC

Consumer Product Safety Commission  
4330 East West Highway  
Bethesda, MD 20814

Standard reference number	Title	Referenced in code section number
16 CFR Part 1500.41—2009	Method for Testing Primary Irritant Substances . . . . .	202
16 CFR Part 1500.42—2009	Test for Eye Irritants . . . . .	202
16 CFR Part 1500.44—2009	Method for Testing Extremely Flammable and Flammable Solids . . . . .	202
16 CFR Part 1500—2009	Hazardous Substances and Articles; Administration and Enforcement Regulations. . . . .	202, 5601.1.3
16 CFR Part 1507—2002	Fireworks Devices . . . . .	5601.1.3
16 CFR Part 1630—2007	Standard for the Surface Flammability of Carpets and Rugs. . . . .	804.3.3.1, 804.3.3.2

# DOC

U.S. Department of Commerce  
1401 Constitution Avenue, NW  
Washington, DC 20230

Standard reference number	Title	Referenced in code section number
16 CFR Part 1632—2009	Standard for the Flammability of Mattress and Mattress Pads (FF 4-72, Amended). . . . .	805.1.2.1, 805.2.2.1, 805.3.2.1, 805.4.2.1

# DOL

U.S. Department of Labor  
c/o Superintendent of Documents  
U.S. Government Printing Office  
Washington, DC 20402-9325

Standard reference number	Title	Referenced in code section number
29 CFR Part 1910.1000—2009	Air Contaminants . . . . .	202, 2104.2.1
29 CFR Part 1910.1200—2009	Hazard Communication . . . . .	202, 5603.6

# DOTn

U.S. Department of Transportation  
Office of Hazardous Material Safety  
1200 New Jersey Avenue, SE  
East Building, 2nd Floor  
Washington, DC 20590

Standard reference number	Title	Referenced in code section number
33 CFR Part 154—1998	Facilities Transferring Oil or Hazardous Material in Bulk . . . . .	5706.8
33 CFR Part 155—1998	Oil or Hazardous Material Pollution Prevention Regulations for Vessels. . . . .	5706.8
33 CFR Part 156—1998	Oil and Hazardous Material Transfer Operations . . . . .	5706.8
49 CFR Parts 100-185—2005	Hazardous Materials Regulations . . . . .	202, 3505.4, 5303.2, 5503.4.3, 5503.7, 5601.1, 5601.1.3, 5601.3, 5706.5.1.15
49 CFR Part 172—2009	Hazardous Materials Tables, Special Provisions, Hazardous Materials Communications, Emergency Response Information and Training Requirements . . . . .	5604.6.5.2

**REFERENCED STANDARDS**

**DOTn—continued**

49 CFR Part 173—2009 49 CFR Part 173.137—2009	Shippers—General Requirements for Shipments and Packagings . . . . .	5104.1.1, 5606.3
	Shippers—General Requirements for Shipments and Packagings: Class 8—Assignment of Packing Group . . . . .	202

**DOTy**

U.S. Department of Treasury  
c/o Superintendent of Documents  
U.S. Government Printing Office  
Washington, DC 20402-9325

Standard reference number	Title	Referenced in code section number
27 CFR Part 55—1998	Commerce in Explosives, as amended through April 1, 1998 . . . . .	202, 5604.6.5.2

**EN**

European Committee for Standardization (EN)  
Central Secretariat  
Rue de Stassart 36  
B-10 50 Brussels

Standard reference number	Title	Referenced in code section number
European Standard EN 1081	1998 Resilient Floor Coverings—Determination of the Electrical Resistance. . . . .	2309.5.1.1

**FCC**

Federal Communications Commission  
Wireless Telecommunications Bureau (WTB)  
445 12th Street, SW  
Washington, DC 20554

Standard reference number	Title	Referenced in code section number
47 CFR Part 90.219—2007	Private Land Mobile Radio Services—Use of Signal Boosters . . . . .	510.5.4

**FM**

Factory Mutual Global Research  
Standards Laboratories Department  
1301 Atwood Avenue, P.O. Box 7500  
Johnston, RI 02919

Standard reference number	Title	Referenced in code section number
4430—12	Approval Standard for Heat and Smoke Vents. . . . .	910.3.1
ANSI/FM 4996—13	Approval Standard for Classification of Pallets and Other Material Handling Products as Equivalent to Wood Pallets. . . . .	3206.4.1.1



International Code Council, Inc.  
 500 New Jersey Avenue, NW  
 6th Floor  
 Washington, DC 20001

Standard reference number	Title	Referenced in code section number
ICC A117.1—09	Accessible and Usable Buildings and Facilities . . . . .	.907.5.2.3.3, 1009.9, 1009.11, 1010.14.9.7, 1012.1, 1012.6.5, 1012.10, 1013.4, 1023.9
ICC 300—12	Standard on Bleachers, Folding and Telescopic Seating and Grandstands . . . . .	1029.1.1, 1029.16
IBC—15	International Building Code® . . . . .	102.3, 102.4, 201.3, 202, 304.1.3, 306.1, 311.1.1, 311.3, 313.1, 317.1, 403.8.2, 403.11.4, 404.2.1, 504.1, 508.1, 508.1.2, 603.2, 603.5.2, 603.6.1, 603.8, 604.1.2, 604.1.7, 604.2.2, 604.2.6, 604.2.7, 604.2.9, 604.2.13, 604.2.16, 605.11, 607.3, 607.4, 607.5, 607.6, 608.4, 608.8, 701.1, 704.1, 801.1, 803.1, Table 803.3, 803.7.2, 803.8.1, 803.8.2, 807.3, 807.5.1.2, 808.1, 808.2, 901.4.1, 901.4.2, 901.4.3, 901.8.2, 903.2, 903.2.5.2, 903.2.8.3.2, 903.2.9.1, 903.2.10, 903.3.1.1.1, 903.3.1.2, 903.3.2, 904.13, 907.1.1, 907.2.1, 907.2.1.9, 907.2.6.2, 907.2.6.3.3, 907.2.7, 907.2.13, 907.2.18, 907.5.2.1, 907.5.2.2.4, 907.6.6, 909.1, 909.2, 909.3, 909.4.3, 909.5, 909.5.3, 909.5.3.1, 909.5.3.2, 909.6.3, 909.10.5, 909.11.1, 909.18.8, 909.21.1, 910.4.5, Table 911.1, 911.2, 914.1, 914.2.1, 914.3.1, 914.3.2, 914.4.1, 914.5.3, Table 914.8.3, 914.8.3.2, 914.10, 915.1.6, 1003.2, 1003.5, Table 1004.1.2, 1004.4, 1005.7.2, 1006.2.1, 1009.2, 1009.4, 1009.5, 1009.6.4, 1010.1.4.1, 1010.1.4.3, 1010.1.5, 1010.1.7, 1010.1.9.1, 1010.1.9.11, 1011.10, 1011.11, 1011.12.2, 1012.6.3, 1012.6.4, 1014.1, 1015.2, 1015.2.1, 1016.2, 1018.3, 1018.5, 1019.3, 1019.4, 1020.1, Table 1020.1, 1021.4, 1023.2, 1023.3.1, 1023.4, 1023.5, 1023.6, 1023.7, 1023.11.1, 1023.11.2, 1024.4, 1024.5, 1024.6, 1024.7, 1026.2, 1026.3, 1027.5, 1028.1.6, 1029.1.1.1, 1101.2, 1101.3, 1103.1, 1103.3.2, 1103.4.1, 1103.4.8, 1103.4.9.1, 1103.4.9.2.1, 1103.4.9.2.2, 1103.4.9.4, 1103.4.9.5, 1103.4.10, 1104.5, 1104.17, 1104.17.1, Table 1104.17.2, 1105.3.1, 1105.3.3.1, 1105.3.3.2, 1105.4.7, 1105.6.2, 1105.6.3, 1105.6.4, 1105.6.5, 1105.6.6, 1105.6.7, 1105.7, 2004.6, 2006.17, 2007.1, 2007.4, 2103.3, 2107.1, 2301.1, 2301.4, 2303.1, 2307.4, 2308.3, 2308.3.1, 2308.3.1.2, 2309.3.1.5.1, 2309.3.2, 2309.6.1.2.3, 2310.1, 2311.1, 2311.3.1, 2311.4.1, 2404.2, 2404.3.1, 2404.3.2.6, 2404.3.3, 2405.2, 2701.1, 2701.4, 2703.2.2, 2703.3.1, 2703.3.2, 2703.3.3, 2703.3.4, 2703.3.8, 2703.14, 2703.14.1, 2703.14.2, 2703.15.1, 2704.3.1, 2705.2.3.2, 2705.3.1, 2705.3.2.1, 2705.3.3, 2803.1, 2905.1, 2909.2, 2909.4, 2909.6, 3101.1, 3103.1, 3103.8.2, 3103.8.4, 3103.9.1, 3104.1, 3105.5, 3314.1, 3403.1, 3704.3, 3704.4, 3704.5, 5003.2.2.2, 5003.2.8, 5003.8.1, Table 5003.8.2, 5003.8.3.1, 5003.8.4.1, 5003.9.9, 5004.13, 5005.2, 5005.3.9, 5101.1, 5303.16.1, 5303.16.2, 5306.2, 5306.2.1, 5503.1.2, 5503.5.2, 5504.2.1.2, 5504.2.2.2, 5505.4.1, 5604.2, Table 5604.5.2(3), 5605.5, 5701.3, 5704.2.7.7, 5704.2.8.1, 5704.2.8.2, 5704.2.9.3, 5704.2.9.4, 5704.3.3.5, 5704.3.7.1, 5704.3.8, 5705.3.4, 5705.3.5.3, 5705.3.7.1, 5705.3.7.2, 5705.3.7.3, 5705.3.7.4, 5705.3.7.5.1, 5706.2.3, 5706.4.1, 5803.1.1, 5806.4.3, 5808.1, 5808.3, 5808.3.2, 5906.2.2, 5906.2.3, 5906.4.2, 6003.1.4.2, 6005.3.1, 6109.11.2, 6204.1.2, 6306.4, 6404.1.4, 6604.1
IEBC—15	International Existing Building Code® . . . . .	1011.5.2, 1103.1
IFGC—15	International Fuel Gas Code® . . . . .	201.3, 603.1, 603.1.2, 603.5.2, 603.8, 2301.1, 2301.6, 2309.3.1.2, 2309.3.1.5, 2504.5, 3001.1, 3003.1, 3004.1, 3004.2, 3104.15.1, 3104.15.2, 3104.16.1, 3303.1, 3303.3, 3306.2.1, Table 5003.1.1(1), 5301.1, 5801.1, 5803.1.4, 6103.1, 6103.2.1.7, 6103.3
IMC—15	International Mechanical Code® . . . . .	201.3, 202, 308.3, 603.1, 603.1.2, 603.2, 603.3, 603.3.2.4, 603.5.2, 603.8, 606.1, 606.2, 606.3, 606.4, 606.7, 606.8, 606.9, 606.16, 608.6.1, 609.1, 903.2.11.4, 904.12, 907.3.1, 909.1, 909.10.2, 909.13.1, 910.4.7, 1006.2.2.3, 1011.16, 1020.5.1, 2104.2.1, 2105.3, 2301.1, 2301.6, 2309.3.1.2, 2309.3.2.3, 2311.3.1, 2311.4.3, 2311.7.1, 2404.7, 2404.7.2, 2504.5, 2703.2.2, 2703.10.4, 2703.14, 2803.2, 2803.3, 3001.1, 3003.1, 3004.2, 3104.15.1, 3104.15.2, 3303.1, 3703.5, Table 5003.1.1(1), 5003.8.4.2, 5003.8.5.2, 5003.8.6.2, 5004.3.1, 5303.7.6, 5303.16.9, 5305.5, 5306.2.2, 5307.5.1, 5504.2.1.3, 5504.2.2.3, 5505.4.1.1, 5701.3, 5703.6.1, 5704.2.8.9, 5705.3.7.5.1, 5706.2, 5706.4.4, 6003.1.3, 6003.2.3.2, 6004.2.2.7, 6005.3.1, 6005.3.2, 6103.2.1.7
IPC—15	International Plumbing Code® . . . . .	201.3, 903.3.5, 904.11.1.3, 912.6, 2311.2.3, 5004.2.2.6
IPMC—15	International Property Maintenance Code® . . . . .	311.1.1
IRC—15	International Residential Code® . . . . .	102.5, 202, 605.11, 605.11.1.2, 1001.1
IWUIC—15	International Wildland-Urban Interface Code® . . . . .	304.1.2

REFERENCED STANDARDS

# IIAR

International Institute of Ammonia Refrigeration  
1001 N. Fairfax Street, Suite 503  
Alexandria, VA 22314

Standard reference number	Title	Referenced in code section number
IIAR-2—2014	Equipment, Design and Installation of Closed-Circuit Ammonia Mechanical Refrigerating Systems . . . . .	606.12.1.1
IIAR-7—2013	Developing Operating Procedures for Closed-Circuit Ammonia Mechanical Refrigerating Systems . . . . .	606.12.1.1

# IKECA

International Kitchen Exhaust Cleaning Association  
100 North 20th Street, Suite 400  
Philadelphia, PA 19103

Standard reference number	Title	Referenced in code section number
C10—2011 ANSI/IKECA	Standard for Cleaning of Commercial Kitchen Exhaust Systems . . . . .	609.3.3.2

# ISO

International Organization for Standardization (ISO)  
ISO Central Secretariat  
1 ch. de la Voie-Creuse, Case postale 56  
CH-1211 Geneva 20, Switzerland

Standard reference number	Title	Referenced in code section number
ISO 8115—86	Cotton Bales—Dimensions and Density. . . . .	Table 2704.2.2.1, Table 5003.1.1(1)

# NEMA

National Electrical Manufacturer’s Association  
1300 N. 17th Street, Suite 1752  
Rosslyn, VA 22209

Standard reference number	Title	Referenced in code section number
250—2003	Enclosures for Electrical Equipment (1,000 Volt Maximum) . . . . .	6005.2

# NFPA

National Fire Protection Association  
1 Batterymarch Park  
Quincy, MA 02169-7471

Standard reference number	Title	Referenced in code section number
02—11	Hydrogen Technologies Code. . . . .	2309.3.1.1, 2309.3.1.2, 5301.1, 5307.3, 5801.1
10—13	Standard for Portable Fire Extinguishers . . . . .	Table 901.6.1, 906.2, 906.3, Table 906.3(1), Table 906.3(2), 906.3.2, 906.3.4, 3006.3, I101.1
11—10	Standard for Low-, Medium- and High-expansion Foam. . . . .	904.7, 5704.2.9.2.2
12—11	Standard on Carbon Dioxide Extinguishing Systems. . . . .	Table 901.6.1, 904.8, 904.12
12A—09	Standard on Halon 1301 Fire Extinguishing Systems . . . . .	Table 901.6.1, 904.9
13—13	Standard for the Installation of Sprinkler Systems . . . . .	903.3.1.1, 903.3.2, 903.3.8.2 903.3.8.5, 904.12, 905.3.4, 907.6.4, 914.3.2, 1019.3, 1103.4.8, 3201.1, 3204.2, Table 3206.2, 3206.4.1, 3206.9, 3207.2, 3207.2.1, 3208.2.2, 3208.2.2.1, 3208.4, 3210.1, 3401.1, 5104.1, 5104.1.1, 5106.5.7, 5704.3.3.9, Table 5704.3.6.3(7), 5704.3.7.5.1, 5704.3.8.4

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13D—13	Standard for the Installation of Sprinkler Systems in One- and Two-family Dwellings and Manufactured Homes. . . . .	903.3.1.3
13R—13	Standard for the Installation of Sprinkler Systems in Low Rise Residential Occupancies . . . . .	903.3.1.2, 903.3.5.2, 903.4
14—13	Standard for the Installation of Standpipe and Hose Systems . . . . .	905.2, 905.3.4, 905.4.2, 905.6.2, 905.8
15—12	Standard for Water Spray Fixed Systems for Fire Protection . . . . .	5704.2.9.2.3
16—15	Standard for the Installation of Foam-water Sprinkler and Foam-water Spray Systems. . . . .	904.7, 904.12
17—13	Standard for Dry Chemical Extinguishing Systems. . . . .	Table 901.6.1, 904.6, 904.12
17A—13	Standard for Wet Chemical Extinguishing Systems . . . . .	Table 901.6.1, 904.5, 904.12
20—13	Standard for the Installation of Stationary Pumps for Fire Protection. . . . .	913.1, 913.2, 913.5.1
22—13	Standard for Water Tanks for Private Fire Protection . . . . .	507.2.2
24—13	Standard for Installation of Private Fire Service Mains and Their Appurtenances . . . . .	507.2.1, 2809.5
25—14	Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems . . . . .	507.5.3, Table 901.6.1, 904.7.1, 912.7, 913.5
30—12	Flammable and Combustible Liquids Code. . . . .	610.1, 5701.2, 5703.6.2, 5703.6.2.1, 5704.2.7, 5704.2.7.1, 5704.2.7.2, 5704.2.7.3.2, 5704.2.7.4, 5704.2.7.6, 5704.2.7.7, 5704.2.7.8, 5704.2.7.9, 5704.2.9.3, 5704.2.9.4, 5704.2.9.6.1.1, 5704.2.9.6.1.2, 5704.2.9.6.1.3, 5704.2.9.6.1.4, 5704.2.9.6.1.5, 5704.2.9.6.2, 5704.2.9.7.3, 5704.2.10.2, 5704.2.11.3, 5704.2.11.4.2, 5704.2.12.1, 5704.3.1, 5704.3.6, Table 5704.3.6.3(1), Table 5704.3.6.3(2), Table 5704.3.6.3(3), 5704.3.7.2.3, 5704.3.8.4, 5706.8.3
30A—15	Code for Motor Fuel-dispensing Facilities and Repair Garages . . . . .	2301.4, 2301.5, 2301.6, 2306.6.3, 2310.1
30B—15	Code for the Manufacture and Storage of Aerosol Products . . . . .	5101.1, 5103.1, 5104.1, Table 5104.3.1, Table 5104.3.2, Table 5104.3.2.2, 5104.4.1, 5104.5.2, 5104.6, 5106.2.3 5106.3.2, Table 5106.4, 5106.5.1, 5106.5.6, 5107.1
31—11	Standard for the Installation of Oil-burning Equipment . . . . .	603.1.7, 603.3.1, 603.3.3
32—11	Standard for Dry Cleaning Plants . . . . .	2107.1, 2107.3
33—15	Standard for Spray Application Using Flammable or Combustible Materials . . . . .	2404.3.2
34—15	Standard for Dipping, Coating and Printing Processes Using Flammable or Combustible Liquids . . . . .	2405.3, 2405.4.1.1
35—11	Standard for the Manufacture of Organic Coatings . . . . .	2901.3, 2905.4
40—11	Standard for the Storage and Handling of Cellulose Nitrate Film. . . . .	306.2
51—13	Standard for the Design and Installation of Oxygen-fuel Gas Systems for Welding, Cutting and Allied Processes . . . . .	3501.5, 3507.1, 3509.1
51A—12	Standard for Acetylene Cylinder Charging Plants . . . . .	3508.1
52—13	Vehicular Gaseous Fuel System Code . . . . .	5301.1
55—13	Compressed Gases and Cryogenic Fluids Code. . . . .	2309.2.1, 5301.1, 5307.3, 5501.1, 5801.1, 6301.1
56—12	Standard for Fire and Explosion Prevention during Cleaning and Purging of Flammable Gas Piping Systems. . . . .	3306.2.1
58—14	Liquefied Petroleum Gas Code . . . . .	603.4.2.1.1, 6101.1, 6103.1, 6103.2.1, 6103.2.1.2, 6103.2.1.7, 6103.2.2, 6104.1, 6104.3.2, 6104.4, 6105.2, 6106.2, 6106.3, 6107.2, 6107.4, 6108.1, 6108.2, 6109.11.2, 6111.3
59A—13	Standard for the Production, Storage and Handling of Liquefied Natural Gas (LNG) . . . . .	5301.1, 5501.1
61—13	Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities . . . . .	Table 2204.1
69—14	Standard on Explosion Prevention Systems. . . . .	911.1, 911.3, Table 2204.1
70—14	National Electrical Code . . . . .	603.1.3, 603.1.7, 603.5.2, 604.1.2, 605.3, 605.4, 605.9, 605.11, 606.16, 610.6, 610.7, 904.3.1, 907.6.1, 909.12.2, 909.16.3, 910.4.6, 2006.3.4, 2104.2.3, 2108.2, Table 2204.1, 2301.5, 2305.4, 2308.8.1.2.4, 2309.2.3, 2309.6.1.2.4, 2311.3.1, 2403.2.1, 2403.2.1.1, 2403.2.1.4, 2403.2.5, 2404.6.1.2.2, 2404.9.4, 2504.5, 2603.2.1, 2606.4, 2703.7.1, 2703.7.2, 2703.7.3, 2803.4, 2904.1, 3103.12.6.1, 3104.15.7, 3304.7, 3506.4, 5003.7.3, 5003.8.7.1, 5003.9.4, 5303.7.6, 5303.8, 5303.16.11, 5303.16.14, 5503.6, 5503.6.2, 5703.1, Table 5703.1.1, 5703.1.3, 5704.2.8.12, 5704.2.8.17, 5706.2.8, 5803.1.5, 5803.1.5.1, 5807.1.10, 5906.5.5, 5906.5.6, 6109.15.1
72—13	National Fire Alarm and Signaling Code. . . . .	508.1.6, 604.2.4, Table 901.6.1, 903.4.1, 904.3.5, 907.2, 907.2.6, 907.2.9.3, 907.2.11, 907.2.13.2, 907.3, 907.3.3, 907.3.4, 907.5.2.1.2, 907.5.2.2, 907.5.2.2.5, 907.6, 907.6.1, 907.6.2, 907.6.6, 907.7, 907.7.1, 907.7.2, 907.8, 907.8.2, 907.8.5, 1103.3.2

**REFERENCED STANDARDS**

**NFPA—continued**

80—13	Standard for Fire Doors and Other Opening Protectives . . . . .	703.1.3, 1010.1.4.3
85—15	Boiler and Combustion System Hazards Code . . . . .	Table 2204.1
86—15	Standard for Ovens and Furnaces . . . . .	3001.1
92—15	Standard for Smoke Control Systems . . . . .	909.7, 909.8
99—15	Health Care Facilities Code . . . . .	611.1, 1105.5.2, 1105.10.1, 1105.10.2, 5306.4, 5306.5
101—15	Life Safety Code . . . . .	1029.6.2
105—13	Standard for Smoke Door Assemblies and Other Opening Protectives . . . . .	703.1.2
110—13	Standard for Emergency and Standby Power Systems . . . . .	604.1.2, 604.4, 604.5, 913.5.2, 913.5.3
111—13	Standard on Stored Electrical Energy Emergency and Standby Power Systems . . . . .	604.1.2, 604.4, 604.5
120—15	Standard for Fire Prevention and Control in Coal Mines . . . . .	Table 2204.1
160—11	Standard for the Use of Flame Effects Before an Audience . . . . .	308.3.2
170—15	Standard for Fire Safety and Emergency Symbols . . . . .	1025.2.6.1
204—15	Standard for Smoke and Heat Venting . . . . .	Table 901.6.1, 910.5.1
211—13	Standard for Chimneys, Fireplaces, Vents and Solid Fuel-burning Appliances . . . . .	603.2
241—13	Standard for Safeguarding Construction, Alteration and Demolition Operations . . . . .	3301.1
253—15	Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source . . . . .	804.3.1, 804.3.2, 804.4
260—13	Methods of Tests and Classification System for Cigarette Ignition Resistance of Components of Upholstered Furniture . . . . .	805.1.1.1, 805.2.1.1, 805.3.1.1, 805.4.1.1
261—13	Standard Method of Test for Determining Resistance of Mock-up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes . . . . .	805.2.1.1, 805.3.1.1, 805.4.1.1
265—11	Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile Wall Coverings in Full Height Panels and Walls . . . . .	803.5.1, 803.5.1.1, 803.5.1.2, 803.5.2, 803.6
286—15	Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth . . . . .	803.1, 803.1.2, 803.1.2.1, 803.5.1, 803.5.2, 803.6, 803.7
289—13	Standard Method of Fire Test for Individual Fuel Packages . . . . .	806.2, 807.4, 807.5.1.1, 808.3
303—11	Fire Protection Standard for Marinas and Boatyards . . . . .	905.3.7, 3603.5, 3603.6, 3604.2
318—15	Standard for the Protection of Semiconductor Fabrication Facilities . . . . .	2703.16
326—10	Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair . . . . .	3510.1
385—12	Standard for Tank Vehicles for Flammable and Combustible Liquids . . . . .	5706.5.4.5, 5706.6, 5706.6.1
400—13	Hazardous Materials Code . . . . .	5601.1.5, 6304.1.2, Table 6304.1.5(1), Table 6304.1.5(2)
407—12	Standard for Aircraft Fuel Servicing . . . . .	2006.2, 2006.3
409—11	Standard for Aircraft Hangars . . . . .	914.8.3, Table 914.8.3, 914.8.3.1, 914.8.6
410—10	Standard on Aircraft Maintenance . . . . .	2004.7
484—15	Standard for Combustible Metals . . . . .	Table 2204.1
495—13	Explosive Materials Code . . . . .	202, 911.1, 911.4, 5601.1.1, 5601.1.5, 5604.2, 5604.6.2, 5604.6.3, 5604.7.1, 5605.1, 5606.1, 5606.5.2.1, 5606.5.2.3, 5607.1, 5607.9, 5607.11, 5607.15
498—13	Standard for Safe Havens and Interchange Lots for Vehicles Transporting Explosives . . . . .	5601.1.2
505—13	Fire Safety Standard for Powered Industrial Trucks, Including Type Designations, Areas of Use, Maintenance and Operation . . . . .	5003.7.3
654—13	Standard for Prevention of Fire and Dust Explosions from the Manufacturing, Processing and Handling of Combustible Particulate Solids . . . . .	Table 2204.1
655—12	Standard for the Prevention of Sulfur Fires and Explosions . . . . .	Table 2204.1
664—12	Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities . . . . .	Table 2204.1, 2805.3
701—10	Standard Methods of Fire Tests for Flame-propagation of Textiles and Films . . . . .	806.2, 807.4, 807.5.1.2, 2603.5, 3104.2
703—15	Standard for Fire Retardant-Wood and Fire-Retardant Coatings for Building Materials . . . . .	803.4
704—12	Standard System for Identification of the Hazards of Materials for Emergency Response . . . . .	606.7, 202, 3104.2, 5003.2.2.1, 5003.2.2.2, 5003.5, 5003.10.2, 5005.1.10, 5005.2.1.1, 5005.4.4, 5503.4.1, 5704.2.3.2,
720—15	Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment . . . . .	915.5.1, 915.5.2, 915.6
750—14	Standard on Water Mist Fire Protection Systems . . . . .	202, Table 901.6.1, 904.11.1.1
914—10	Code for Fire Protection of Historic Structures . . . . .	1103.1.1
1122—13	Code for Model Rocketry . . . . .	5601.1.4
1123—14	Code for Fireworks Display . . . . .	202, 5604.2, 5608.1, 5608.2.2, 5608.5, 5608.6
1124—06	Code for the Manufacture, Transportation, Storage and Retail Sales of Fireworks and Pyrotechnic Articles . . . . .	202, 5601.1.3, 5604.2, 5605.1, 5605.3, 5605.4, 5605.5, 5609.1

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1125—12	Code for the Manufacture of Model Rocket and High Power Rocket Motors . . . . .	5601.1.4
1126—11	Standard for the Use of Pyrotechnics Before a Proximate Audience . . . . .	5604.2, 5605.1, 5608.1, 5608.2.2, 5608.4, 5608.5
1127—13	Code for High Power Rocketry . . . . .	5601.1.4
2001—15	Standard on Clean Agent Fire Extinguishing Systems . . . . .	Table 901.6.1, 904.10

**UL**

Underwriters Laboratories LLC  
333 Pfingsten Road  
Northbrook, IL 60062

Standard reference number	Title	Referenced in code section number
10C—09	Positive Pressure Fire Tests of Door Assemblies . . . . .	1010.1.10.1
30—95	Metal Safety Cans—with revisions through July 2009 . . . . .	5003.9.10, 5005.1.10, 5705.2.4
58—96	Steel Underground Tanks for Flammable and Combustible Liquids—with revisions through July 1998 . . . . .	5704.2.13.1.5
80—07	Steel Tanks for Oil-Burner Fuels and Other Combustible Liquids— with revisions Through August 2009 . . . . .	610.2
87A—12	Outline of Investigation for Power-Operated Dispensing Devices for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations up to 85 Percent . . . . .	2306.8.1
142—06	Steel Aboveground Tanks for Flammable and Combustible Liquids—with revisions through February 12, 2010 . . . . .	610.2, 2306.2.3
199E—04	Outline of Investigation for Fire Testing of Sprinklers and Water Spray Nozzles for Protection of Deep Fat Fryers . . . . .	904.12.4.1
217—06	Single and Multiple Station Smoke Alarms—with revisions through April 2012 . . . . .	907.2.11, 915.4.3
268—09	Smoke Detectors for Fire Alarm Systems . . . . .	907.2.6.2, 907.2.11.7, 915.5.3
294—1999	Access Control System Units—with revisions through September 2010 . . . . .	1010.1.9.6, 1010.1.9.8, 1010.1.9.9
300—05(R2010)	Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment— with revisions through July 16, 2010 . . . . .	904.12
300A—06	Outline of Investigation for Extinguishing System Units for Residential Range Top Cooking Surfaces . . . . .	904.13
305—2012	Panic Hardware . . . . .	1010.1.10.1
325—02	Door, Drapery, Gate, Louver and Window Operators and Systems— with revisions through June 2013 . . . . .	503.5, 503.6
499—05	Standard for Electrical Heating Appliances—with revisions through February 2013 . . . . .	610.6
710B—2011	Recirculating Systems . . . . .	609.2, 904.12
723—08	Standard for Test for Surface Burning Characteristics of Building Materials— with revisions through September 2010 . . . . .	202, 803.5.1, 803.5.2, 803.6, 803.7, 803.10, 804.1, 804.2.4
790—04	Standard Test Methods for Fire Tests of Roof Coverings— with revisions through October 2008 . . . . .	317.2, 317.3
793—08	Automatically Operated Roof Vents for Smoke and Heat— with revisions through September 2011 . . . . .	910.3.1
864—03	Control Units and Accessories for Fire Alarm Systems— with revisions through August 2012 . . . . .	909.12, 2311.7.2.1.1, 5808.5.2, 6004.2.2.10.1
900—04	Air Filter Units—with revisions through February 2012 . . . . .	2404.7.8
924—06	Standard for Safety Emergency Lighting and Power Equipment— with revisions through February 2011 . . . . .	1013.5, 3103.12.6.1
1037—99	Antitheft Alarms and Devices—with revisions through December 2009 . . . . .	506.1
1275—05	Flammable Liquid Storage Cabinets—with revisions through February 2010 . . . . .	5003.8.7.1, 5704.3.2.1.1
1313—93	Standard for Nonmetallic Safety Cans for Petroleum Products— with revisions through November 2012 . . . . .	5003.9.10
1315—95	Standard for Safety for Metal Waste Paper Containers— with revisions through September 2012 . . . . .	808.1, 808.2
1316—94	Glass Fiber Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-gasoline Mixtures— with revisions through May 2006 . . . . .	5704.2.13.1.5
1363—07	Relocatable Power Taps—with revisions through September 2012 . . . . .	605.4.1
1975—06	Fire Tests for Foamed Plastics Used for Decorative Purpose . . . . .	807.4.2.1, 808.3
1994—04	Standard for Luminous Egress Path Marking Systems— with revisions through November 2010 . . . . .	1008.2.1, 1025.2.1, 1025.2.3, 1025.2.4, 1025.4
2017—08	General-Purpose Signaling Devices and Systems— with revisions through May 2011 . . . . .	2311.7.2.1.1, 5808.5.2, 6004.2.2.10.1

**REFERENCED STANDARDS**

**UL—continued**

2034—08	Single and Multiple Station Carbon Monoxide Alarms— with revisions through February 2009 . . . . .	915.4.2, 915.4.3, 1103.9
2075—2013	Standard for Gas and Vapor Detectors and Sensors . . . . .	915.5.1, 915.5.3, 2311.7.2.1.1, 5808.5.2, 6004.2.2.10.1
2079—04	Tests for Fire Resistance of Building Joint Systems— with revisions through December 2012 . . . . .	202
2085—97	Protected Above-ground Tanks for Flammable and Combustible Liquids— with revisions through September 2010 . . . . .	202, 2306.2.2, 2306.2.3, 5704.2.7.4, 5704.2.9.2.3, 5704.2.9.7.4, 5705.3.8.2
2196—2001	Tests for Fire Resistive Cables—with revisions through March 2012 . . . . .	604.3, 913.2.2
2200—2012	Stationary Engine Generator Assemblies—with revisions through June 2013 . . . . .	604.1.1
2208—2010	Solvent Distillation Units—with revisions through March 2011 . . . . .	5705.4.1
2245—06	Below-grade Vaults for Flammable Liquid Storage Tanks . . . . .	5704.2.8.1
2335—10	Fire Tests of Storage Pallets—with revisions through September 2012 . . . . .	3206.4.1.1, 3208.2.1
2360—00	Test Methods for Determining the Combustibility Characteristics of Plastics Used in Semi-Conductor Tool Construction— with revisions through May 2013 . . . . .	2703.10.1.2

**USC**

United States Code  
c/o Superintendent of Documents  
U.S. Government Printing Office  
Washington, DC 20402-9325

Standard reference number	Title	Referenced in code section number
18 USC Part 1, Chapter 40	Importation, Manufacture, Distribution and Storage of Explosive Materials. . . . .	202
21 USC Chapter 9	United States Food, Drug and Cosmetic Act . . . . .	4002.1

## Part VII—Appendices

# Appendix A: Board of Appeals

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

### General Comments

When adopted, this appendix provides jurisdictions with detailed appeals board member qualifications and administrative procedures to supplement the basic requirements found in Section 108 of the code.

### Purpose

This appendix contains optional criteria for administrative procedures of the board of appeals and board member qualifications. A jurisdiction that wants to make this appendix a mandatory part of the code needs to specifically list this appendix in its adoption ordinance (see page xxi of the code for a sample ordinance for adoption).

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### SECTION A101 GENERAL

**A101.1 Scope.** A board of appeals shall be established within the jurisdiction for the purpose of hearing applications for modification of the requirements of the *International Fire Code* pursuant to the provisions of Section 108 of the *International Fire Code*. The board shall be established and operated in accordance with this section, and shall be authorized to hear evidence from appellants and the *fire code official* pertaining to the application and intent of this code for the purpose of issuing orders pursuant to these provisions.

❖ Section 108 establishes a board of appeals, provides a framework for the composition of the board, defines the limits of the board's authority and requires that the board adopt a set of rules of procedure for its operation. This appendix describes a model board of appeals that the jurisdiction may adopt and gives both a recommended board membership and a recommended operating procedure for the conduct of the board. The jurisdiction must adopt this appendix as part of its fire code before the board and its operations, as described in the appendix, can be authorized.

**A101.2 Membership.** The membership of the board shall consist of five voting members having the qualifications established by this section. Members shall be nominated by the *fire code official* or the chief administrative officer of the jurisdiction, subject to confirmation by a majority vote of the governing body. Members shall serve without remuneration or compensation, and shall be removed from office prior to the end of their appointed terms only for cause.

❖ This section details the method of appointment and the general administrative policy pertaining to the

board. The five subsections, Sections A101.2.1 through A101.2.5, list the recommended makeup of the board and the qualifications each member should have to serve on the board.

It is important that the decisions of the appeals board be based purely on the technical merits involved in an appeal and that only technical people rule on technical matters, with due regard for state-of-the-art fire protection and construction technology. The board should not be expected to engage in policy or political deliberations. Members of the appeals board are expected to have experience in matters of fire safety and building construction technology as prescribed in Sections A101.2.1 through A101.2.5.

The board of appeals is to consist of five members recommended by the fire code official and appointed by the chief administrative officer of the jurisdiction—typically, the mayor or city manager. To enhance the integrity of the board and its deliberations and preclude any accusations of partiality on the part of a board member, the members are to serve strictly as volunteers in the community interest, without salary, stipend or any other form of compensation.

**A101.2.1 Design professional.** One member shall be a practicing design professional registered in the practice of engineering or architecture in the state in which the board is established.

❖ The architectural or engineering design professional serves on the board to give a balanced perspective to board deliberations. His or her role should be to evaluate the general design features of the appeal to determine whether they satisfy the intent of the code.

**A101.2.2 Fire protection engineering professional.** One member shall be a qualified engineer, technologist, technician or safety professional trained in fire protection engineering, fire science or fire technology. Qualified representatives in this category shall include fire protection contractors and certified technicians engaged in *fire protection system* design.

- ❖ This board member is expected to evaluate appeals to determine whether they represent good, logical solutions to fire safety questions that satisfy code requirements and are consistent with current fire protection engineering principles. Note that this position does not specifically require professional registration in the state but may be filled by any technical person qualified in fire protection technology, including experienced fire protection system installation contractors and system designers.

**A101.2.3 Industrial safety professional.** One member shall be a registered industrial or chemical engineer, certified hygienist, certified safety professional, certified hazardous materials manager or comparably qualified specialist experienced in chemical process safety or industrial safety.

- ❖ The key words in this section are “chemical process safety” or “industrial safety.” This board member should contribute specialized knowledge of this field to board deliberations. His or her concerns should be more with industrial processes and inventories than with design or safety features, although his or her knowledge of the processes and the materials involved in them should bear on both. Note that this position also does not necessarily require professional registration in the state but may be filled by any technical person qualified in matters of chemical or industrial safety. This member’s input would be especially valuable in appeals involving the application and enforcement of the hazardous material provisions of the code.

**A101.2.4 General contractor.** One member shall be a contractor regularly engaged in the construction, *alteration*, maintenance, repair or remodeling of buildings or building services and systems regulated by the code.

- ❖ The experienced general contractor adds to the board’s expertise in determining the practicality of an appeal. This member many times may be a counterbalance to the opinion of the design professional. That is, the design may satisfy the definition of good engineering practice but not be practical or economical to construct or be compatible with an existing structure in the case of building modifications or additions.

**A101.2.5 General industry or business representative.** One member shall be a representative of business or industry not represented by a member from one of the other categories of board members described above.

- ❖ This board member, as stated in the code text, is expected to represent a point of view not represented by the other four board members. This member could, for example, be nominated by the jurisdiction’s

Chamber of Commerce or Industrial Development Board.

**A101.3 Terms of office.** Members shall be appointed for terms of 4 years. No member shall be reappointed to serve more than two consecutive full terms.

- ❖ Limiting terms of service serves two purposes. First, it ensures a turnover of membership so that professionals not currently on the board will have an opportunity to serve. Second, it tells the prospective board nominee that there is a definite term of service being committed to. In larger jurisdictions where the board may be very busy, these principles can also help reduce the potential for the so-called “burnout” syndrome among board members.

**A101.3.1 Initial appointments.** Of the members first appointed, two shall be appointed for a term of 1 year, two for a term of 2 years, one for a term of 3 years.

- ❖ The staggered terms for initial appointees ensures that no more than two board members will come up for reappointment or replacement in any one year unless one or more members resigns for personal reasons or is replaced for cause. This method of staggered appointment also allows for a smooth transition of board of appeals members, providing continuity of board action over the years.

**A101.3.2 Vacancies.** Vacancies shall be filled for an unexpired term in the manner in which original appointments are required to be made. Members appointed to fill a vacancy in an unexpired term shall be eligible for reappointment to two full terms.

- ❖ This section authorizes filling vacancies on the board outside of regular term expirations and sets the limits on terms of service for the new appointee. Vacancies are filled in the same manner as outlined in Section A101.2, with persons possessing qualifications equivalent to those of the board member being replaced.

**A101.3.3 Removal from office.** Members shall be removed from office prior to the end of their terms only for cause. Continued absence of any member from regular meetings of the board shall, at the discretion of the applicable governing body, render any such member liable to immediate removal from office.

- ❖ No board member can be removed from office without cause. Although there may be many reasons for removing a serving board member, the only one identified here is chronic failure to perform board duties by attending scheduled regular meetings. This does not mean absence is the only reason for removal.

**A101.4 Quorum.** Three members of the board shall constitute a quorum. In varying the application of any provisions of this code or in modifying an order of the *fire code official*, affirmative votes of the majority present, but not less than three, shall be required.

- ❖ This section clearly defines a quorum and also states that no matter how many members are present at the meeting, at least three affirmative votes are required

for passage of a proposal for code variance or modification.

**A101.5 Secretary of board.** The *fire code official* shall act as secretary of the board and shall keep a detailed record of all its proceedings, which shall set forth the reasons for its decisions, the vote of each member, the absence of a member and any failure of a member to vote.

❖ This section establishes the fire code official as the board secretary and defines the secretary's duties. Because the deliberations and actions of a board of appeals are considered legal proceedings, the secretary is required to record the proceedings in substantial detail. These details may be needed for any future review of the board's decision or for documentation in executing the procedures established by this appendix.

**A101.6 Legal counsel.** The jurisdiction shall furnish legal counsel to the board to provide members with general legal advice concerning matters before them for consideration. Members shall be represented by legal counsel at the jurisdiction's expense in all matters arising from service within the scope of their duties.

❖ This section requires the jurisdiction to appoint legal counsel to give the board opinions on the legality of proposed variances and also to represent board members at the jurisdiction's expense should a legal action result from their decisions within the scope of their duties. This legal representation for board members would not be considered remuneration or compensation to the board member, which is prohibited by Section A101.2.

**A101.7 Meetings.** The board shall meet at regular intervals, to be determined by the chairman. In any event, the board shall meet within 10 days after notice of appeal has been received.

❖ This section establishes ground rules for when meetings are to be held and gives the chairperson of the board the responsibility for making sure meetings are held to give timely response to appellants. In order that an appellant's request be heard in a timely manner, the board must meet within 10 days of the filing of an appeal. In large jurisdictions, where there are likely to be more appeals, the board will often set a regular schedule of meeting dates, such as monthly, and the 10-day rule would not apply.

**A101.8 Conflict of interest.** Members with a material or financial interest in a matter before the board shall declare such interest and refrain from participating in discussions, deliberations and voting on such matters.

❖ This section defines conflict of interest for board members and states their expected behavior. All members must recuse themselves from any appeal proceeding in which they have a personal, professional or financial interest.

**A101.9 Decisions.** Every decision shall be promptly filed in writing in the office of the *fire code official* and shall be open to public inspection. A certified copy shall be sent by mail or

otherwise to the appellant, and a copy shall be kept publicly posted in the office of the *fire code official* for 2 weeks after filing.

❖ This section establishes guidelines for posting decisions and notifying appellants. Once an appeal is concluded and a board has taken action, the board secretary must prepare one or more certified copies of the written report for record and distribution. The report copies must be certified as required by applicable state laws pertaining to such matters, which can often be accomplished by a commissioned notary public. The office of the municipal clerk or the board's legal counsel should be able to provide guidance on the subject. To ensure that the decisions and actions of the board are publicly broadcast, a copy of all decisions must be posted in a publicly accessible location in the office of the fire code official for at least two weeks from the date of the action. The appellant must also be given a certified copy of the decision by personal service or ordinary mail service, although certified mail with a requested return receipt would be advisable.

**A101.10 Procedures.** The board shall be operated in accordance with the Administrative Procedures Act of the state in which it is established or shall establish rules and regulations for its own procedure not inconsistent with the provisions of this code and applicable state law.

❖ This section establishes the responsibility of the board to operate using procedures established by the state or jurisdiction having authority. If those administrative procedures do not exist in a given jurisdiction, the board is to write its own procedures consistent with both the code and existing state law.

Hearings before the board must be open to the public as required by state law. The appellant, the appellant's representative, the building official and any person whose interests are affected must be heard.



# Appendix B: Fire-Flow Requirements for Buildings

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

## General Comments

The availability of water is essential for fire-fighting operations. The amount of water required to fight a fire depends on many things, including the type of construction, the location of the fire, the contents of the building, response time and the capabilities of the fire department. Fires will increase in size very quickly from the time of ignition to the arrival of the fire department. Couple these unknowns with the fact that the actual water available varies significantly from one jurisdiction to another and, in many cases, from one location to another in the same jurisdiction, and it is easy to see that determining the necessary water supply is not an exact science. The fire-flow rates given in this appendix are a simplified version of the method previously published by the Insurance Services Office (ISO), *Guide for Determination of Required Fire Flow* (ISO 1972). This particular method took several factors into account that included construction type, size and location of the building. The actual equation used with the ISO guide was as follows:

$$F = 18 C(A)^{0.5}$$

where:

$F$  = Required fire flow (gpm).

$C$  = Coefficient related to the type of construction.

$A$  = Total floor area (including all stories but excluding the basement).

Type of Construction	Coefficient
Wood-frame construction	1.5
For ordinary construction	1.0
Noncombustible construction	0.8
Fire-resistive construction	0.6

This equation came with various increases and decreases that will be discussed throughout this commentary. The simplified version of this method is included here for two reasons. First, the guidelines were difficult to obtain; and second, the methodology was considered overly complex for the degree of accuracy it

gave.

Fire-flow determination is not an exact science. Several methods beyond the one presented by ISO have been available over the years and none is able to provide a correct answer for all situations. Fires grow quickly during their initial stages and the amount of water necessary increases as the fire grows. The larger the fire, the larger the water supply necessary. This is why sprinklers require, comparably, much less water as they can attack the fire at a very early stage. For these reasons, this appendix does not provide a single answer to solve the problem of determining the amount of fire flow required. It is a decision that must involve many factors.

This appendix was developed independent of the sprinkler standards NFPA 13, 13R and 13D. These standards sometimes have requirements for inside and outside hose streams that are independent of the fire-flow requirements.

## Purpose

This appendix provides a tool for jurisdictions to establish a policy for fire-flow requirements. The determination of required fire flow is not an exact science, but having some level of information provides a consistent way of choosing the appropriate fire flow for buildings throughout a jurisdiction.

The primary tool used in this appendix is Table B105.1, which presents fire flows based on construction type and building area. This table is based on the correlation of the ISO method and the construction types used in the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>). Because of the wide variations in water availability and the application of fire flow in different communities, these provisions are presented in this appendix.

The important message sent by this appendix is that some sort of policy should be in place to provide requirements that are consistent within a jurisdiction. Fire-flow requirements have the tendency to be somewhat controversial for the simple reasons that the facilities needed to provide them can be very costly to construct and install and appear to the building owners, in many cases, to yield little benefit.

## SECTION B101 GENERAL

**B101.1 Scope.** The procedure for determining fire-flow requirements for buildings or portions of buildings hereafter constructed shall be in accordance with this appendix. This appendix does not apply to structures other than buildings.

- ❖ This appendix is clearly intended for buildings only and would not be applicable to outside storage areas or similar hazards. Target hazards such as petroleum bulk plants, refineries, lumberyards, junk yards, etc., which present high-challenge fire suppression scenarios, must be specifically evaluated and protected commensurate with the hazards and operational challenges that they present.

The provisions of this appendix were originally drafted based on the ISO *Guide for Determination of Required Fire Flow* (now called the *Guide for Determination of Needed Fire Flow*), which focuses on buildings only and takes into account the construction type and building size as well as exposures from other buildings nearby. This method may not translate very well to other hazards but could be used as a starting point for other types of facilities. Also, the scope of this appendix is intended for new construction rather than existing buildings. Providing fire flow is generally costly, and requiring it for existing buildings would likely be unreasonable.

Note that the appendix applies only if specifically adopted by ordinance by a jurisdiction. See the commentary to Sections 102.5 and 507.1 for a discussion of this appendix's application (if adopted) to buildings constructed under the *International Residential Code*® (IRC®).

## SECTION B102 DEFINITIONS

**B102.1 Definitions.** For the purpose of this appendix, certain terms are defined as follows:

- ❖ Definitions can help in the understanding and application of the code requirements. Having the definitions here puts them close to the subject matter to which they pertain.

**FIRE-FLOW.** The flow rate of a water supply, measured at 20 pounds per square inch (psi) (138 kPa) residual pressure, that is available for fire fighting.

- ❖ A consistent criterion is used to measure the water available for fire fighting. The criterion is that the fire flow available be measured at a residual pressure of 20 pounds per square inch (psi) (138 kPa). Residual pressure is the pressure in the water main measured when the water is flowing, as opposed to static pressure, which is measured when the water is not flowing.

The residual pressure criterion of 20 psi (138 kPa) is used because it is the minimum pressure recommended for fire engine use by water authorities in

order to minimize the possibility of creating a negative pressure in the water main and damaging the water supply system. It also provides a consistent point from which to measure the available flow. Flow will vary based on the pressure for each system. NFPA 291 provides information on fire-flow testing and formulae for calculating test results, including how to calculate the flow available at the 20 psi (138 kPa) residual pressure.

**FIRE-FLOW CALCULATION AREA.** The floor area, in square feet (m<sup>2</sup>), used to determine the required fire flow.

- ❖ This term defines what portion of the building is to be accounted for when applying Table B105.1. This term differs from the IBC definition of "Fire area" in that this definition allows a fire-flow calculation area, for the purposes of defining fire flow, to be divided only by a fire wall with no openings or penetrations. Fire barriers and fire partitions could not be used to create separate fire-flow calculation areas (see commentary, Section B104.2).

## SECTION B103 MODIFICATIONS

**B103.1 Decreases.** The fire chief is authorized to reduce the fire-flow requirements for isolated buildings or a group of buildings in rural areas or small communities where the development of full fire-flow requirements is impractical.

- ❖ The purpose of this section is to recognize that many factors may require adjustments to the numbers in Table B105.1. This particular section generally addresses issues such as proximity to exposures, general location, configuration and practicality.

This section gives the fire code official the authority to make adjustments based on the impracticality of fire-flow requirements in rural areas. The text conveys the message that the requirements found here will not be appropriate for all situations. For example, requiring that a fire main be extended to a house located by itself in the middle of a large open field is impractical. This is especially the case if the fire department has a considerable response time. When a considerable response time exists for buildings, such as one- and two-family dwellings in isolated locations, the effectiveness of fire flow is likely to be low because intervention may not be necessary once the fire department arrives. Although, if this same house is located in an wildland-urban interface area, this may be a different issue. The house may be a complete loss, but the protection of the wildland from the exposure of this fire may be necessary.

This section is intended to provide flexibility to better fit the needs of a specific community. In addition to the example above, the following examples describe instances where requiring the full fire flow given in Table B105.1(2) would be unreasonable:

- A rural area dependent on tanker supplies and on-site water sources.

- A water system for a small town or community provided for domestic consumption with some incidental fire hydrants, but with no serious intent to provide fire protection water.
- A fire department that does not have the equipment to pump the required fire flow.

Section B103.3 discusses alternative approaches for water supplies.

**B103.2 Increases.** The fire chief is authorized to increase the fire-flow requirements where conditions indicate an unusual susceptibility to group fires or conflagrations. An increase shall not be more than twice that required for the building under consideration.

❖ As discussed in Section B103.1, the fire flows provided in this appendix are not appropriate for all situations. This section gives jurisdictions the authority to increase fire flow when necessary. The focus of this section is on densely populated occupancies and on buildings arranged in a way that makes conflagration more likely. These provisions were based on the ISO guide, and this particular section is primarily focusing on proximity to exposures. The ISO guide included specific increases for close proximity buildings and other exposures. This appendix does not include specific increases but does give jurisdictions the authority to make adjustments based on these concerns. Adjustments, however, are not to exceed twice the required fire flow. This section and Section B103.1 together suggest that each jurisdiction have a specific policy that can anticipate various scenarios to enable a consistent approach to those undertaking construction in the jurisdiction.

**B103.3 Areas without water supply systems.** For information regarding water supplies for fire-fighting purposes in rural and suburban areas in which adequate and reliable water supply systems do not exist, the *fire code official* is authorized to utilize NFPA 1142 or the *International Wildland-Urban Interface Code*.

❖ In many cases the infrastructure simply does not exist to provide the large amounts of water required by Table B105.1, but the hazards require that some level of water be available for fire-fighting activities. This section provides an outside resource in the use of either NFPA 1142 or the *International Wildland-Urban Interface Code*® (IWUIC®). NFPA 1142 gives options for areas where adequate and reliable water supplies are not available. It provides minimum requirements for situations where the water is to come from drafting sources, such as a river, canal, stream or pond.

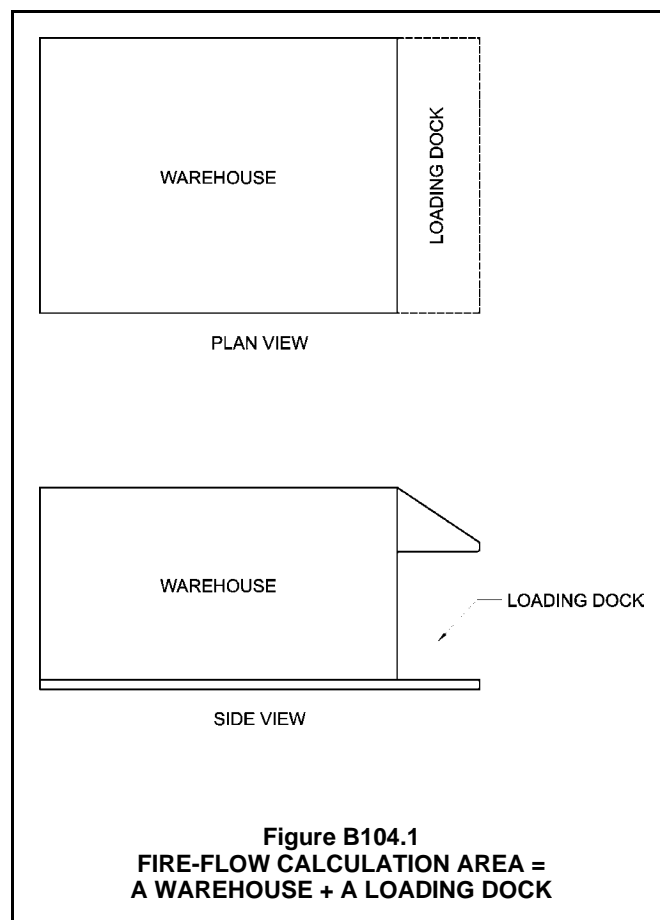
The IWUIC, in Chapter 4, includes alternative approaches to address the lack of water supplies in areas where providing necessary fire flow is typically difficult. Such alternatives include more restrictive construction types and providing defensible spaces to compensate for a reduced water supply. Also, water supply methodologies are presented for both natural and man-made sources.

## SECTION B104 FIRE-FLOW CALCULATION AREA

**B104.1 General.** The fire-flow calculation area shall be the total floor area of all floor levels within the *exterior walls*, and under the horizontal projections of the roof of a building, except as modified in Section B104.3.

❖ This section establishes the area that is to be taken to Tables B105.1(1) and B105.1(2) to determine the minimum fire flow, including how to separate a building into multiple fire-flow calculation areas in order to have lower fire-flow requirements. Fire-flow calculation areas are defined differently here than is the term “Fire area” in the IBC. This difference is described in the commentary for the definition of “Fire-flow calculation area” in Section B102 of this appendix.

The fire-flow calculation area includes all floors and horizontal projections of a building (see Figure B104.1). The area under horizontal projections is important because either combustibles may be located below those areas or the construction itself is combustible. Both situations add to the fire loading of the building. In some cases, horizontal projections can cover a significant area. There are some exceptions for Type IA and IB construction because they are inherently less combustible structures (see commentary, Section B104.3).



**B104.2 Area separation.** Portions of buildings which are separated by *fire walls* without openings, constructed in accordance with the *International Building Code*, are allowed to be considered as separate fire-flow calculation areas.

❖ To reduce the amount of fire flow required, fire walls without openings can be constructed to create separate fire-flow calculation areas. Fire barriers or fire partitions cannot be used to create separate fire-flow calculation areas. It should be noted that IBC Section 706 regulates the construction of fire walls and would generally allow properly protected openings in them (see IBC Section 706.8). However, consistent with Section 102.10 of the code, this section would supercede the IBC fire wall opening provisions since this section is a specific prohibition on any openings in fire walls that are used to reduce the fire-flow calculation area.

**B104.3 Type IA and Type IB construction.** The fire-flow calculation area of buildings constructed of Type IA and Type IB construction shall be the area of the three largest successive floors.

**Exception:** Fire-flow calculation area for open parking garages shall be determined by the area of the largest floor.

❖ Type IA and IB construction are essentially noncombustible and have the tendency to limit fire spread within the buildings more so than other construction types. Therefore, the fire-flow calculation area needs to include only the three largest successive floors. Successive floors are specified because of the logical progression of a fire. The concept of three largest successive floors appears to come from the ISO guide. These guidelines allowed the fire-flow calculation area for fire-resistive construction to only include six successive floors if vertical openings were not protected, and three successive floors if the vertical openings were protected. Taking the three largest floors when they are separated from one another may be overly conservative.

The exception to this section allows open parking garages to count only the largest floor for the fire-flow calculation area. This is probably related to the facts that fires in such facilities tend to be limited to one or two cars and that such facilities have large openings through which the hot gases and smoke from a fire can dissipate quickly, limiting the intensity of the fire.

**SECTION B105**

**FIRE-FLOW REQUIREMENTS FOR BUILDINGS**

**B105.1 One- and two-family dwellings, Group R-3 and R-4 buildings and townhouses.** The minimum fire-flow and flow duration requirements for one- and two-family *dwellings*, Group R-3 and R-4 buildings and townhouses shall be as specified in Tables B105.1(1) and B105.1(2).

❖ This section establishes fire-flow requirements for one- and two-family dwellings, in two distinct categories. The first category is one- and two-family dwellings, Group R3 and R4 buildings and townhouses through reference to Tables B105.1(1) and B105.1(2). Table B105.1(1) essentially addresses two different area ranges and whether automatic sprinkler systems are installed. Where the area is 3,600 square feet or greater, reference is made to Table B105.1(2). It should be noted that automatic sprinkler systems shall comply with either NFPA 13D or IRC Section 2904. Buildings addressed by Section B105.2 allow a larger decrease in fire flow but require an NFPA 13 or NFPA 13R system.

**TABLE B105.1(1).** See below.

❖ This table sets out the requirements for one- and two-family dwellings, Group R3 and R4 buildings and townhouses. The criteria for fire flow is based on two major factors. The first is the area of the building. The table addresses buildings up to 3,600 square feet and greater than 3,600 square feet. The second is whether a sprinkler system is provided. The type of sprinkler system is either that required by NFPA 13D or IRC P2904. The assumption would be that more restrictive systems, such as those required by NFPA13R or 13, would also be permitted.

Essentially, for less than 3,600 square feet, the fire flow is reduced by 50 percent. This is consistent with exceptions present in past editions of the code. Once 3,600 square feet has been reached, compliance with Table B105.1(2) is required. Note that a 50-percent reduction is allowed by Table B105.1(2) for these buildings.

The original ISO guide provided a simplified approach for one- and two-family dwellings. That approach stated that fire flows should be based on a limitation of two stories and a relationship to proximity of exposures. The fire-flow requirements based on

**TABLE B105.1(1)  
REQUIRED FIRE-FLOW FOR ONE- AND TWO-FAMILY DWELLINGS, GROUP R-3 AND R-4 BUILDINGS AND TOWNHOUSES**

FIRE-FLOW CALCULATION AREA (square feet)	AUTOMATIC SPRINKLER SYSTEM (Design Standard)	MINIMUM FIRE-FLOW (gallons per minute)	FLOW DURATION (hours)
0-3,600	No automatic sprinkler system	1,000	1
3,601 and greater	No automatic sprinkler system	Value in Table B105.1(2)	Duration in Table B105.1(2) at the required fire-flow rate
0-3,600	Section 903.3.1.3 of the <i>International Fire Code</i> or Section P2904 of the <i>International Residential Code</i>	500	1/2
3,601 and greater	Section 903.3.1.3 of the <i>International Fire Code</i> or Section P2904 of the <i>International Residential Code</i>	1/2 value in Table B105.1(2)	1

For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 gallon per minute = 3.785 L/m.

proximity to exposures in the ISO guide were as follows:

EXPOSURE DISTANCE (ft)	FIRE-FLOW REQUIREMENT (gpm)
Over 100	500
31-100	750-1000
11-30	1000-1500
10 or less	1500-2000

For SI: 1 foot = 304.8 mm, 1 gallon per minute = 3.785 L/m.

This appendix uses 1,000 gpm (3785 L/min), which would be equivalent to a 30-foot (9144 mm) distance from exposures. This was taken as an average to provide a reasonable number for a majority of one- and two-family dwellings. Also, as discussed in the beginning of this appendix, based on the amount of variability involved with fighting fires, taking an average and applying it to all one- and two-family dwellings may be the most reasonable approach.

This appendix also does not use the two-story limitation but, rather, uses an area limitation of 3,600 square feet (345 m<sup>2</sup>) for the 1,000-gpm (3785 L/min) requirement. This is a more realistic approach because the ISO guide probably did not anticipate the larger floor area of today's houses and the large number of townhouses.

The table recognizes the efficacy of automatic sprinkler systems in reducing the amount of water needed to suppress fires and allows a reduction in fire flow of 50 percent where sprinklers are installed. This allowance for sprinklers does not amount to a requirement that a sprinkler system be installed. Rather, it allows a design alternative to be utilized in the event that there is insufficient water available to meet the required fire flow for a building established by this appendix. Table B105.2 allows a similar reduction for all other types of buildings.

A review of the original ISO guide reveals that there was no reduction for sprinklers in one- and two-family dwellings. However, in 1972 sprinklers were extremely uncommon within homes, and since that time sprinkler technology has changed dramatically. Section B105.2 contains more discussion on the application of this concept of reductions for sprinklers. Generally, the reduction is intended to encourage installation of an automatic sprinkler system because it is easier to control a fire that is attacked during the incipient stages.

**TABLE B105.1(2).** See page B-6.

❖ Table B105.1(2) establishes the fire-flow and duration requirements based on the fire-flow calculation area, as defined by the definition in this appendix and Section B103, and the construction types defined in the IBC. As the construction type becomes more combustible, the fire-flow requirements increase. Likewise, as the area of the building increases, the fire-flow requirements increase. The last column also specifies a minimum duration of fire flow. The duration of fire flow varies from a minimum of 2 hours to 4

hours. Flow duration may be an issue that each jurisdiction may need to consider when assessing the capabilities of the department, the hazards presented and the availability of water supply (see commentary, Section B105.1).

Applying this table, for example, a 50,000-square-foot (4546 m<sup>2</sup>) Type IV construction building would require a fire flow of 4,000 gpm (15 140 L/min) with a duration of 4 hours. If the building was sprinklered in accordance with NFPA 13, the required fire flow would only be 25 percent or 1,000 gpm (5678 L/min).

This table does not address use and occupancy classifications. A Type IA construction building housing a Group A occupancy would be treated the same as a Type IA construction building housing a Group H or F occupancy. Again, this table was formed based on the approaches presented by the ISO guide, which focus on construction types.

A common question when applying this table is how to deal with a building that incorporates multiple construction types. Such scenarios would be better addressed through a percentage approach. For example, in a building that has two construction types, Types IA and VA, having areas of 25,000 square feet (2323 m<sup>2</sup>) and 10,000 square feet (929 m<sup>2</sup>), respectively, the fire flow would be calculated as follows:

Total building area

25,000 square feet (Type IA) + 10,000 square feet (Type VA) = 35,000 square feet (3252 m<sup>2</sup>)

Fire flow per construction type

Type IA at 35,000 square feet = 2,000 gpm (7370 L/min)  
Type VA at 35,000 square feet = 3,250 gpm (12 112 L/min)

Percentage of building

IA = 25,000/35,000 × 100 = 71.4 percent

VA = 10,000/35,000 × 100 = 28.6 percent

Therefore

0.714 (2,000 gpm) + 0.286 (3,250 gpm) = 2,357.5 = Approximately 2,350 gpm (8894 L/min)

**B105.2 Buildings other than one- and two-family dwellings, Group R-3 and R-4 buildings and townhouses.** The minimum fire-flow and flow duration for buildings other than one- and two-family *dwellings*, Group R-3 and R-4 buildings and townhouses shall be as specified in Tables B105.2 and B105.1(2).

❖ This section refers all buildings that are not one- and two-family dwellings to Tables B105.1(2) and B105.2 for the minimum fire-flow and duration requirements. Table B105.1(2) provides the fire flow and Table B105.2 provides the reductions allowed for having either an NFPA 13 or NFPA 13R automatic sprinkler system. In such buildings, the reduction is 75 percent versus the 50-percent reduction allowed for one- and two-family dwellings in Table B105.1(1).

The tabular fire flows, based on the 1972 ISO

APPENDIX B

guide, are extremely high and it is doubtful that many water supply systems and fire departments can develop them. Also, it should be noted that the current ISO guide on this topic for sprinklered buildings requires providing only the calculated sprinkler demand plus hose stream allowances, calling the continued validity of this appendix into question. The updated ISO publication, *Guide for the Determination of Needed Fire Flows*, as with its predecessor, is a tool for the development of fire insurance ratings and is not intended to be used for legislating an individual sprinklered building's fire flow. That document states, "ISO does not determine a needed fire flow for buildings rated and coded by ISO as protected by an automatic sprinkler system meeting applicable National Fire Protection Association standards."

The allowance for buildings equipped with an automatic sprinkler system is intended to encourage the

use of sprinklers. It does not link to any other portions of the code or the IBC in terms of height and area requirements and limitations. Therefore, it can be used in addition to any trade-offs for sprinklers. Keep in mind that as the area of the building increases so do the fire-flow requirements. Therefore, even though a reduction may be given to a building that has already increased its area based on sprinklers, the overall fire flow will be larger because of this area increase.

The original ISO guide allowed only a 25-percent reduction for sprinklers. As mentioned in Section B105.1, sprinkler technology has changed dramatically since the guidelines were developed in the early 1970s. Also, the ISO guide allowed reduction in fire flow for buildings with light fire loads that this appendix does not.

**TABLE B105.1(2)**  
**REFERENCE TABLE FOR TABLES B105.1(1) AND B105.2**

FIRE-FLOW CALCULATION AREA (square feet)					FIRE-FLOW (gallons per minute) <sup>b</sup>	FLOW DURATION (hours)
Type IA and IB <sup>a</sup>	Type IIA and IIIA <sup>a</sup>	Type IV and V-A <sup>a</sup>	Type IIB and IIIB <sup>a</sup>	Type V-B <sup>a</sup>		
0-22,700	0-12,700	0-8,200	0-5,900	0-3,600	1,500	2
22,701-30,200	12,701-17,000	8,201-10,900	5,901-7,900	3,601-4,800	1,750	
30,201-38,700	17,001-21,800	10,901-12,900	7,901-9,800	4,801-6,200	2,000	
38,701-48,300	21,801-24,200	12,901-17,400	9,801-12,600	6,201-7,700	2,250	
48,301-59,000	24,201-33,200	17,401-21,300	12,601-15,400	7,701-9,400	2,500	
59,001-70,900	33,201-39,700	21,301-25,500	15,401-18,400	9,401-11,300	2,750	3
70,901-83,700	39,701-47,100	25,501-30,100	18,401-21,800	11,301-13,400	3,000	
83,701-97,700	47,101-54,900	30,101-35,200	21,801-25,900	13,401-15,600	3,250	
97,701-112,700	54,901-63,400	35,201-40,600	25,901-29,300	15,601-18,000	3,500	
112,701-128,700	63,401-72,400	40,601-46,400	29,301-33,500	18,001-20,600	3,750	
128,701-145,900	72,401-82,100	46,401-52,500	33,501-37,900	20,601-23,300	4,000	4
145,901-164,200	82,101-92,400	52,501-59,100	37,901-42,700	23,301-26,300	4,250	
164,201-183,400	92,401-103,100	59,101-66,000	42,701-47,700	26,301-29,300	4,500	
183,401-203,700	103,101-114,600	66,001-73,300	47,701-53,000	29,301-32,600	4,750	
203,701-225,200	114,601-126,700	73,301-81,100	53,001-58,600	32,601-36,000	5,000	
225,201-247,700	126,701-139,400	81,101-89,200	58,601-65,400	36,001-39,600	5,250	
247,701-271,200	139,401-152,600	89,201-97,700	65,401-70,600	39,601-43,400	5,500	
271,201-295,900	152,601-166,500	97,701-106,500	70,601-77,000	43,401-47,400	5,750	
295,901-Greater	166,501-Greater	106,501-115,800	77,001-83,700	47,401-51,500	6,000	
—	—	115,801-125,500	83,701-90,600	51,501-55,700	6,250	
—	—	125,501-135,500	90,601-97,900	55,701-60,200	6,500	
—	—	135,501-145,800	97,901-106,800	60,201-64,800	6,750	
—	—	145,801-156,700	106,801-113,200	64,801-69,600	7,000	
—	—	156,701-167,900	113,201-121,300	69,601-74,600	7,250	
—	—	167,901-179,400	121,301-129,600	74,601-79,800	7,500	
—	—	179,401-191,400	129,601-138,300	79,801-85,100	7,750	
—	—	191,401-Greater	138,301-Greater	85,101-Greater	8,000	

For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 gallon per minute = 3.785 L/m, 1 pound per square inch = 6.895 kPa.

a. Types of construction are based on the *International Building Code*.

b. Measured at 20 psi residual pressure.

**TABLE 105.2.** See below.

❖ This table provides allowances for reduced fire flow based on the installation of an automatic sprinkler system. More specifically, the fire flow obtained from Table B105.1(2) can be reduced to 25 percent where an NFPA 13 or NFPA 13R system is installed. The only major difference in the allowance given for both sprinkler systems is the minimum flow permitted. NFPA 13 systems can have a fire flow as low as 1,000 gpm, whereas an NFPA 13R system will allow a reduction to a minimum of 1,500 gpm. This is related to the relative performance of the type of sprinkler system. More credit was deemed necessary for NFPA 13 systems. Note with the reductions in this table and also Table B105.1(1) for one- and two-family dwellings, Group R3 and R4 Buildings and townhouses that there is no specific approval required by the fire official to apply these reductions. In the past, this approach has led to confusion as to how to differentiate situations where such an allowance was appropriate and where a lesser reduction was necessary.

**B105.3 Water supply for buildings equipped with an automatic sprinkler system.** For buildings equipped with an approved *automatic sprinkler system*, the water supply shall be capable of providing the greater of:

1. The *automatic sprinkler system* demand, including hose stream allowance.
2. The required fire-flow.

❖ This section clarifies that the fire-flow requirements are not in addition to the sprinkler demand. What is required is determining which needs a larger water supply. The greater of the sprinkler demand or the demand developed in accordance with Appendix B will be the required fire flow.

**SECTION B106  
REFERENCED STANDARDS**

ICC	IBC—15	International Building Code	B104.2,
			Tables
ICC	IFC—15	International Fire Code	B105.1(1) and B105.2
ICC	IWUIC—15	International Wildland-Urban Interface Code	B103.3

ICC	IRC—15	International Residential Code	Table B105.1(1)
NFPA	1142—12	Standard on Water Supplies for Suburban and Rural Fire Fighting	B103.3

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*Fire Service Hydraulics and Water Supply, 1st ed.* Stillwater, OK: International Fire Service Training Association Fire Protection Publications, 2005.

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NFPA 291-10, *Fire Flow Testing and Marking of Hydrants*. Quincy, MA: National Fire Protection Association, 2010.

NFPA 1141-08, *Fire Protection Infrastructure for Land Development in Suburban and Rural Areas*. Quincy, MA: National Fire Protection Association, 2008.

NFPA 1142-12, *Water Supplies for Suburban and Rural Fire Fighting*. Quincy, MA: National Fire Protection Association, 2011.

Smith, P.D. "What Are the Real Fire Flow Requirements?" *Fire Journal*, 1975.

Wenzel, L.J. "Water Supply Requirements for Public Supply Systems," Section 10, Chapter 4. *NFPA Fire Protection Handbook, 19th ed.* Quincy, MA: National Fire Protection Association, 2003.

**TABLE B105.2  
REQUIRED FIRE-FLOW FOR BUILDINGS OTHER THAN ONE- AND TWO-FAMILY DWELLINGS, GROUP R-3 AND R-4 BUILDINGS AND TOWNHOUSES**

AUTOMATIC SPRINKLER SYSTEM (Design Standard)	MINIMUM FIRE-FLOW (gallons per minute)	FLOW DURATION (hours)
No automatic sprinkler system	Value in Table B105.1(2)	Duration in Table B105.1(2)
Section 903.3.1.1 of the <i>International Fire Code</i>	25% of the value in Table B105.1(2) <sup>a</sup>	Duration in Table B105.1(2) at the reduced flow rate
Section 903.3.1.2 of the <i>International Fire Code</i>	25% of the value in Table B105.1(2) <sup>b</sup>	Duration in Table B105.1(2) at the reduced flow rate

For SI: 1 gallon per minute = 3.785 L/m.

- a. The reduced fire-flow shall be not less than 1,000 gallons per minute.
- b. The reduced fire-flow shall be not less than 1,500 gallons per minute.



# Appendix C: Fire Hydrant Locations and Distribution

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

## General Comments

Fire hydrants are among the primary ways to access water for fighting fires. The location and spacing of hydrants are important to the success of fire-fighting operations. The difficulty with determining the spacing of fire hydrants is that every situation is unique and has unique challenges. Finding one methodology for determining hydrant spacing is difficult. This particular appendix gives one methodology fire departments can work with to set a policy for new buildings and facilities.

This methodology is located in an appendix because, as with fire-flow requirements (Appendix B), many factors affect the need for and location of hydrants. Also, in many jurisdictions, hydrant spacing is prescribed by zoning regulations or by the water authority. This appendix is simply one approach for spacing hydrants that can be used when no other guidelines are given.

## Purpose

Section 507.5.1 requires hydrants to be within 400 feet (122 m) of all portions of new buildings and facilities. If a building or facility cannot meet that criterion, on-site fire hydrants and mains are required. This appendix provides some guidance on the spacing of the on-site hydrants based on the required fire flow. These guidelines could also be used to require hydrants on public streets and roads where no other entity regulates such hydrants.

The general approach is to use fire-flow requirements to determine the number and spacing of hydrants—the higher the fire-flow requirements, the larger the number of hydrants required and the smaller the spacing between hydrants. The spacings given in this appendix are independent of the distance to a building and are simply focused on having the correct number and spacing of hydrants on a fire apparatus access road.

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## SECTION C101 GENERAL

**C101.1 Scope.** In addition to the requirements of Section 507.5.1 of the *International Fire Code*, fire hydrants shall be provided in accordance with this appendix for the protection of buildings, or portions of buildings, hereafter constructed or moved into the jurisdiction.

❖ This section establishes the applicability of this appendix, where specifically adopted, to only new buildings and portions of buildings constructed or moved into a jurisdiction. Another important aspect of this section is that these requirements are in addition to what is already required in Section 507.5.1. This is similar to the scope of Appendix B. Generally, both fire flow and fire hydrants are fairly expensive and requiring them for an existing building would likely be cost prohibitive. Note also that the provisions in this appendix may not be adequate for structures other than buildings or for outside storage or processing operations. Target hazards such as petroleum bulk plants, refineries, lumberyards, junk yards, etc., which present high-challenge fire suppression scenarios, must be specifically evaluated and protected commensurate with the hazards and operation challenges they present.

A question that often arises is whether the code is intended to regulated fire hydrant systems in residential developments where buildings are constructed under the provisions of the *International Residential Code*® (IRC®). That question is specifically addressed in Section 102.5. See the commentary to that section for further discussion of this topic.

## SECTION C102 NUMBER OF FIRE HYDRANTS

**C102.1 Minimum number of fire hydrants for a building.**

The number of fire hydrants available to a building shall be not less than the minimum specified in Table C102.1.

❖ This section is focused only on the number of hydrants required. Table C102.1 shows a minimum number of hydrants based on the required fire flow. In many cases, a particular fire flow may require only one or two hydrants.

**TABLE C102.1.** See page Appendix C-2.

❖ This table is referenced throughout this appendix for the minimum number of hydrants and spacing limits. These limits are based on the fire flow required for a particular building. In terms of the spacing limitations,

there are two criteria. First is the average distance between hydrants. Second is a maximum distance limitation from any point on a street or accessway to a hydrant. When the number of required fire hydrants increases, the maximum distance does not always correspond to half of the average distance between hydrants. Instead, this distance is larger than half the distance to compensate for the fact that the average spacing between hydrants as the number of hydrants increases may result in spacings larger than those shown in column three. Otherwise, the maximum distance listed in column four would limit the spacing [see Commentary Figure C102.1(1)].

One question that is often asked with these requirements is whether the table—or the entire appendix, for that matter—requires minimum flows per hydrant. This particular appendix does not address minimum flow per hydrant or how the flow is to be subdivided. Fire-flow requirements are addressed in Appendix B.

**Note a**

This note is referenced in the third column for the average spacing between hydrants and restricts the spacing between hydrants on dead-end streets or roads to 100 feet less than the required spacing. This avoids a hydrant being located an impractical distance from hazards. Otherwise, a hydrant could literally be placed at the end of street and provide little benefit to buildings on that street.

**Note b**

The intent of this note is to provide guidance for placing hydrants along boulevards with uncrossable medians and multilane roads that carry a heavy traffic load each day. Such roadways present the fire department with several challenges to rapidly accessing installed fire hydrants. Boulevards with built-up or walled medians can prevent ready access to hydrants if they are on the opposite side of the street from a fire incident. Accordingly, fire hydrants are required to be installed on both sides of the boulevard right-of-way. Arterial streets with high traffic flows are also problematic as accessing hydrants on the opposite side of the street presents risk to fire fighters and apparatus when leading out or manually dragging supply hoses across such busy thoroughfares.

In addition to those dangers, police agencies already faced with the traffic control needs of the fire scene are often opposed to shutting down major streets for prolonged periods of time since doing so can have an adverse “domino effect” on traffic management in other areas of the community. These hydrants are typically intended for use only with highway hazards and may be spaced every 500 feet (152 m) on each side in alternating positions [resulting in a hydrant every 250 feet (76 200 mm)] [see Commentary Figure C102.1(2)]

**TABLE C102.1  
REQUIRED NUMBER AND SPACING OF FIRE HYDRANTS**

FIRE-FLOW REQUIREMENT (gpm)	MINIMUM NUMBER OF HYDRANTS	AVERAGE SPACING BETWEEN HYDRANTS <sup>a, b, c, f, g</sup> (feet)	MAXIMUM DISTANCE FROM ANY POINT ON STREET OR ROAD FRONTAGE TO A HYDRANT <sup>d, f, g</sup>
1,750 or less	1	500	250
2,000-2,250	2	450	225
2,500	3	450	225
3,000	3	400	225
3,500-4,000	4	350	210
4,500-5,000	5	300	180
5,500	6	300	180
6,000	6	250	150
6,500-7,000	7	250	150
7,500 or more	8 or more <sup>c</sup>	200	120

For SI: 1 foot = 304.8 mm, 1 gallon per minute = 3.785 L/m.

- a. Reduce by 100 feet for dead-end streets or roads.
- b. Where streets are provided with median dividers that cannot be crossed by fire fighters pulling hose lines, or where arterial streets are provided with four or more traffic lanes and have a traffic count of more than 30,000 vehicles per day, hydrant spacing shall average 500 feet on each side of the street and be arranged on an alternating basis.
- c. Where new water mains are extended along streets where hydrants are not needed for protection of structures or similar fire problems, fire hydrants shall be provided at spacing not to exceed 1,000 feet to provide for transportation hazards.
- d. Reduce by 50 feet for dead-end streets or roads.
- e. One hydrant for each 1,000 gallons per minute or fraction thereof.
- f. A 50-percent spacing increase shall be permitted where the building is equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1 of the *International Fire Code*.
- g. A 25-percent spacing increase shall be permitted where the building is equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.2 or 903.3.1.3 of the *International Fire Code* or Section P2904 of the *International Residential Code*.

**Note c**

This note requires that new fire mains installed along fire apparatus access roads or streets without structures have hydrants at least every 1,000 feet (305 m) for the protection of hazards such as car fires or other traffic- or transportation-related hazards. This note does not require that water mains specifically be placed along roadways for this purpose; only that when such mains are installed or extended, hydrants must be provided.

**Note d**

This note requires, as does Note a, that the distance to a hydrant be reduced by 50 feet (13 240 mm) on dead-end streets and roads. Again, this avoids a hydrant being unnecessarily far from buildings.

**Note e**

This note applies only to situations where the table requires eight or more hydrants and that hydrants be added for every 1,000 gpm (3785 L/min) or fraction thereof of fire flow required beyond 7,500 gpm (28 387 L/min). This means that one additional hydrant would be required for fire flows up to 8,500 gpm (2028 L/min). No minimum fire flow per hydrant is specified.

**Note f**

This note is consistent with the decreases in fire flow allowed in Appendix b. This note allows a 50-percent increase in spacing between hydrants where buildings are equipped throughout with an NFPA 13 automatic sprinkler system.

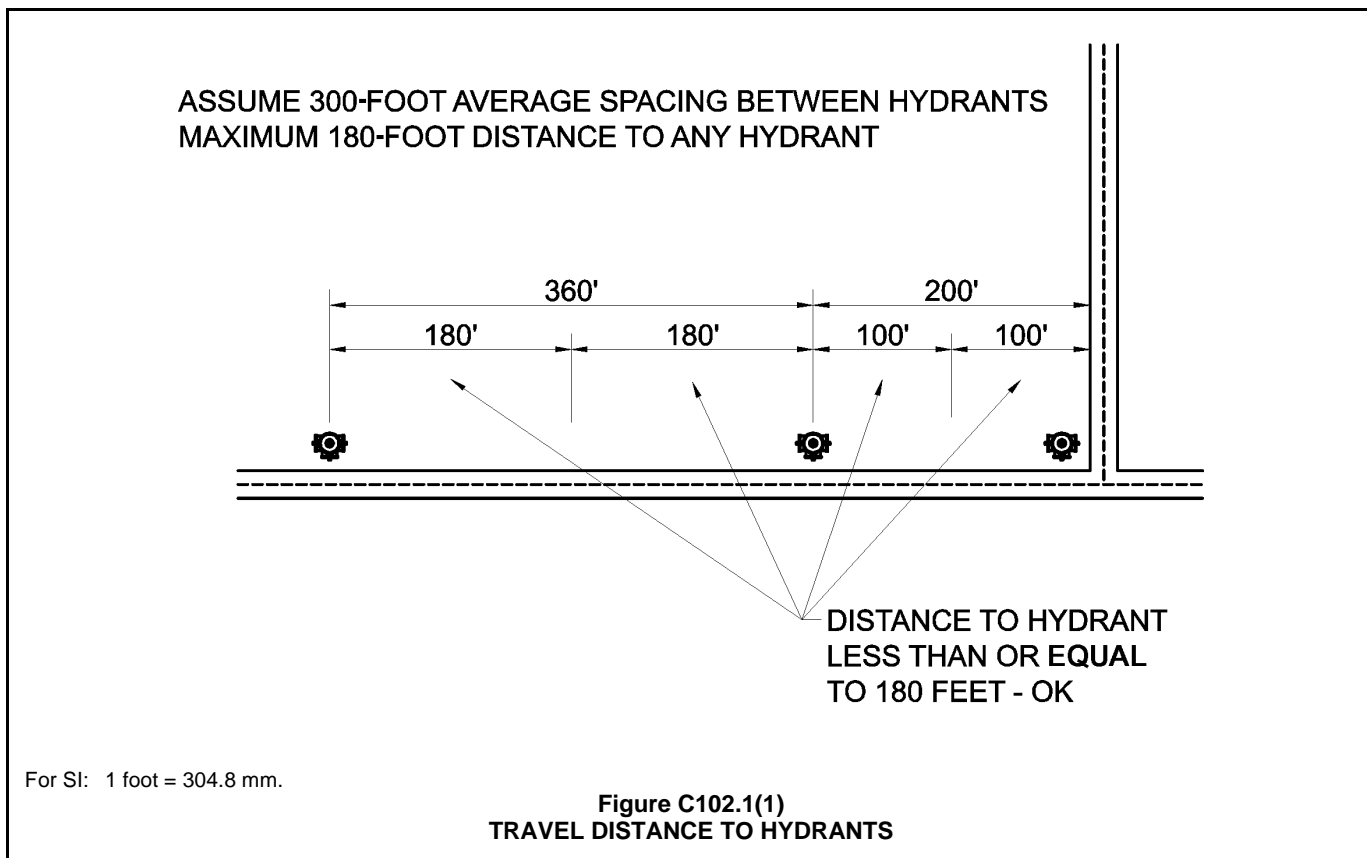
**Note g**

Similar to Note f, this note is consistent with the decreases in fire flow allowed in Appendix B. This note allows a 25-percent increase in spacing between hydrants where buildings are equipped throughout with an NFPA 13R or 13D automatic sprinkler system.

**SECTION C103  
FIRE HYDRANT SPACING**

**C103.1 Hydrant spacing.** Fire apparatus access roads and public streets providing required access to buildings in accordance with Section 503 of the *International Fire Code* shall be provided with one or more fire hydrants, as determined by Section C102.1. Where more than one fire hydrant is required, the distance between required fire hydrants shall be in accordance with Sections C103.2 and C103.3.

❖ This section specifies that when fire apparatus access roads are required by Section 503 such roads be provided with hydrants as set forth in Section C102.1. Where more than one hydrant is required, the distance between hydrants is more specifically dealt with in Sections C103.2 and C103.3. If there is a complex of buildings, each with a low required fire flow, the spacing requirements would dictate additional hydrants. A fire flow of 2,000 gpm (7570 L/min) would require only two hydrants with a maximum average spacing of 450 feet (137 160 mm), but because of the size of the complex additional



hydrants may be necessary to achieve proper spacing along the access road (see Commentary Figure C103.1). In this particular case, the number of hydrants, not the spacing, drives the layout.

**C103.2 Average spacing.** The average spacing between fire hydrants shall be in accordance with Table C102.1.

**Exception:** The average spacing shall be permitted to be increased by 10 percent where existing fire hydrants provide all or a portion of the required number of fire hydrants.

❖ This section states that the spacing designated in Table C102.1 is an average. Real-life conditions, however, often result in the need for approximate spacing of hydrants. In some cases, good judgment would dictate deviation from rigid exact spacing so that hydrants could be located where more than one building could access them [see Commentary Figure C103.2].

The exception allows a 10-percent deficiency in average hydrant spacing when using existing hydrants. For example, if the average spacing allowed is 350 feet (106 m), the largest average spacing allowed by this exception would be  $350 \times 1.10 = 385$  feet (117 m). The allowance of longer average spacing for existing hydrants is important in enabling their use with new buildings.

**C103.3 Maximum spacing.** The maximum spacing between fire hydrants shall be in accordance with Table C102.1.

❖ This section requires that no point on a street or access road be beyond the distance to a hydrant shown in the last column of Table C102.1. This distance is not an average but a maximum distance (see Commentary Figure C103.3).

**SECTION C104**

**CONSIDERATION OF EXISTING FIRE HYDRANTS**

**C104.1 Existing fire hydrants.** Existing fire hydrants on public streets are allowed to be considered as available to meet the requirements of Sections C102 and C103. Existing fire hydrants on adjacent properties are allowed to be considered as available to meet the requirements of Sections C102 and C103 provided that a fire apparatus access road extends between properties and that an easement is established to prevent obstruction of such roads.

❖ To meet the number and spacing requirements of this appendix, existing hydrants may be counted as available. In smaller buildings, this could mean that the fire hydrants available may be sufficient to meet the hydrant spacing needs. Hydrants on adjacent property should not be used unless access is always available to the fire department. This may require an easement on the adjacent property.

**SECTION C105**

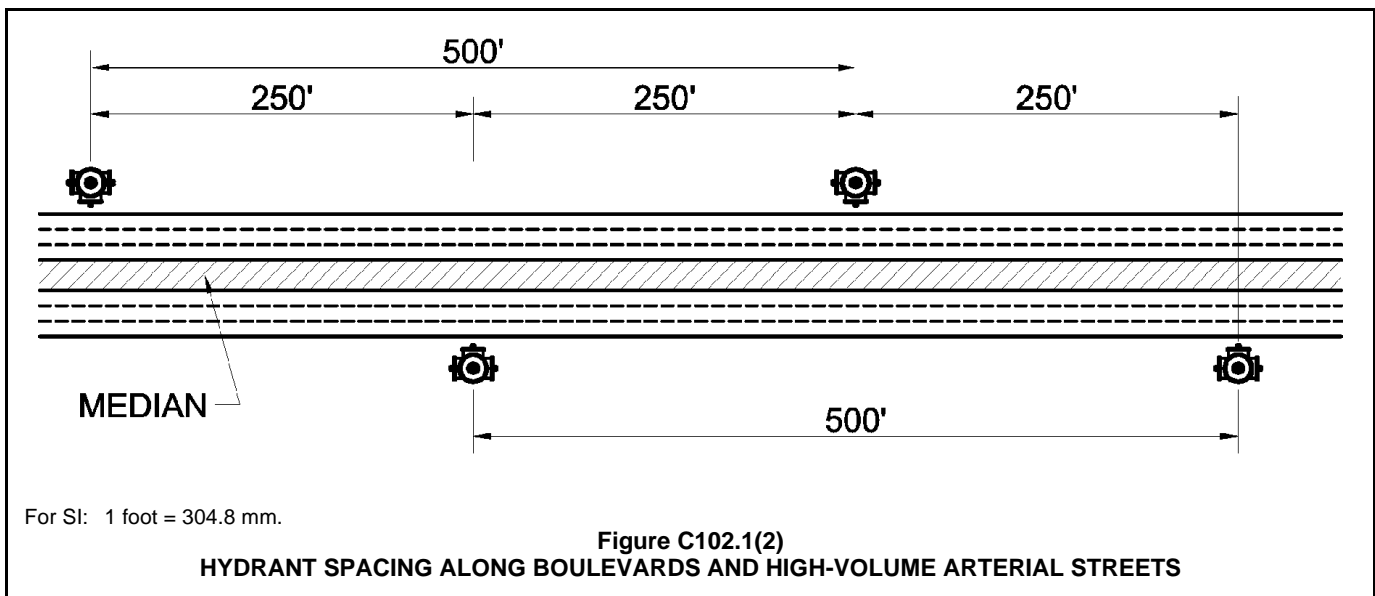
**REFERENCED STANDARDS**

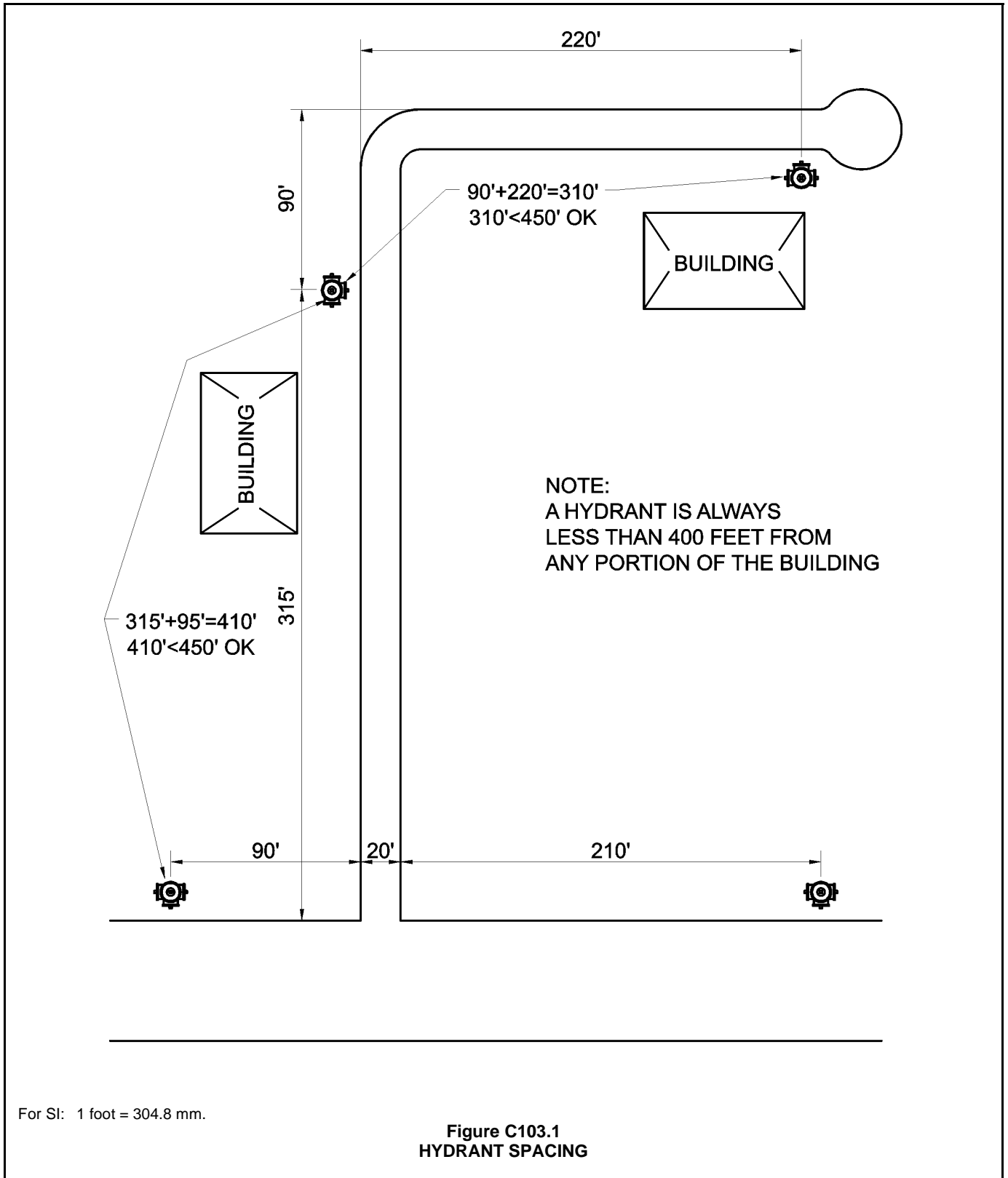
ICC	IFC—15	International Fire Code	C101.1, C103.1, Table C102.1
ICC	IRC—15	International Residential Code	Table C102.1

**Bibliography**

The following resource material was used in the preparation of the commentary for this appendix of the code.

IRC-15, *International Residential Code*. Washington, DC: International Code Council, 2014.





**Figure C103.1  
HYDRANT SPACING**



# Appendix D: Fire Apparatus Access Roads

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

## General Comments

Fire apparatus access is essential to successful fire-fighting and rescue operations. Fire department vehicles vary widely in size and operational needs and must be able to maneuver into position to properly undertake their fire-fighting activities. The needs of each jurisdiction will therefore vary with the equipment used. Needs assessment should also include consideration of mutual-aid companies that may respond from outside the jurisdiction. Access roads must be designed to provide the fire department with the required access to all structures on a site.

## Purpose

This appendix contains more detailed elements for use with the basic access requirements found in Section

503. Section 503 gives some minimum criteria, such as a maximum distance of 150 feet (45 720 mm) and a minimum width of 20 feet (6090 mm), but in many cases Section 503 does not state specific criteria. For example, what specific load should a fire apparatus access road be able to carry and what specific grade is allowed? Section 503 cannot go to this level of detail because needs vary widely from one jurisdiction to another. This appendix, like Appendices B and C, is a tool for jurisdictions seeking guidance in establishing access requirements.

Some of the other requirements found in this appendix address access layouts for multiple-family residential developments and large one- and two-family subdivisions. Also, specific examples for various types of turnarounds for fire department apparatus and parking regulation signage are included.

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## SECTION D101 GENERAL

**D101.1 Scope.** Fire apparatus access roads shall be in accordance with this appendix and all other applicable requirements of the *International Fire Code*.

- ❖ If this appendix has been adopted by a jurisdiction, this particular section simply states that all fire apparatus access roads must meet the requirements of this appendix and other applicable requirements. More specifically, Section 503 would also apply.

Be aware that essentially all roads leading to a particular building or facility, whether public or private, are fire apparatus access roads. Generally, the requirements of this appendix and Section 503 would be required only for new buildings and facilities. However, in some cases, improvements to existing roads and access ways may be necessary to meet the needs of the fire department.

Note that the appendix applies only if specifically adopted by ordinance by a jurisdiction. See the commentary to Sections 102.5 and 507.1 for a discussion of this appendix's application (if adopted) to buildings constructed under the *International Residential Code*® (IRC®).

## SECTION D102 REQUIRED ACCESS

**D102.1 Access and loading.** Facilities, buildings or portions of buildings hereafter constructed shall be accessible to fire department apparatus by way of an *approved* fire apparatus access road with an asphalt, concrete or other *approved* driving surface capable of supporting the imposed load of fire apparatus weighing at least 75,000 pounds (34 050 kg).

- ❖ This section contains more detailed specifications for the road surface and applied loads. In Section 503, it simply states that the road must be able to withstand the loads and be of "all-weather driving capability." This section states that the surface be of asphalt, concrete or other approved material and be able to withstand a load of 75,000 pounds (34 050 kg).

## SECTION D103 MINIMUM SPECIFICATIONS

**D103.1 Access road width with a hydrant.** Where a fire hydrant is located on a fire apparatus access road, the minimum road width shall be 26 feet (7925 mm), exclusive of shoulders (see Figure D103.1).

- ❖ The access road width of 20 feet (6096 mm) stated in Section 503 does not specifically account for the

presence of the hydrant. This section specifically requires a minimum width of 26 feet (7925 mm) when a hydrant is located along that access roadway (see Figure D103.1). This provides more room for the fire department vehicle to maneuver and connect to the hydrant. In many cases, a full 26-foot (7925 mm) width may not be possible for a majority of the access road and a possible solution is to simply widen the access road for a short distance to accommodate hydrant use. Including adjacent road shoulders in the width measurement could yield substandard and inadequate driving surfaces for apparatus. Accordingly, this section makes it clear that any road shoulders are not to be included in the minimum fire apparatus access road width. Section 503 is generic because available water supplies are not always accessed using hydrants. In some cases, the water comes from a tanker or from an on-site water supply.

**D103.2 Grade.** Fire apparatus access roads shall not exceed 10 percent in grade.

**Exception:** Grades steeper than 10 percent as *approved* by the fire chief.

❖ Section 503 discusses grade in generalities and states that the grade be within the limits established by the fire code official. The criteria are generic because the conditions in different jurisdictions will

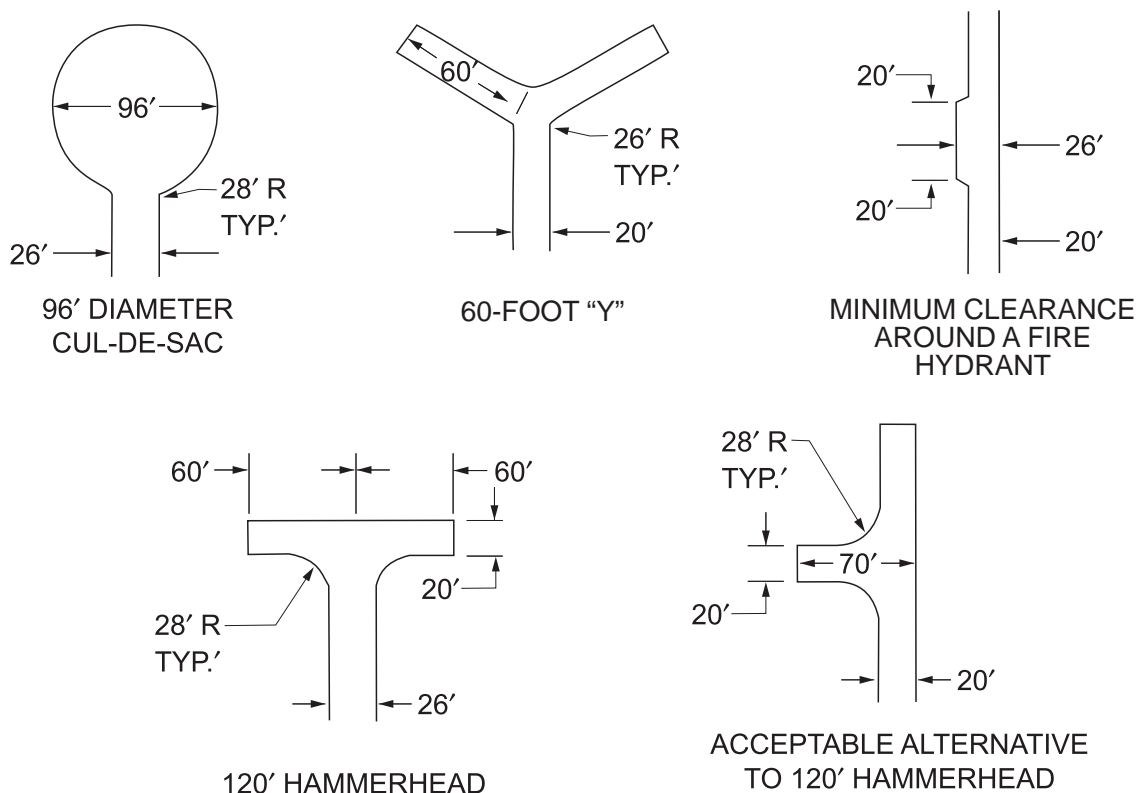
vary. For example, some fire department apparatus is able to handle steeper grades than others, and the likelihood of inclement weather, such as snow, will affect the ability of the vehicles to handle the terrain.

This appendix states a numerical criterion of not more than 10 percent, which is fairly conservative for most situations. This number gives something specific for a jurisdiction to cite without having to determine the actual grade. There is an exception to this section that would allow the fire chief to approve a grade greater than 10 percent. This gives the jurisdiction flexibility for specific situations where terrain might call for a steeper grade.

**D103.3 Turning radius.** The minimum turning radius shall be determined by the *fire code official*.

❖ The turning radius is left generic within both Section 503 and this section because of the large variation in the equipment used by fire departments. Each fire department must assess the specific abilities of its vehicles to set a minimum turning radius. The diagrams in Figure D103.1 set the turning radius at 28 feet (8534 mm), which may not be satisfactory for all jurisdictions.

**D103.4 Dead ends.** Dead-end fire apparatus access roads in excess of 150 feet (45 720 mm) shall be provided with width and turnaround provisions in accordance with Table D103.4.



For SI: 1 foot = 304.8 mm.

**FIGURE D103.1**  
**DEAD-END FIRE APPARATUS ACCESS ROAD TURNAROUND**

**TABLE D103.4**  
**REQUIREMENTS FOR DEAD-END**  
**FIRE APPARATUS ACCESS ROADS**

LENGTH (feet)	WIDTH (feet)	TURNAROUNDS REQUIRED
0-150	20	None required
151-500	20	120-foot Hammerhead, 60-foot “Y” or 96-foot diameter cul-de-sac in accordance with Figure D103.1
501-750	26	120-foot Hammerhead, 60-foot “Y” or 96-foot diameter cul-de-sac in accordance with Figure D103.1
Over 750		Special approval required

For SI: 1 foot = 304.8 mm.

❖ Though the widths of the access roadways may be sufficient to move and operate the necessary equipment at a fire scene, they may not be wide enough for the vehicles to turn around. On through streets this is not an issue, but when the road is a dead end and is sufficiently long, some means are necessary to enable fire department vehicles to turn around rather than having to back up over excessive distances. The three major methods used to provide a turn-around area are a cul-de-sac, hammerhead and “Y.” Figure D103.1 shows examples of all three types. Section 503 does not give any specific guidance. Each jurisdiction can choose from a variety of ways to accomplish this.

Dead ends require a fire vehicle turnaround when they exceed 150 feet (45 720 mm). The turnaround is to be located at the end of the roadway or within 150 feet (45 720 mm) of the end of the roadway to limit the backing distance to a maximum of 150 feet (45 720 mm). Backing a large vehicle, such as a tower ladder, over 150 feet (45 720 mm) can be especially challenging, especially in cases where the engineer may have to use a video camera-equipped back-up system due to the vehicle’s length. Refer to the table for more guidance in determining the kind of turning radius required. In any event, the configuration of the roadway and turnaround must be approved by the fire code official.

This table, which is based on the length of a dead end, sets minimum widths and recommends which types of turnarounds should be used. The diagrams in Figure D103.1 show the configurations of these turnarounds.

**D103.5 Fire apparatus access road gates.** Gates securing the fire apparatus access roads shall comply with all of the following criteria:

1. Where a single gate is provided, the gate width shall be not less than 20 feet (6096 mm). Where a fire apparatus road consists of a divided roadway, the gate width shall be not less than 12 feet (3658 mm).
2. Gates shall be of the swinging or sliding type.
3. Construction of gates shall be of materials that allow manual operation by one person.

4. Gate components shall be maintained in an operative condition at all times and replaced or repaired when defective.
5. Electric gates shall be equipped with a means of opening the gate by fire department personnel for emergency access. Emergency opening devices shall be *approved by the fire code official*.
6. Methods of locking shall be submitted for approval by the *fire code official*.
7. Electric gate operators, where provided, shall be *listed* in accordance with UL 325.
8. Gates intended for automatic operation shall be designed, constructed and installed to comply with the requirements of ASTM F 2200.

❖ Gates are sometimes required by the fire code official to limit access to certain hazardous fire areas. They are also often used as a security mechanism for gated communities and complexes. Section 503 discusses the use of gates in more general terms whereas this section provides more specific guidelines. The nine requirements stated here all must be complied with where applicable. They focus on maintaining the required width, ease of use and ability to open in an emergency. The construction and installation of gates and methods for opening the gates, whether by manual means or by a listed electrical mechanism, must comply with the referenced standards and be approved by the fire code official. This ensures that the operating procedures of the fire department are taken into account. See the commentary to Sections 503.5 and 503.6 for further information on gates.

**D103.6 Signs.** Where required by the *fire code official*, fire apparatus access roads shall be marked with permanent NO PARKING—FIRE LANE signs complying with Figure D103.6. Signs shall have a minimum dimension of 12 inches (305 mm) wide by 18 inches (457 mm) high and have red letters on a white reflective background. Signs shall be posted on one or both sides of the fire apparatus road as required by Section D103.6.1 or D103.6.2.

❖ One of the more challenging aspects of access roads is maintaining the necessary width. Parked cars can reduce this width if parking is not prohibited and the prohibition is posted. Section 503.3 addresses this need by giving the fire code official the authority to require marking of fire access roads. This section and Figure D103.6 add wording and dimension specifications for the signs needed to mark areas where parking is prohibited.

**D103.6.1 Roads 20 to 26 feet in width.** Fire lane signs as specified in Section D103.6 shall be posted on both sides of fire apparatus access roads that are 20 to 26 feet wide (6096 to 7925 mm).

❖ This section requires that parking be prohibited on both sides of narrower fire apparatus access roads. Twenty feet (6096 mm) is the appropriate width

needed for two average-size fire trucks to pass one another. If that width is reduced by parking even on one side, it will be potentially difficult for a fire department to undertake emergency operations in that area.

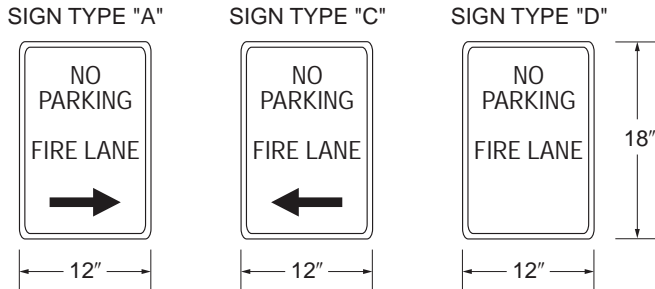


FIGURE D103.6  
FIRE LANE SIGNS

**D103.6.2 Roads more than 26 feet in width.** Fire lane signs as specified in Section D103.6 shall be posted on one side of fire apparatus access roads more than 26 feet wide (7925 mm) and less than 32 feet wide (9754 mm).

- ❖ Because this width is more than sufficient for maneuvering at least two fire department vehicles by one another, parking would be allowed on one side.

**SECTION D104  
COMMERCIAL AND INDUSTRIAL DEVELOPMENTS**

**D104.1 Buildings exceeding three stories or 30 feet in height.** Buildings or facilities exceeding 30 feet (9144 mm) or three stories in height shall have at least two means of fire apparatus access for each structure.

- ❖ This section addresses commercial and industrial buildings that, because of their height, can create a large challenge to a fire department. This section, along with Sections D105, D106 and D107, contains requirements for fire apparatus access roads for specific kinds of buildings or developments. Section 503 gives the fire code official the authority to require more access roads but does not specify when the additional roads are required. The need for additional access roads will depend on so many factors that each situation must be judged individually.

Because of the height of these buildings, various types of vehicles may be needed, and having two or more means of approaching the site may be necessary to manage and manipulate the vehicles.

**D104.2 Buildings exceeding 62,000 square feet in area.** Buildings or facilities having a gross *building area* of more than 62,000 square feet (5760 m<sup>2</sup>) shall be provided with two separate and *approved* fire apparatus access roads.

**Exception:** Projects having a gross *building area* of up to 124,000 square feet (11 520 m<sup>2</sup>) that have a single *approved* fire apparatus access road when all buildings are

equipped throughout with *approved automatic sprinkler systems*.

- ❖ Where buildings are very large in area, two separate fire apparatus access roads are required because a large building may be difficult to access rapidly and, if one of the access roads is blocked, there is a potential for a large fire loss. The exception acknowledges the ability of automatic sprinklers to prevent most fires from growing out of control quickly even when the building area is doubled and there is only a single, approved fire apparatus access road.

**D104.3 Remoteness.** Where two fire apparatus access roads are required, they shall be placed a distance apart equal to not less than one half of the length of the maximum overall diagonal dimension of the lot or area to be served, measured in a straight line between accesses.

- ❖ This concept is similar to the one dealing with the remoteness of exits in Section 1007.1.1. One of the primary reasons for multiple access roads is to ensure that if one access road is blocked or otherwise unavailable, another will allow access to the fire department. Therefore, when more than one access road is required, they need to be separated by enough distance to avoid a situation where both would be blocked or unavailable simply because they are too close to one another.

**SECTION D105  
AERIAL FIRE APPARATUS ACCESS ROADS**

**D105.1 Where required.** Where the vertical distance between the grade plane and the highest roof surface exceeds 30 feet (9144 mm), approved aerial fire apparatus access roads shall be provided. For purposes of this section, the highest roof surface shall be determined by measurement to the eave of a pitched roof, the intersection of the roof to the exterior wall, or the top of parapet walls, whichever is greater.

- ❖ Aerial apparatus access roads are required when the fire department cannot reach the roof or upper stories with ground ladders. The Insurance Services Office (ISO) Fire Suppression Rating Schedule suggests that fire departments carry a 35-foot ground ladder. When setting up a 35-foot ground ladder appropriately, the effective vertical reach of the ladder is approximately 30 feet; hence the 30-foot requirement within this section. Note that the measurement in this section is from grade plane to the edge of the roof where the ladder would be placed. If this measurement is greater than 30 feet, then an aerial apparatus access road would be required. The term eave is the most common term used in the *International Building Code*® (IBC®) when describing the edge of a peaked roof and is thus used herein. See also the commentary to the definition of “Grade plane” in Chapter 2.

**D105.2 Width.** Aerial fire apparatus access roads shall have a minimum unobstructed width of 26 feet (7925 mm), exclu-

sive of shoulders, in the immediate vicinity of the building or portion thereof.

- ❖ This section specifies the minimum road width needed for aerial apparatus. This width allows the aerial apparatus outriggers to be set solidly on the road surface for safe operation of the aerial equipment. Including adjacent road shoulders in the width measurement could yield substandard and inadequate driving or set-up surfaces for aerial apparatus. Accordingly, this section makes it clear that any road shoulders are not to be included in the minimum fire apparatus access road width.

**D105.3 Proximity to building.** At least one of the required access routes meeting this condition shall be located within a minimum of 15 feet (4572 mm) and a maximum of 30 feet (9144 mm) from the building, and shall be positioned parallel to one entire side of the building. The side of the building on which the aerial fire apparatus access road is positioned shall be approved by the *fire code official*.

- ❖ This section requires that the access road be specifically located where aerial equipment will have maximum access to the building. The fire code official, in consultation with the fire chief, must approve the final location of the aerial fire apparatus access road required by this section. Although not stated in this section, fireground operation protocols often place an aerial apparatus/truck company on the front side of the building so that the entire front, which could include emergency escape and rescue openings, can be reached by the ladder or the tower basket. The road that will meet the requirements of this section will often be the public street upon which the building fronts. The distance from the building to the road must be reviewed and approved to match the capabilities of the fire department aerial equipment versus the building's height.

**D105.4 Obstructions.** Overhead utility and power lines shall not be located over the aerial fire apparatus access road or between the aerial fire apparatus road and the building. Other obstructions shall be permitted to be placed with the approval of the *fire code official*.

- ❖ This section establishes requirements for controlling overhead obstructions to aerial fire apparatus positioned on aerial fire apparatus access roads to avoid the possibility of personnel injury and equipment damage, especially from electrical shock. The requirements prohibit overhead obstructions between the aerial fire apparatus access road and the building, but permit the fire code official to allow limited obstructions that do not affect the placement or use of aerial fire apparatus, such as site vegetation or a porte-cochere at the entrance to a building.

## SECTION D106

### MULTIPLE-FAMILY RESIDENTIAL DEVELOPMENTS

**D106.1 Projects having more than 100 dwelling units.** Multiple-family residential projects having more than 100

*dwelling units* shall be equipped throughout with two separate and *approved* fire apparatus access roads.

**Exception:** Projects having up to 200 *dwelling units* may have a single *approved* fire apparatus access road when all buildings, including nonresidential occupancies, are equipped throughout with *approved automatic sprinkler systems* installed in accordance with Section 903.3.1.1 or 903.3.1.2.

- ❖ This section is intended to provide some specific guidance to jurisdictions for dealing with larger apartment complexes. Again, Section 503 suggests that more than one access road is needed when there is a potential for an access road to be unavailable. In a large complex there is a large potential for loss. Lack of access should not become a factor in such a loss.

This section requires at least two separate access roads any time the number of dwelling units exceeds 100. The term "approved" is used because the layout of the complex may require some specific considerations when providing the access roads. For example, having two access roads leading onto a facility that come together before reaching the actual buildings may not satisfy the criterion of remoteness to be effective in an emergency.

The exception would allow a single access road for up to 200 dwelling units if all buildings on the site are fully sprinklered to meet code requirements. This exception acknowledges the effectiveness of sprinklers in slowing the growth of fires; therefore, the risk of having the access road blocked or unusable is more acceptable.

**D106.2 Projects having more than 200 dwelling units.** Multiple-family residential projects having more than 200 *dwelling units* shall be provided with two separate and *approved* fire apparatus access roads regardless of whether they are equipped with an *approved automatic sprinkler system*.

- ❖ Because of the large size of such complexes and the potential for large losses, even where sprinklers are installed as required by Section 903.2.8, two approved access roads must be provided. This section emphasizes that the exception in Section D106.1 is for up to 200 units only.

**D106.3 Remoteness.** Where two fire apparatus access roads are required, they shall be placed a distance apart equal to not less than one-half of the length of the maximum overall diagonal dimension of the property or area to be served, measured in a straight line between accesses.

- ❖ This concept is similar to the one dealing with the remoteness of exits in Section 1007.1.1. One of the primary reasons for multiple access roads is to ensure that if one access road is blocked or otherwise unavailable, another will allow access by the fire department. Therefore, when more than one access road is required, those roads must be separated by enough distance to avoid a situation where both would be blocked or unavailable simply because they are too close to one another.

## SECTION D107 ONE- OR TWO-FAMILY RESIDENTIAL DEVELOPMENTS

**D107.1 One- or two-family dwelling residential developments.** Developments of one- or two-family dwellings where the number of *dwelling units* exceeds 30 shall be provided with two separate and *approved* fire apparatus access roads.

### Exceptions:

1. Where there are more than 30 *dwelling units* on a single public or private fire apparatus access road and all *dwelling units* are equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1, 903.3.1.2 or 903.3.1.3 of the *International Fire Code*, access from two directions shall not be required.
  2. The number of *dwelling units* on a single fire apparatus access road shall not be increased unless fire apparatus access roads will connect with future development, as determined by the *fire code official*.
- ❖ This section requires that one- and two-family dwelling subdivisions with more than 30 dwellings have more than one fire apparatus access road into the development. The second access road is needed in case one access road for any reason becomes unusable

Exception 1 states that when there are more than 30 dwelling units equipped throughout with an approved sprinkler system in accordance with NFPA 13, 13R or 13D, as applicable or approved, a second access road is not required. This recognizes the effectiveness and reliability of properly designed and installed automatic sprinkler systems in mitigating the need to have two access points.

Exception 2 requires approval by the fire code official any time a new house is constructed on an existing access road. Once the maximum number of dwelling units allowed by this section has been reached, no further development may occur unless the fire code official determines that there will be a future road connection that will prevent creation of an excessive dead-end situation with no means for apparatus turn-around. Such determination by the fire code official should consider the phased development of an individual project or adjacent projects. Requiring evidence of legal agreements for specific future development would be prudent, especially in times of economic uncertainty. This gives the fire code official an opportunity to assess whether additional access is required in the interim.

**D107.2 Remoteness.** Where two fire apparatus access roads are required, they shall be placed a distance apart equal to not less than one-half of the length of the maximum overall diagonal dimension of the property or area to be served, measured in a straight line between accesses.

- ❖ This concept is similar to the one dealing with the remoteness of exits in Section 1007.1.1. One of the primary reasons for multiple access roads is to

ensure that if one access road is blocked or otherwise unavailable, another will allow access by the fire department. Therefore, when more than one access road is required, those roads must be separated by enough distance to avoid a situation where both would be blocked or unavailable simply because they are too close to one another.

## SECTION D108 REFERENCED STANDARDS

ASTM	F2200—13	Standard Specification for Automated Vehicular Gate Construction	D103.5
ICC	IFC—15	International Fire Code	D101.1, D107.1
UL	325—02	Door, Drapery, Gate, Louver, and Window Operators and Systems, with Revisions through June 2013	D103.5

### Bibliography

The following resource material was used in the preparation of the commentary for this appendix of the code.

*2015 International Code Interpretations*. Washington, DC: International Code Council, 2015.

# Appendix E: Hazard Categories

*This appendix is for information purposes and is not intended for adoption.*

## General Comments

This appendix contains guidance for designers, engineers, architects, building officials, plans reviewers and inspectors in the classifying of hazardous materials so that proposed designs can be evaluated intelligently and accurately and can be an extremely useful tool for all concerned. A thorough understanding of how Material Safety Data Sheets (MSDS) are created and how to read them makes these hazard evaluations much easier.

## Purpose

The descriptive materials and explanations of hazardous materials and how to report and evaluate them on the MSDS that are contained in this appendix are intended to be instructional as well as informative. A thorough understanding of how to prepare and interpret the MSDS makes the code user's job easier.

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## SECTION E101 GENERAL

**E101.1 Scope.** This appendix provides information, explanations and examples to illustrate and clarify the hazard categories contained in Chapter 50 of the *International Fire Code*. The hazard categories are based upon the DOL 29 CFR. Where numerical classifications are included, they are in accordance with nationally recognized standards.

This appendix should not be used as the sole means of hazardous materials classification.

❖ Although this appendix contains guidance in classifying hazardous materials, there are several other sources available to the fire code official or building official. The actual MSDS should be the only method used in the final classification of products because of the different characteristics that a blend of products produces. General classification information can come from NFPA 704, Chemical Hazards Response Information System (CHRIS) manuals, MSDS online and other methods.

It is important to remember that many chemicals have multiple hazards associated with them. A chemical may be a toxic poison (Group H-4) and also have a flammable or combustible base (Group H-2 or H-3), which creates additional problems. Section 5001 states, "Where a material has multiple hazards, all hazards shall be addressed." This means that the building must be protected in the above example as a Group H-4 use, as well as a Group H-3 use when the products are in sealed containers and a Group H-2 use if they are open to the air.

## SECTION E102 HAZARD CATEGORIES

**E102.1 Physical hazards.** Materials classified in this section pose a *physical hazard*.

❖ A chemical presents a physical hazard when there is evidence that it is a combustible liquid, compressed gas, cryogenic, explosive, a flammable gas, a flammable liquid, a flammable solid, an organic peroxide, an oxidizer, or a pyrophoric or unstable (reactive) or water-reactive material (see commentary, Section 5001.2.2.1).

**E102.1.1 Explosives and blasting agents.** The current UN/ DOT classification system recognized by international authorities, the Department of Defense and others classifies all *explosives* as Class 1 materials. They are then divided into six separate divisions to indicate their relative hazard. There is not a direct correlation between the designations used by the old DOT system and those used by the current system nor is there correlation with the system (high and low) established by the Bureau of Alcohol, Tobacco, Firearms and Explosives (BATF). Table 5604.3 of the *International Fire Code* provides some guidance with regard to the current categories and their relationship to the old categories. Some items may appear in more than one division, depending on factors such as the degree of confinement or separation, by type of packaging, storage configuration or state of assembly.

In order to determine the level of hazard presented by *explosive materials*, testing to establish quantitatively their *explosive* nature is required. There are numerous test methods that have been used to establish the character of an *explosive material*. Standardized tests, required for finished goods con-

taining *explosives* or *explosive materials* in a packaged form suitable for shipment or storage, have been established by UN/DOT and BATF. However, these tests do not consider key elements that should be examined in a manufacturing situation. In manufacturing operations, the condition and/or the state of a material may vary within the process. The in-process material classification and classification requirements for materials used in the manufacturing process may be different from the classification of the same material where found in finished goods depending on the stage of the process in which the material is found. A classification methodology must be used that recognizes the hazards commensurate with the application to the variable physical conditions as well as potential variations of physical character and type of *explosive* under consideration.

Test methods or guidelines for hazard classification of energetic materials used for in-process operations shall be *approved* by the *fire code official*. Test methods used shall be DOD, BATF, UN/DOT or other *approved* criteria. The results of such testing shall become a portion of the files of the jurisdiction and be included as an independent section of any Hazardous Materials Management Plan (HMMP) required by Section 5605.2.1 of the *International Fire Code*. Also see Section 104.7.2 of the *International Fire Code*.

Examples of materials in various Divisions are as follows:

1. Division 1.1 (High *Explosives*). Consists of *explosives* that have a mass explosion hazard. A mass explosion is one that affects almost the entire pile of material instantaneously. Includes substances that, where tested in accordance with *approved* methods, can be caused to detonate by means of a blasting cap where unconfined or will transition from *deflagration* to a *detonation* where confined or unconfined. Examples: dynamite, TNT, nitroglycerine, C-3, HMX, RDX, encased *explosives*, military ammunition.
2. Division 1.2 (Low *Explosives*). Consists of *explosives* that have a projection hazard, but not a mass explosion hazard. Examples: nondetonating encased *explosives*, military ammunition and the like.
3. Division 1.3 (Low *Explosives*). Consists of *explosives* that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard. The major hazard is radiant heat or violent burning, or both. Can be deflagrated where confined. Examples: smokeless powder, propellant *explosives*, display fireworks.
4. Division 1.4. Consists of *explosives* that pose a minor explosion hazard. The *explosive* effects are largely confined to the package and no projection of fragments of appreciable size or range is expected. An internal fire must not cause virtually instantaneous explosion of almost the entire contents of the package. Examples: squibs (nondetonating igniters), *explosive* actuators, *explosive* trains (low-level detonating cord).
5. Division 1.5 (Blasting Agents). Consists of very insensitive *explosives*. This division comprises substances that have a mass explosion hazard, but are so insensitive that there is very little probability of initiation or of transition from burning to *detonation* under normal conditions of transport. Materials are not cap sensitive; however, they are mass detonating where provided with sufficient input. Examples: oxidizer and liquid fuel slurry mixtures and gels, ammonium nitrate combined with fuel oil.
6. Division 1.6. Consists of extremely insensitive articles that do not have a mass *explosive* hazard. This division comprises articles that contain only extremely insensitive detonating substances and that demonstrate a negligible probability of accidental initiation or propagation. Although this category of materials has been defined, the primary application is currently limited to military uses. Examples: Low vulnerability military weapons.

*Explosives* in each division are assigned a compatibility group letter by the Associate Administrator for Hazardous Materials Safety (DOT) based on criteria specified by DOTn 49 CFR. Compatibility group letters are used to specify the controls for the transportation and storage related to various materials to prevent an increase in hazard that might result if certain types of *explosives* were stored or transported together. Altogether, there are 35 possible classification codes for *explosives*, e.g., 1.1A, 1.3C, 1.4S, etc.

- ❖ It is recognized that the hazard classification of goods packaged for release to the Department of Transportation (DOT) system is likely to be different from that of the same material when found in an unpackaged or bulk form. For example, a finished article as manufactured or packaged and classified as Division 1.4 may contain Division 1.1 or 1.3 material. Although the ingredients may in fact be classified differently when removed from the package or article, the hazard level of the finished device may be classified with a different level of hazard from the ingredients alone. Classification, in part, is based on the protection offered by the final package, the article itself, as well as the configuration or nature of the energetic materials as they exist within the article. Recognizing the fact that the hazard level of an energetic material can vary based on the physical character (size and shape) or configuration (physical arrangement) in which the material is found is key to understanding the nature of *explosives* and proper application of the code.

Scientific methods are needed to appraise the hazards of materials as they appear in the manufacturing process. By granting the fire code official authority to approve test methods, flexibility is provided while at the same time maintaining a reasonable level of control. By recording the technical basis of decision within the Hazardous Materials Management Plan (HMMP), a record of the criteria used to establish the

hazard level is maintained by the applicant. The reference to Section 104.7.2 refers the fire code official back to the administrative section of the code to exercise authority for outside technical assistance in those cases where such assistance is warranted. The terminology used in the examples reflects the current terminology, and examples accurately portray materials that may be encountered. The explanatory language has been drawn in pertinent part from 49 CFR Sections 173.50 and 173.58. Although the DOT has eliminated the Class A, B and C nomenclature, the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) has retained the use of the terms “high explosives” and “low explosives.” These terms are included in parenthesis where appropriate.

By definition, an “Explosive” is a chemical compound, mixture or device, the primary or common purpose of which is to function by explosion. The term includes, but is not limited to, dynamite, black powder, pellet powder, initiating explosives, detonators, safety fuses, squibs, detonating cord, igniter cord, igniters and display fireworks, 1.3G.

The term “explosive” includes any material determined to be within the scope of USC Title 18: Chapter 63 and also includes any material classified as an explosive other than consumer fireworks, 1.4G, by the hazardous materials regulations of DOTn 49 CFR. See the commentary to the definition of “Explosive” in Section 202.

The former classification system used by DOTn (UN/DOTn Class 1 explosives) included the terms “high explosives” and “low explosives.” The following terms further define explosives under the current system used by DOTn for all explosive materials defined as hazard Class 1 materials. Compatibility group letters are used together with the division to specify further limitations on each division noted; for example, the letter “G” identifies the material as a pyrotechnic substance or article containing a pyrotechnic substance and similar materials.

**Division 1.1.** Explosives that are a mass explosion hazard. A mass explosion is one that affects almost the entire load instantaneously.

**Division 1.2.** Explosives that have a projection hazard but not a mass explosion hazard.

**Division 1.3.** Explosives that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.

**Division 1.4.** Explosives that pose a minor explosion hazard. The explosive effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire must not cause virtually instantaneous explosion of almost the entire contents of the package.

**Division 1.5.** Very insensitive explosives. This division comprises substances that have a mass explosion hazard but are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions of transport.

**Division 1.6.** Extremely insensitive articles that do not have a mass explosion hazard. This division comprises articles that contain only extremely insensitive detonating substances and which demonstrate a negligible probability of accidental initiation or propagation.

The term “explosive material” means explosives, blasting agents and detonators.

Chemicals in this classification must meet the minimum requirements of Sections 5001, 5003, 5004 and 5005, and Chapter 56.

#### **E102.1.2 Compressed gases.** Examples include:

1. Flammable: acetylene, carbon monoxide, ethane, ethylene, hydrogen, methane. Ammonia will ignite and burn although its flammable range is too narrow for it to fit the definition of “Flammable gas.”

For binary mixtures where the hazardous component is diluted with a nonflammable gas, the mixture shall be categorized in accordance with CGA P-23.

2. Oxidizing: oxygen, ozone, oxides of nitrogen, chlorine and fluorine. Chlorine and fluorine do not contain oxygen but reaction with flammables is similar to that of oxygen.
3. Corrosive: ammonia, hydrogen chloride, fluorine.
4. Highly toxic: arsine, cyanogen, fluorine, germane, hydrogen cyanide, nitric oxide, phosphine, hydrogen selenide, stibine.
5. Toxic: chlorine, hydrogen fluoride, hydrogen sulfide, phosgene, silicon tetrafluoride.
6. Inert (chemically unreactive): argon, helium, krypton, neon, nitrogen, xenon.
7. Pyrophoric: diborane, dichloroborane, phosphine, silane.
8. Unstable (reactive): butadiene (unstabilized), ethylene oxide, vinyl chloride.

#### ❖ Compressed gases by definition are a material, or mixture of materials, that:

1. Is a gas at 68°F (20°C) or less at 14.7 pounds per square inch atmosphere (psia) (101 kPa) of pressure; and
2. Has a boiling point of 68°F (20°C) or less at 14.7 psia (101 kPa), which is either liquefied, nonliquefied or in solution, except those gases that have no other health or physical hazard properties and are not considered to be compressed until the pressure in the packaging exceeds 41 psia (282 kPa) at 68°F (20°C).

The states of a compressed gas are categorized as follows:

1. Nonliquefied compressed gases are gases, other than those in solution, that are in a packaging under the charged pressure and are entirely gaseous at a temperature of 68°F (20°C).
2. Liquefied compressed gases are gases that, in a packaging under the charged pressure, are partially liquid at a temperature of 68°F (20°C).
3. Compressed gases in solution are nonliquefied gases that are dissolved in a solvent.
4. Compressed gas mixtures consist of a mixture of two or more compressed gases contained in a packaging, the hazard properties of which are represented by the properties of the mixture as a whole.

Chemicals in this classification must meet the minimum requirements of Sections 5001, 5003, 5004, 5005 and 6004 and Chapters 53, 54, 55 and 58. In addition, flammable gases that are binary mixtures (i.e., compounded or consisting of two things or parts) diluted with a nonflammable gas present special categorization challenges, and therefore must be evaluated in accordance with CGA P-23. This standard provides consistency with industry standards for categorization.

**E102.1.3 Flammable and combustible liquids.** Examples include:

1. Flammable liquids.

Class IA liquids shall include those having *flash points* below 73°F (23°C) and having a *boiling point* at or below 100°F (38°C).

Class IB liquids shall include those having *flash points* below 73°F (23°C) and having a *boiling point* at or above 100°F (38°C).

Class IC liquids shall include those having *flash points* at or above 73°F (23°C) and below 100°F (38°C).

2. Combustible liquids.

Class II liquids shall include those having *flash points* at or above 100°F (38°C) and below 140°F (60°C).

Class IIIA liquids shall include those having *flash points* at or above 140°F (60°C) and below 200°F (93°C).

Class IIIB liquids shall include those liquids having *flash points* at or above 200°F (93°C).

- ❖ Chemicals in this classification must meet the minimum requirements of Sections 5001, 5003, 5004 and 5005, and Chapter 57.

**E102.1.4 Flammable solids.** Examples include:

1. Organic solids: camphor, cellulose nitrate, naphthalene.

2. Inorganic solids: decaborane, lithium amide, phosphorous heptasulfide, phosphorous sesquisulfide, potassium sulfide, anhydrous sodium sulfide, sulfur.
3. Combustible metals (except dusts and powders): cesium, magnesium, zirconium.

- ❖ A flammable solid is a solid, other than a blasting agent or explosive, that is capable of causing fire through friction, absorption of moisture, spontaneous chemical change or retained heat from manufacturing or processing; has an ignition temperature below 212°F (100°C); or that burns so vigorously and persistently when ignited as to create a serious hazard. A chemical shall be considered a flammable solid as determined in accordance with the test method of CPSC 16 CFR; Part 1500.44 if it ignites and burns with a self-sustained flame at a rate greater than 0.1 inch (2.5 mm) per second along its major axis.

Chemicals in this classification must meet the minimum requirements of Sections 5001, 5003, 5004 and 5005, and Chapter 59.

**E102.1.5 Combustible dusts and powders.** Finely divided solids that could be dispersed in air as a dust cloud: wood sawdust, plastics, coal, flour, powdered metals (few exceptions).

- ❖ Combustible dusts and combustible fibers are listed separately because they are not subcategories of flammable solids in either the maximum allowable quantity tables in Chapter 50 or in their respective material-specific hazard chapters.

**E102.1.6 Combustible fibers.** See Section 5202.1.

- ❖ See the commentary to Section E102.1.5.

**E102.1.7 Oxidizers.** Examples include:

1. Gases: oxygen, ozone, oxides of nitrogen, fluorine and chlorine (reaction with flammables is similar to that of oxygen).
2. Liquids: bromine, hydrogen peroxide, nitric acid, perchloric acid, sulfuric acid.
3. Solids: chlorates, chromates, chromic acid, iodine, nitrates, nitrites, perchlorates, peroxides.

- ❖ An oxidizer is material that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of combustible materials. An oxidizing gas is a gas that can support and accelerate combustion of other materials. Examples of other oxidizing gases include bromine, chlorine and fluorine.

**E102.1.7.1 Examples of liquid and solid oxidizers according to hazard.**

Class 4: ammonium perchlorate (particle size greater than 15 microns), ammonium permanganate, guanidine nitrate, hydrogen peroxide solutions more than 91 percent by weight, perchloric acid solutions more than 72.5 percent by weight, potassium superoxide, tetranitromethane.

Class 3: ammonium dichromate, calcium hypochlorite (over 50 percent by weight), chloric acid (10 percent maximum concentration), hydrogen peroxide solutions (greater than 52 percent up to 91 percent), mono-(trichloro)-tetra-(monopotassium di-chloro)-penta-s-triazinetrione, nitric acid, (fuming -more than 86 percent concentration), perchloric acid solutions (60 percent to 72 percent by weight), potassium bromate, potassium chlorate, potassium dichloro-s-triazinetrione (potassium dichloro-isocyanurate), potassium perchlorate (99 percent), potassium permanganate (greater than 97.5 percent), sodium bromate, sodium chlorate, sodium chlorite (over 40 percent by weight) and sodium dichloro-s-triazinetrione anhydrous (sodium dichloro-isocyanurate anhydrous).

Class 2: barium bromate, barium chlorate, barium hypochlorite, barium perchlorate, barium permanganate, 1-bromo-3-chloro-5, 5-dimethylhydantoin, calcium chlorate, calcium chlorite, calcium hypochlorite (50 percent or less by weight), calcium perchlorate, calcium permanganate, calcium peroxide (75 percent), chromium trioxide (chromic acid), copper chlorate, halane (1, 3-di-chloro-5, 5-dimethylhydantoin), hydrogen peroxide (greater than 27.5 percent up to 52 percent), lead perchlorate, lithium chlorate, lithium hypochlorite (more than 39 percent available chlorine), lithium perchlorate, magnesium bromate, magnesium chlorate, magnesium perchlorate, mercurous chlorate, nitric acid (more than 40 percent but less than 86 percent), perchloric acid solutions (more than 50 percent but less than 60 percent), potassium peroxide, potassium superoxide, silver peroxide, sodium chlorite (40 percent or less by weight), sodium perchlorate, sodium perchlorate monohydrate, sodium permanganate, sodium peroxide, sodium persulfate (99 percent), strontium chlorate, strontium perchlorate, thallium chlorate, urea hydrogen peroxide, zinc bromate, zinc chlorate and zinc permanganate.

Class 1: all inorganic nitrates (unless otherwise classified), all inorganic nitrites (unless otherwise classified), ammonium persulfate, barium peroxide, hydrogen peroxide solutions (greater than 8 percent up to 27.5 percent), lead dioxide, lithium hypochlorite (39 percent or less available chlorine), lithium peroxide, magnesium peroxide, manganese dioxide, nitric acid (40 percent concentration or less), perchloric acid solutions (less than 50 percent by weight), potassium dichromate, potassium monopersulfate (45 percent KHSO<sub>5</sub> or 90 percent triple salt), potassium percarbonate, potassium persulfate, sodium carbonate peroxide, sodium dichloro-s-triazinetrione dihydrate, sodium dichromate, sodium perborate (anhydrous), sodium perborate monohydrate, sodium perborate tetra-hydrate, sodium percarbonate, strontium peroxide, trichloro-s-triazinetrione (trichloroisocyanuric acid) and zinc peroxide.

- ❖ **Class 4.** An oxidizer that can undergo an explosive reaction as a result of contamination or exposure to thermal or physical shock. In addition, the oxidizer will enhance the burning rate and can cause spontaneous ignition of combustibles.

**Class 3.** An oxidizer that will cause a severe increase in the burning rate of combustible materials with which it comes in contact or that will undergo vigorous self-sustained decomposition as a result of contamination or exposure to heat.

**Class 2.** An oxidizer that will cause a moderate increase in the burning rate or that causes spontaneous ignition of combustible materials with which it comes in contact.

**Class 1.** An oxidizer whose primary hazard is that it slightly increases the burning rate but that does not cause spontaneous ignition when it comes in contact with combustible materials.

Chemicals in this classification must meet the minimum requirements of Sections 5001, 5003, 5004 and 5005, and Chapter 63.

**E102.1.8 Organic peroxides.** Organic peroxides contain the double oxygen or peroxy (-o-o) group. Some are flammable compounds and subject to explosive decomposition. They are available as:

1. Liquids.
2. Pastes.
3. Solids (usually finely divided powders).

❖ Organic peroxides can pose an explosion hazard (detonation or deflagration) or they can be shock sensitive. They can also decompose into various unstable compounds over an extended period of time.

**E102.1.8.1 Classification of organic peroxides according to hazard.**

Unclassified: Unclassified organic peroxides are capable of *detonation* and are regulated in accordance with Chapter 56 of the *International Fire Code*.

Class I: acetyl cyclohexane sulfonyl 60-65 percent concentration by weight, fulfonyl peroxide, benzoyl peroxide over 98 percent concentration, t-butyl hydroperoxide 90 percent, t-butyl peroxyacetate 75 percent, t-butyl peroxyisopropylcarbonate 92 percent, diisopropyl peroxydicarbonate 100 percent, di-n-propyl peroxydicarbonate 98 percent, and di-n-propyl peroxydicarbonate 85 percent.

Class II: acetyl peroxide 25 percent, t-butyl hydroperoxide 70 percent (with DTBP and t-BuOH diluents), t-butyl peroxybenzoate 98 percent, t-butyl peroxy-2-ethylhexanoate 97 percent, t-butyl peroxyisobutyrate 75 percent, t-butyl peroxyisopropyl-carbonate 75 percent, t-butyl peroxy-pivalate 75 percent, dibenzoyl peroxydicarbonate 85 percent, di-sec-butyl peroxydicarbonate 98 percent, di-sec-butyl peroxydicarbonate 75 percent, 1,1-di-(t-butylperoxy)-3,5,5-trimethylcyclohexane 95 percent, di-(2-ethylhexyl) peroxydicarbonate 97 percent, 2,5-dimethyl-2,5 di (benzoylperoxy) hexane 92 percent, and peroxyacetic acid 43 percent.

Class III: acetyl cyclohexane sulfonal peroxide 29 percent, benzoyl peroxide 78 percent, benzoyl peroxide paste 55 percent, benzoyl peroxide paste 50 percent peroxide/50 percent butylbenzylphthalate diluent, cumene hydroperoxide 86 percent, di-(4-butylcyclohexyl) peroxydicarbonate 98 percent, t-butyl peroxy-2-ethylhexanoate 97 percent, t-butyl peroxyneodecanoate 75 percent, decanoyl peroxide 98.5 percent, di-t-butyl peroxide 99 percent, 1,1-di-(t-butylperoxy)3,5,5-trimethylcyclohexane 75 percent, 2,4-dichlorobenzoyl peroxide 50 percent, di-isopropyl peroxydicarbonate 30 percent, 2,-5-di-methyl-2,5-di-(2-ethylhexanolyperoxy)-hexane 90 percent, 2,5-dimethyl-2,5-di-(t-butylperoxy) hexane 90 percent and methyl ethyl ketone peroxide 9 percent active oxygen diluted in dimethyl phthalate.

Class IV: benzoyl peroxide 70 percent, benzoyl peroxide paste 50 percent peroxide/15 percent water/35 percent butylphthalate diluent, benzoyl peroxide slurry 40 percent, benzoyl peroxide powder 35 percent, t-butyl hydroperoxide 70 percent, (with water diluent), t-butyl peroxy-2-ethylhexanoate 50 percent, decumyl peroxide 98 percent, di-(2-ethylhexal) peroxydicarbonate 40 percent, laurel peroxide 98 percent, p-methane hydroperoxide 52.5 percent, methyl ethyl ketone peroxide 5.5 percent active oxygen and methyl ethyl ketone peroxide 9 percent active oxygen diluted in water and glycols.

Class V: benzoyl peroxide 35 percent, 1,1-di-t-butyl peroxy 3,5,5-trimethylcyclohexane 40 percent, 2,5-di-(t-butyl peroxy) hexane 47 percent and 2,4-pentanedione peroxide 4 percent active oxygen.

- ❖ **Unclassified detonable.** Organic peroxides that are capable of detonation. These peroxides pose an extremely high explosion hazard through rapid explosive decomposition.

**Class I.** Those formulations that are capable of deflagration but not detonation.

**Class II.** Those formulations that burn very rapidly and that pose a moderate reactivity hazard.

**Class III.** Those formulations that burn rapidly and that pose a moderate reactivity hazard.

**Class IV.** Those formulations that burn in the same manner as ordinary combustibles and that pose a minimal reactivity hazard.

**Class V.** Those formulations that burn with less intensity than ordinary combustibles or do not sustain combustion and that pose no reactivity hazard.

Chemicals in this classification must meet the minimum requirements of Sections 5001, 5003, 5004 and 5005, and Chapter 62.

#### **E102.1.9 Pyrophoric materials.** Examples include:

1. Gases: diborane, phosphine, silane.
2. Liquids: diethylaluminum chloride, di-ethylberyllium, diethylphosphine, diethylzinc, dimethylarsine, triethylaluminum etherate, tri-ethylbismuthine, triethylboron, trimethylaluminum, trimethylgallium.

3. Solids: cesium, hafnium, lithium, white or yellow phosphorous, plutonium, potassium, rubidium, sodium, thorium.

- ❖ **Pyrophoric materials** are two or more unmixed, commercially manufactured, prepackaged chemical substances, including oxidizers, flammable liquids or solids or similar substances that are not independently classified as explosives but that, when mixed or combined, form an explosive that is intended for blasting.

Chemicals in this classification must meet the minimum requirements of Sections 5001, 5003, 5004 and 5005, and Chapter 64.

#### **E102.1.10 Unstable (reactive) materials.** Examples include:

Class 4: acetyl peroxide, dibutyl peroxide, dinitrobenzene, ethyl nitrate, peroxyacetic acid and picric acid (dry) trinitrobenzene.

Class 3: hydrogen peroxide (greater than 52 percent), hydroxylamine, nitromethane, paranitroaniline, perchloric acid and tetrafluoroethylene monomer.

Class 2: acrolein, acrylic acid, hydrazine, methacrylic acid, sodium perchlorate, styrene and vinyl acetate.

Class 1: acetic acid, hydrogen peroxide 35 percent to 52 percent, paraldehyde and tetrahydrofuran.

- ❖ An unstable (reactive) material is a material, other than an explosive, that in its pure state or as commercially produced, will vigorously polymerize, decompose, condense or become self-reactive and undergo other violent chemical changes, including explosion, when:

1. Exposed to heat, friction, or shock;
2. In the absence of an inhibitor;
3. In the presence of contaminants; or
4. In contact with incompatible materials.

Unstable (reactive) materials are subdivided as follows:

**Class 4.** Materials that in themselves are readily capable of detonation, explosive decomposition or reaction at normal temperatures and pressures. This class includes materials that are sensitive to mechanical or localized thermal shock at normal temperatures and pressures.

**Class 3.** Materials that in themselves are capable of detonation, explosive decomposition or reaction but that require a strong initiating source or must be heated under confinement before initiation. This class includes materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures.

**Class 2.** Materials that in themselves are normally unstable and readily undergo violent chemical change but do not detonate. This class includes materials that can undergo chemical change with rapid release of energy at normal temperatures

and pressures, and that can undergo violent chemical change at elevated temperatures and pressures.

**Class 1.** Materials that in themselves are normally stable but that can become unstable at elevated temperatures and pressures.

Chemicals in this classification must meet the minimum requirements of Sections 5001, 5003, 5004 and 5005, and Chapter 66.

**E102.1.11 Water-reactive materials.** Examples include:

Class 3: aluminum alkyls such as triethylaluminum, isobutylaluminum and trimethylaluminum; bromine pentafluoride, bromine trifluoride, chlorodiethylaluminum and diethylzinc.

Class 2: calcium carbide, calcium metal, cyanogen bromide, lithium hydride, methylchlorosilane, potassium metal, potassium peroxide, sodium metal, sodium peroxide, sulfuric acid and trichlorosilane.

Class 1: acetic anhydride, sodium hydroxide, sulfur monochloride and titanium tetrachloride.

- ❖ A water-reactive material explodes; violently reacts; produces flammable, toxic or other hazardous gases; or evolves enough heat to cause self-ignition or ignition of nearby combustibles upon exposure to water or moisture. Water-reactive materials are subdivided as follows:

Class 3. Materials that react explosively with water without requiring heat or confinement.

Class 2. Materials that may form potentially explosive mixtures with water.

Class 1. Materials that may react with water with some release of energy, but not violently.

Chemicals in this classification must meet the minimum requirements of Sections 5001, 5003, 5004 and 5005, and Chapter 67.

**E102.1.12 Cryogenic fluids.** The cryogenics listed will exist as *compressed gases* where they are stored at ambient temperatures.

1. Flammable: carbon monoxide, deuterium (heavy hydrogen), ethylene, hydrogen, methane.
2. Oxidizing: fluorine, nitric oxide, oxygen.
3. *Corrosive*: fluorine, nitric oxide.
4. Inert (chemically unreactive): argon, helium, krypton, neon, nitrogen, xenon.
5. Highly toxic: fluorine, nitric oxide.

- ❖ A cryogenic fluid is liquid having a boiling point lower than 150°F (101°C) at 14.7 pounds per square inch atmosphere (psia) (101 kPa).

A flammable cryogenic fluid is cryogenic fluid that is flammable in its vapor state.

Chemicals in this classification must meet the minimum requirements of Sections 5001, 5003, 5004 and 5005, and Chapter 55.

**E102.2 Health hazards.** Materials classified in this section pose a *health hazard*.

- ❖ If a chemical is classified as a health hazard, there is statistically significant evidence that it can cause acute or chronic health effects in exposed persons. The term “health hazard” includes chemicals that are toxic, highly toxic and corrosive.

**E102.2.1 Highly toxic materials.** Examples include:

1. Gases: arsine, cyanogen, diborane, fluorine, germane, hydrogen cyanide, nitric oxide, nitrogen dioxide, ozone, phosphine, hydrogen selenide, stibine.
2. Liquids: acrolein, acrylic acid, 2-chloroethanol (ethylene chlorohydrin), hydrazine, hydrocyanic acid, 2-methylaziridine (propylenimine), 2-methyl-acetonitrile (acetone cyanohydrin), methyl ester isocyanic acid (methyl isocyanate), nicotine, tetranitromethane and tetraethylstannane (tetraethyltin).
3. Solids: (aceto) phenylmercury (phenyl mercuric acetate), 4-aminopyridine, arsenic pentoxide, arsenic trioxide, calcium cyanide, 2-chloroacetophenone, aflatoxin B, decaborane(14), mercury (II) bromide (mercuric bromide), mercury (II) chloride (*corrosive* mercury chloride), pentachlorophenol, methyl parathion, phosphorus (white) and sodium azide.

- ❖ A highly toxic material produces a lethal dose or lethal concentration that falls within any of the following categories:

1. A chemical that has a median lethal dose (LD<sub>50</sub>) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
2. A chemical that has a median lethal dose (LD<sub>50</sub>) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
3. A chemical that has a median lethal concentration (LC<sub>50</sub>) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

Mixtures of these materials with ordinary materials, such as water, might not warrant classification as highly toxic. Although this system is basically simple in application, any hazard evaluation that is required for the precise categorization of this type of material must be performed by experienced, technically competent persons.

Chemicals in this classification must meet the minimum requirements of Sections 5001, 5003, 5004 and 5005, and Chapter 60.

**E102.2.2 Toxic materials.** Examples include:

1. Gases: boron trichloride, boron trifluoride, chlorine, chlorine trifluoride, hydrogen fluoride, hydrogen sulfide, phosgene, silicon tetrafluoride.
2. Liquids: acrylonitrile, allyl alcohol, alpha-chlorotoluene, aniline, 1-chloro-2,3-epoxypropane, chloroformic acid (allyl ester), 3-chloropropene (allyl chloride), o-cresol, crotonaldehyde, dibromomethane, diisopropylamine, diethyl ester sulfuric acid, dimethyl ester sulfuric acid, 2-furaldehyde (furfural), furfural alcohol, phosphorus chloride, phosphoryl chloride (phosphorus oxychloride) and thionyl chloride.
3. Solids: acrylamide, barium chloride, barium (II) nitrate, benzidine, p-benzoquinone, beryllium chloride, cadmium chloride, cadmium oxide, chloroacetic acid, chlorophenylmercury (phenyl mercuric chloride), chromium (VI) oxide (chromic acid, solid), 2,4-dinitrotoluene, hydroquinone, mercury chloride (calomel), mercury (II) sulfate (mercuric sulfate), osmium tetroxide, oxalic acid, phenol, P-phenylenediamine, phenylhydrazine, 4-phenylmorpholine, phosphorus sulfide, potassium fluoride, potassium hydroxide, selenium (IV) disulfide and sodium fluoride.

❖ A toxic chemical falls within any of the following categories:

1. A chemical that has a median lethal dose (LD<sub>50</sub>) of more than 50 milligrams per kilogram, but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
2. A chemical that has a median lethal dose (LD<sub>50</sub>) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
3. In air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than 2 milligrams per liter but not more than 20 milligrams per liter of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

Chemicals in this classification must meet the minimum requirements of Sections 5001, 5003, 5004 and 5005, and Chapter 60.

**E102.2.3 Corrosives.** Examples include:

1. Acids: Examples: chromic, formic, hydrochloric (muriatic) greater than 15 percent, hydrofluoric, nitric

(greater than 6 percent, perchloric, sulfuric (4 percent or more).

2. Bases (alkalis): hydroxides-ammonium (greater than 10 percent), calcium, potassium (greater than 1 percent), sodium (greater than 1 percent); certain carbonates-potassium.
3. Other *corrosives*: bromine, chlorine, fluorine, iodine, ammonia.

**Note:** *Corrosives* that are oxidizers, e.g., nitric acid, chlorine, fluorine; or are *compressed gases*, e.g., ammonia, chlorine, fluorine; or are water-reactive, e.g., concentrated sulfuric acid, sodium hydroxide, are *physical hazards* in addition to being *health hazards*.

- ❖ Corrosive chemicals cause visible destruction of, or irreversible alterations in, living tissue by chemical action at the point of contact. A chemical shall be considered corrosive if, when tested on the intact skin of albino rabbits by the method described in DOTn 49 CFR, Part 173, it destroys or changes irreversibly the structure of the tissue at the point of contact following an exposure period of 4 hours. This term does not refer to action on inanimate surfaces.

Chemicals in this classification must meet the minimum requirements of Sections 5001, 5003, 5004 and 5005, and Chapter 54.

## SECTION E103 EVALUATION OF HAZARDS

**E103.1 Degree of hazard.** The degree of hazard present depends on many variables that should be considered individually and in combination. Some of these variables are as shown in Sections E103.1.1 through E103.1.5.

- ❖ How can the degree of hazard presented by the various chemicals that may be in the structure under design or review be determined? The only way to ensure that the structure is constructed or reviewed to the correct standards is to obtain and review the MSDS on the specific chemicals proposed. Owners can expect their structures to be required to meet a number of federal laws that regulate hazardous materials, including: the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Resource Conservation and Recovery Act of 1976 (RCRA), the Hazardous Materials Transportation Act (HMTA), the Occupational Safety and Health Act (OSHA), the Toxic Substances Control Act (TSCA) and the Clean Air Act and Title III of SARA.

Community building/fire departments must make certain that the properties in their areas meet Title III of SARA, which regulates the packaging, labeling, handling, storage and transportation of hazardous materials. The law requires facilities to furnish information about the quantities and health effects of materials used at the facility and to promptly notify local and state officials whenever a significant release of hazardous materials occurs. Title 42, Chapter 116, Subchapter II, Section 11021 of the

Emergency Planning and Community Right-to-Know Act contains the following requirements for the submittal of MSDS:

Basic requirement

1. Submission of MSDS or list

The owner or operator of any facility which is required to prepare or have available a material safety data sheet for a hazardous chemical under the Occupational Safety and Health Act of 1970 (29 U.S.C. 651 et seq.) and regulations promulgated under that Act shall submit a material safety data sheet for each chemical.

These MSDS are a guide to determining the specific hazards presented to a community. The sections that follow, along with their commentary, should help determine whether the MSDS is complete and correct in identifying the properties and characteristics of the hazardous materials expected in the subject occupancy.

**E103.1.1 Chemical properties of the material.** Chemical properties of the material determine self reactions and reactions that could occur with other materials. Generally, materials within subdivisions of hazard categories will exhibit similar chemical properties. However, materials with similar chemical properties could pose very different hazards. Each individual material should be researched to determine its hazardous properties and then considered in relation to other materials that it might contact and the surrounding environment.

❖ When we think of chemical properties, what should we be looking for in the MSDS in terms of reactivity hazards?

*Hypergolic materials* are those chemicals that will ignite when they come in contact with each other. Rocket propellants and military munitions are the most common uses of this type of material.

*Pyrophoric materials* react and ignite on contact with air. Common storage practices have this type of material stored in inert substances or under pressure in sealed containers to prevent the introduction of air.

*Water-reactive materials* will react on contact with water. It is very important to the emergency personnel that these chemicals be identified and labeled properly. The use of fire hoses and sprinklers with this type of material can be very dangerous for the responding personnel.

*Unstable materials* can violently decompose with little or no outside stimulus. Several of the materials used in the development of plastics can exhibit these traits.

**E103.1.2 Physical properties of the material.** Physical properties, such as whether a material is a solid, liquid or gas at ordinary temperatures and pressures, considered along with chemical properties will determine requirements for containment of the material. Specific gravity (weight of a liquid compared to water) and vapor density (weight of a gas com-

pared to air) are both physical properties that are important in evaluating the hazards of a material.

❖ When we think of physical properties, what should we be looking for in the MSDS?

*Flammable and combustible liquids classifications* are determined by their chemical flash points and boiling points. The only difference between the various classifications of flammable and combustible liquids is the degree difference in these two chemical properties.

*Ignition temperature* is the temperature that the fuel in air must be heated for self-sustained combustion without help from a heat source. This gives the MSDS user a point to determine how the method of storage can change the properties of the chemical.

*Flammability range* is a very important property to understand because it will relate to the amount of ventilation that may be required to satisfy the *International Mechanical Code*<sup>®</sup> (IMC<sup>®</sup>). If a storage atmosphere is within the flammability range, a dangerous situation exists. In this condition the only element missing to start a fire is an ignition source; thus, an incident could happen at any time. In the reverse, when the storage arrangement is outside the flammability range, a much safer condition exists because the air-to-chemical ratio must be within the range prior to a dangerous incident.

*Specific gravity* is the weight of the item compared to the weight of an equal volume of water. Water is given a specific gravity of 1.00. If the chemical has a specific gravity less than 1.00, the chemical will float on water. For that reason, water would not be an effective extinguishing tool. Also, the chemical will flow with any runoff of fire-fighting water. Diking or another containment method is needed to contain the fire-fighting water and chemicals. If the chemical has a specific gravity greater than 1.00, the chemical will sink in water. It is important to note that most flammable liquids have a specific gravity less than 1.00. Review the MSDS for the specific requirements for the chemicals.

*Vapor density* is similar to specific gravity; however, it is a comparison between the densities of a gas/vapor and air. Again, air is given a density of 1.00. If the chemical has a vapor density less than 1.00, it will rise. In many cases the vapor density being less than 1.00 is a good property because there are far fewer high ignition sources; however, remember that in an incident, the gas/vapor can be spread over a larger area. The spreading can reduce the flammability range enough to greatly lessen the possibility of a fire. If the vapor density is greater than 1.00, the gas/vapor will sink to the lowest point in the storage area. An example of a protection method in the codes for this property is the requirement that gas-fired appliances in garages must be 18 inches (457 mm) above the floor surface. This allows a chemical with a high vapor density to spread across

the floor surface without encountering an ignition source.

*Water solubility* refers to the chemical's ability to mix with water. This information can be used in creating a proper response to an emergency incident.

**E103.1.3 Amount and concentration of the material.** The amount of material present and its concentration must be considered along with physical and chemical properties to determine the magnitude of the hazard. Hydrogen peroxide, for example, is used as an antiseptic and a hair bleach in low concentrations (approximately 8 percent in water solution). Over 8 percent, hydrogen peroxide is classed as an oxidizer and is toxic. Above 90 percent, it is a Class 4 oxidizer "that can undergo an explosive reaction when catalyzed or exposed to heat, shock or friction," a definition that incidentally also places hydrogen peroxide over 90-percent concentration in the unstable (reactive) category. Small amounts at high concentrations could present a greater hazard than large amounts at low concentrations.

❖ Many chemicals exhibit combined chemical traits, one of which is toxicity. The amount of damage that can be inflicted on the environment is based on the toxicity and the threshold limit values, lethal dosage, lethal concentration or emergency exposure limits.

Review the chemicals that will be housed in the structure or used in the process. Look at their chemical, physical and toxicity properties. The method of storage and the amounts of chemical will also play a major role in determining hazards. Chemical and physical characteristics were covered in Sections E103.1.1 and E103.1.2. This section covers the properties of toxicity.

*Threshold limit value*, also known as "time weighted average" (TLV/TWA), is the maximum amount of chemical that the human body can be exposed to for 8 hours a day or 40 hours a week without dangerous effects. This number is important when checking or reviewing the ventilation for a structure. TLV/TWA is normally expressed in parts per million, while others are sometimes expressed as a percentage per billion. This is the number of molecules of chemical per molecules of air. It is important to note that the smaller the ratio, the more toxic the material.

*Lethal dosage* (LD) is the minimum amount of solid or liquid that, when ingested or absorbed through the skin, may be fatal. MSDS provide this information typically as LD<sub>50</sub>. This notation represents the amount of chemical that will kill at least 50 percent of the test subjects when exposed. The amount is expressed in milligrams per kilogram of body weight.

*Lethal concentration* (LC) is the minimum concentration in the gaseous state that, when inhaled, may be fatal. MSDS provide this information typically as LC<sub>50</sub>. This notation is expressed in milligrams per liter.

*Emergency exposure limit* or TLV short-term exposure limit (EEL or TLVSTEL) is the maximum amount of chemical that can be tolerated with no permanent toxic effects.

*Ceiling limit* (TLVC) is the amount of chemical that normally will not cause immediate irritation. This limit should never be reached in normal operation, even for an instant.

**E103.1.3.1 Mixtures.** Gases—toxic and highly toxic gases include those gases that have an LC<sub>50</sub> of 2,000 parts per million (ppm) or less when rats are exposed for a period of 1 hour or less. To maintain consistency with the definitions for these materials, exposure data for periods other than 1 hour must be normalized to 1 hour. To classify mixtures of *compressed gases* that contain one or more toxic or highly toxic components, the LC<sub>50</sub> of the mixture must be determined. Mixtures that contain only two components are binary mixtures. Those that contain more than two components are multicomponent mixtures. Where two or more hazardous substances (components) having an LC<sub>50</sub> below 2,000 ppm are present in a mixture, their combined effect, rather than that of the individual substance components, must be considered. In the absence of information to the contrary, the effects of the hazards present must be considered as additive. Exceptions to the above rule could be made when there is a good reason to believe that the principal effects of the different harmful substances (components) are not additive.

For binary mixtures where the hazardous component is diluted with a nontoxic gas such as an inert gas, the LC<sub>50</sub> of the mixture is estimated by use of the methodology contained in CGA P-20. The hazard zones specified in CGA P-20 are applicable for DOTn purposes and shall not be used for hazard classification.

❖ This information allows evaluation of the methods of calculation submitted by the chemical engineer. It is not designed for the inspector/plans examiner to perform the calculations during inspection or plan review. Mixtures and chemicals should be evaluated by a qualified person such as a chemical engineer, with the information submitted to the inspector/plans examiner. MSDS for the specific mixtures can be submitted in place of separate chemical engineering evaluations. Calculations for toxic gas mixtures are included in the referenced standard CGA P-20 and will bring consistency to the definition of "Toxic gas mixtures." It is easy to determine the proper hazard classification of toxic gas mixtures by using CGA P-20.

**E103.1.4 Actual use, activity or process involving the material.** The definition of handling, storage and use in *closed systems* refers to materials in packages or containers. Dispensing and use in open containers or systems describes situations where a material is exposed to ambient conditions or vapors are liberated to the atmosphere. Dispensing and use in *open systems*, then, are generally more hazardous situations than handling, storage or use in *closed systems*. The actual use or process could include heating, electric or other sparks, catalytic or reactive materials and many other factors that could affect the hazard and must therefore be thoroughly analyzed.

❖ The owner must be asked how the products will be used in the facility. Tables 5003.1.1(1) and (2) are

based on normal storage arrangements, open systems and closed systems. The amount of chemical allowed per control area is based on how the chemical is being used or stored. Correct interpretation of the tables depends on knowing how the chemicals will be used. Remember that any process that changes the chemical traits must be accounted for. These would include preheating and pressurizing the chemicals.

**E103.1.5 Surrounding conditions.** Conditions such as other materials or processes in the area, type of construction of the structure, fire protection features (e.g., *fire walls*, sprinkler systems, alarms, etc.), occupancy (use) of adjoining areas, normal temperatures, exposure to weather, etc., must be taken into account in evaluating the hazard.

❖ Final elements in determining hazards are the conditions of storage and use. Will the chemical be in outdoor storage, indoor storage or in a detached building? What types of protection for the chemicals are proposed? What types of protection are required for the type of hazard? What are the requirements for temperature control for the chemicals? What types of processes will the chemicals be used in? The answers to these questions will determine whether the proposed structure meets the minimum requirements of the code.

**E103.2 Evaluation questions.** The following are sample evaluation questions:

❖ Evaluating each chemical proposed to be in a structure and determining whether the structure will be a hazardous use group is very important. In today's society, even those occupancies that would normally not be thought of as having hazardous materials can have enough involved in production to change the use group. For example, during review of a dentist's office (normally considered a business use group) MSDS were requested for all chemicals, along with the amounts and storage methods. When the MSDS were received, the chemicals reported included one that was listed as explosive when at room temperature. The occupancy was to have 3 pounds (1.4 kg) of the product.

The introduction of this one chemical made the structure move from a Group B use to a Group H-1 use, and the product had to be stored in a detached storage building. These questions must be asked and evaluated to determine whether a building is a Group H use.

1. What is the material? Correct identification is important; exact spelling is vital. Check labels, MSDS, ask responsible persons, etc.

❖ The properties of chemicals change with the mixture, manufacturer and blends. Generic information cannot be used; information recorded on the MSDS must match the exact chemical that will be used. Currently, there are at least six different blends of diesel fuel that, based on the flash point and boiling point, can range from a Class IC to a Class III flammable liquid;

thus, different protection and exempt amounts are allowed and required for the chemical. It is important to note that the changing of one letter in the chemical name can change a chemical that is not considered hazardous to one that is extremely hazardous. Precise information is required to determine whether a hazardous use group designation is needed.

2. What are the concentration and strength?

❖ Based on the blend, concentration and strength of solution, each chemical takes on different traits. One MSDS does not cover all concentrations and blends; a separate MSDS must be submitted for each specific chemical.

3. What is the physical form of the material? Liquids, gases and finely divided solids have differing requirements for spill and leak control and containment.

❖ The physical form of the material is important from the standpoint of hazards and the concept of fire. Gases are more dangerous than liquids and liquids are more dangerous than solids. Understanding the form and makeup of the chemical will assist in determining the danger to the structure and the community. Each physical form will have its own problems with protection and containment that must be considered in the review.

4. How much material is present? Consider in relation to permit amounts, *maximum allowable quantity per control area* (from Group H occupancy requirements), amounts that require detached storage and overall magnitude of the hazard.

❖ A review of the chemicals and amounts of product that will be present will raise some questions: Will the chemicals be in an open or closed container? What type of protection will be provided? Will the chemical be placed in control areas in accordance with Section 5003.8.2? Will the amounts be more than the exempt amounts allowed by Tables 5003.1.1 and 5003.1.1(2) or be one of the exceptions listed in Section 5001.1? The answers to these questions will govern the types of requirements that must be addressed.

5. What other materials (including furniture, equipment and building components) are close enough to interact with the material?

❖ Will other items be stored close to the chemical storage? Will the storage of other chemicals that are normally not hazardous cause a more hazardous condition when mixed with the hazardous chemicals in an emergency? Is the fire load of the area increased by the presence of the chemicals and general storage? If so, additional protection may be required based on the additional fire loading and hazards created.

6. What are the likely reactions?

❖ Will the mixing of chemical or fire protection features create a dangerous or hazardous condition if the chemicals are not separated into different contain-

ment areas? Checking the MSDS for adverse reactions to other products in the storage area is extremely important.

7. What is the activity involving the material?
- ❖ What process will the chemical be used in? Will the physical conditions of the chemical be changed by heating, pressurizing or other methods during the use, process or manufacturing of the final product? It is important to note that some nonhazardous chemicals, through the processing phases, can create a hazardous atmosphere. As much information and knowledge as possible of the processing system and use of the chemical must be gained for a good review/inspection process.
  8. How does the activity impact the hazardous characteristics of the material? Consider vapors released or hazards otherwise exposed.
- ❖ Is the chemical being used in an open atmosphere? Chemicals in an open system are normally much more dangerous than they would be in a closed system. When dealing with a toxic chemical, what types of filters are required to protect personnel and the environment?
  9. What must the material be protected from? Consider other materials, temperature, shock, pressure, etc.
- ❖ High explosives can be detonated by light to moderate shock. Some chemicals can react to changes in temperatures. Containers under pressure can react violently. The MSDS must be checked for these types of hazards to make certain protective storage and use arrangements fit requirements.
  10. What effects of the material must people and the environment be protected from?
- ❖ What are the dangers to the environment or to personnel if there is an emergency release? Dikes, special filters, distance from other structures and other methods of protection may be required to reduce the impact from an emergency release.
  11. How can protection be accomplished? Consider:
    - 11.1. Proper containers and equipment.
      - ❖ Plastic pint bottles, glass bottles, safety cans, drums, barrels, above-ground tanks and underground tanks are just a few of the types of containers that may be used for storage. Each type of container has special requirements for size and methods of storage. These requirements can be found in Chapter 50 and other related references.
        - 11.2. Separation by distance or construction.
      - ❖ Group H-1 use areas must be located in a detached building. Outdoor storage must be separated from other buildings and property lines by distances as outlined in Section 5003.12 and other related sections.

11.3. Enclosure in cabinets or rooms.

- ❖ Third-party tested hazardous materials storage cabinets can be used to increase the exempt amounts allowed by Tables 5003.1.1(1) and (2). These cabinets must meet the minimum requirements of Sections 5003.8.4, 6004.1.2 and other related sections. Gas rooms must meet the requirements of Sections 5003.8.3, 6004.1.2 and other related sections. Flammable liquid storage rooms must meet the requirements of Section 5704.3.7.3 and related codes.

11.4. Spill control, drainage and containment.

- ❖ If one can minimize the spill area and contain any accidental release, the amount of potential damage will be greatly reduced. Cleanup will be easier and the hazard reduced for fire service and emergency workers. Spill control, drainage and containment must meet the minimum requirements of Section 5004.2 and related sections. Remember that the containment area is, in a lot of cases, more hazardous than the initial storage area.

11.5. Control systems—ventilation, special electrical, detection and alarm, extinguishment, explosion venting, limit controls, exhaust scrubbers and excess flow control.

- ❖ The methods of control, how much ventilation, special detection and alarms will be obtained from the MSDS. Section 5003 contains guidance into requirements for additional protection.

11.6. Administrative (operational) controls—signs, ignition source control, security, personnel training, established procedures, storage plans and emergency plans.

Evaluation of the hazard is a strongly subjective process; therefore, the person charged with this responsibility must gather as much relevant data as possible so that the decision will be objective and within the limits prescribed in laws, policies and standards.

It could be necessary to cause the responsible persons in charge to have tests made by qualified persons or testing laboratories to support contentions that a particular material or process is or is not hazardous. See Section 104.7.2 of the *International Fire Code*.

- ❖ Posting signs, as required by Section 5003.5, is an important component to alert emergency response personnel to possible dangers to them and the community. Section 5003.7 contains guidance on the requirements for ignition source controls. Section 5003.9.1 contains information on personnel training. Section 5003.9.2 contains information on security. Storage plans and emergency plans requirements can be found in Sections 407, 408 and 5001.4.1 and other related sections. Having an up-to-date emergency plan is very important to both the community and emergency services; however, it is often overlooked.

**SECTION E104  
REFERENCED STANDARDS**

CGA (2009)	P-20—	Standard for Classification of Toxic Mixtures	E103.1.3.1
CGA (2008)	P-23—	Standard for Categorizing Gas Mixtures Containing Flammable and Nonflammable Components	E102.1.2
ICC	IFC—15	International Fire Code	E101.1, E102.1.1, E102.1.8.1, E103.2



# Appendix F: Hazard Ranking

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

## General Comments

The presence of hazardous materials in all types of occupancies is becoming more common. While industrial facilities are constantly developing and expanding their use of hazardous materials, significant quantities of an ever-increasing variety of materials can also be found in other occupancies, such as hospitals, research laboratories and even mercantile uses. Knowledge of hazardous materials within a given occupancy is essential not only for proper code enforcement but also for prefire planning purposes. Although submittal of Material Safety Data Sheets (MSDS) and compliance with right-to-know legislation are necessary to determine the proper mitigation means for all hazardous materials, it is also true that in an emergency response situation, responders must have a clear and readily available warning of the material hazards that confront them. The NFPA 704 hazard classification system was developed for that express purpose and it is the intent of this appendix to provide the fire code official with a ready reference tool for approval of the hazard warnings required by Chapter 50, among others.

## Purpose

The code regulates the storage, dispensing and use of all hazardous materials classified as either physical or health hazards. These materials pose diverse hazards, including instability, reactivity, flammability, oxidizing potential or toxicity; therefore, identifying them by hazard ranking is essential. The information in this appendix is intended to be a companion to the specific requirements of Chapters 51 through 67.

The table included in this appendix lists the various hazardous materials categories that are defined in Chapter 2 of the code, along with the NFPA 704 hazard ranking for each. Once a specific material is properly identified and categorized as meeting a given hazardous material definition, the appropriate flammability, health, reactivity, oxidizing and special hazard designations of the NFPA 704 system can be readily found in the table.

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## SECTION F101 GENERAL

**F101.1 Scope.** Assignment of levels of hazards to be applied to specific hazard classes as required by NFPA 704 shall be in accordance with this appendix. The appendix is based on application of the degrees of hazard as defined in NFPA 704 arranged by hazard class as for specific categories defined in Chapter 2 of the *International Fire Code* and used throughout.

❖ This paragraph establishes the relationship between the hazardous materials definitions found in Chapter 2 and the methods used in NFPA 704 to establish the degree of hazard for a wide variety of hazardous materials.

**F101.2 General.** The hazard rankings shown in Table F101.2 have been established by using guidelines found within NFPA 704. As noted in Section 4.2 of NFPA 704, there could be specific reasons to alter the degree of hazard assigned to a specific material; for example, ignition temperature, flammable range or susceptibility of a container to rupture by an internal combustion explosion or to metal failure while under pressure or because of heat from external fire. As a result, the

degree of hazard assigned for the same material can vary when assessed by different people of equal competence.

The hazard rankings assigned to each class represent reasonable minimum hazard levels for a given class based on the use of criteria established by NFPA 704. Specific cases of use or storage may dictate the use of higher degrees of hazard in certain cases.

❖ These two paragraphs explain the rationale for the hazard rankings shown in Table F101.2. The word of caution sounded here is that rankings will vary depending on the circumstances of each individual application. In addition, because fire code officials are required to use personal judgement to determine rankings, those rankings may vary from one official to another because of their differing personal backgrounds and experience.

The message given in the last sentence of the first paragraph is very significant. The fire code official will be called upon to use every bit of knowledge gained through years of experience to make judgments of hazards on a case-by-case basis. The rankings shown in Table F101.2 are minimums. The fire code official

APPENDIX F

may decide that circumstances in individual cases require higher rankings than are shown in the table.

As an example of how conditions can cause a change in ranking, consider this. The method of storage and processing of a chemical can greatly change the ranking. If a Class IIIB combustible liquid is preheated to its flashpoint, or pressurized to greater than 15 psi (103 kPa), it will exhibit the same traits as a Class IA flammable liquid. Thus, the ranking would change from a 1 (F1) in the flammable diamond to a 4 (F4). This increase in ranking is a result of the change of storage method and process, not any change in the chemical makeup of the combustible liquid.

Diamond” sign depicted in Chapter 9 of NFPA 704 and required by Sections 407.3 and 5003.5. Consistent with Section 5001.2.2, the materials listed in this table may possess multiple hazard characteristics that must be displayed in additional quadrants of the “NFPA 704 Diamond.” The construction and content of the signs must be approved by the fire code official as required by Section 5003.6. Note that the designations in this table are not to be confused with occupancy group designations established by Chapter 3 of the *International Building Code*® (IBC®).

TABLE F101.2. See below.

❖ The alpha-numeric designations indicated in this table represent the primary hazard information that is to appear in the various quadrants of the “NFPA 704

TABLE F101.2  
FIRE FIGHTER WARNING PLACARD DESIGNATIONS BASED ON HAZARD CLASSIFICATION CATEGORIES

HAZARD CATEGORY	DESIGNATION
	F2
	F2
Combustible liquid II	F1
Combustible liquid IIIA	F4
Combustible liquid IIIB	F3
Combustible dust	F4, H3
Combustible fiber	OX, H3
Cryogenic flammable	R4
Cryogenic oxidizing	F2
Explosive	F4
Flammable solid	F4
Flammable gas (gaseous)	F4
Flammable gas (liquefied)	F4
Flammable liquid IA	F3
Flammable liquid IB	F3
Flammable liquid IC	R4
Organic peroxide, UD	F4, R3
Organic peroxide I	F3, R3
Organic peroxide II	F2, R2
Organic peroxide III	F1, R1
Organic peroxide IV	None
Organic peroxide V	OX
Oxidizing gas (gaseous)	OX
Oxidizing gas (liquefied)	OX
Oxidizer 4	OX4
Oxidizer 3	OX3
Oxidizer 2	OX2
Oxidizer 1	OX1
Pyrophoric gases	F4
Pyrophoric solids, liquids	F3
Unstable reactive 4D	R4
Unstable reactive 3D	R4
Unstable reactive 3N	R4
Unstable reactive 2	R2
Unstable reactive 1	R2
Water reactive 3	None
Water reactive 2	W3
Corrosive	W2
Toxic	H3, COR
Highly toxic	H3
	H4

F—Flammable category.  
R—Reactive category.  
H—Health category.  
W—Special hazard: water reactive.  
OX—Special hazard: oxidizing properties.

COR—Corrosive.  
UD—Unclassified detonable material.  
4D—Class 4 detonable material.  
3D—Class 3 detonable material.  
3N—Class 3 nondetonable material.

**SECTION F102  
REFERENCED STANDARDS**

ICC	IFC—15 International Fire Code	F101.1
NFPA	704—12 Standard System for Identification of the Hazards of Materials for Emergency Response	F101.1 F101.2



# Appendix G: Cryogenic Fluids—Weight and Volume Equivalents

*This appendix is for information purposes and is not intended for adoption.*

## General Comments

Chapter 55 of the code regulates cryogenic fluids (liquefied gases) that are used to provide very low temperatures in a variety of scientific and industrial processes. Low temperatures in cryogenic processes are achieved primarily by the liquefaction of gases, resulting in the family of hazardous materials known as cryogenic fluids (see the commentary to the definition of “Cryogenic fluid” in Section 202). More than 25 such cryogenics are currently in use in the cryogenic industry; however, this appendix focuses on the six that account for the greatest volume of use and application in research and industry: helium, hydrogen, nitrogen, argon, oxygen and liquefied natural gas (LNG; methane).

Although cryogenic fluids are characterized by extreme low temperatures, ranging from a boiling point of 258.5°F (161.4°C) for LNG to 453.1°F (269.5°C) for helium, they also possess another hazard characteristic: a high volume expansion ratio from liquid to gas, from approximately 696 to 1 for nitrogen, to 860 to 1 for oxygen. And while argon, helium, oxygen and nitrogen in the cryogenic range are not toxic or flammable, they can cause asphyxiation by displacing the air necessary for the support of life when released. Even pure oxygen, an oxidizer, may have harmful physiological effects if it is breathed over an extended period.

There is also the flammable gas hazard when cryogenic fluids, such as hydrogen and LNG, are stored or used. However, the fire hazard may also be greatly increased when cryogenic fluids normally thought to be

nonflammable are used. The presence of oxygen, for example, will greatly increase the combustibility of ordinary combustible materials, and may even cause some noncombustible materials like carbon steel to burn readily under the right conditions. Liquefied inert gases, such as liquid nitrogen or liquid helium, are also capable, under the right conditions, of condensing oxygen from the atmosphere and causing unsuspected oxygen enrichment or entrapment in areas where there may be ignition sources. Reduction of such conditions, and the potential asphyxiation hazard of cryogenic fluids (liquefied gases) discussed above, may be accomplished, in part, by a properly designed ventilation system.

To properly apply the requirements of Chapter 55 to reduce the hazards discussed here, the volume of gas capable of being generated by a cryogenic fluid installation must be determined. Rather than leaving such determination to case-by-case mathematical calculation, this appendix gives the fire code official and design professional a convenient tool for determining the correct gas volumes for selected cryogenic fluids. For further discussion of cryogenic fluids, see the commentary to Chapter 55.

## Purpose

This appendix gives the fire code official a ready reference tool for the conversion of the liquid weight and volume of cryogenic fluid to their corresponding volume of gas and vice versa.

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## SECTION G101 GENERAL

**G101.1 Scope.** This appendix is used to convert from liquid to gas for *cryogenic fluids*.

- ❖ This appendix gives the liquid volume for the most frequently used cryogenic fluids for a given weight at the normal boiling point of the liquid, and then shows the volume of gas that will expand from that volume of liquid at normal temperature and pressure (NTP). An example showing how to use the table is given in the paragraphs that follow.

Anyone who has followed a truck containing liquid nitrogen down a highway has seen the vapor plume venting from the tank. Anyone who has watched the launch of a liquid-fueled rocket, such as the space shuttle booster or the Saturn V used to put Apollo capsules in moon orbit, has seen a vapor plume coming from the liquid oxygen tanks. In both cases the plume is water vapor that has been condensed from the air by the cold gas escaping from the tanks through overpressure valves.

All of these common cryogenics represent hazards of one kind or another. LNG and hydrogen are both

flammable and present combustion and explosion hazards at concentrations that are addressed in Chapter 55. Oxygen can also contribute tremendously to the intensity of a fire, its size and its spread. On the other hand, helium, argon and nitrogen are nonflammable, but are not breathable. Helium, being lighter than air, would rise to the highest levels of the storage space, presenting a minimal hazard unless the concentration became so large that it displaced breathable air at lower levels. Nitrogen and argon are heavier and would concentrate at lower levels, displacing breathable air.

**G101.2 Conversion.** Table G101.2 shall be used to determine the equivalent amounts of *cryogenic fluids* in either the liquid or gas phase.

❖ Table G101.2 is a convenient reference to determine the volume of gas that will expand from a given volume of cryogenic fluid. This kind of information is important to the decision of what quantities can be safely stored or used under any set of conditions and also to the determination of what ventilation capacity would be required for those storage or use conditions.

**G101.2.1 Use of the table.** To use Table G101.2, read horizontally across the line of interest. For example, to determine the number of cubic feet of gas contained in 1.0 gallon (3.785 L) of liquid argon, find 1.000 in the column entitled “Volume of Liquid at Normal *Boiling Point*.” Reading across the line under the column entitled “Volume of Gas at NTP” (70°F and 1 atmosphere/14.7 psia), the value of 112.45 cubic feet (3.184 m<sup>3</sup>) is found.

❖ This example emphasizes the importance of expansion volume of these cryogenic liquids to determining safe storage and use conditions. Leakage of as little as 10 gallons (38 L) of liquid argon would displace all air in a space measuring 10 feet by 10 feet by 10 feet (3048 mm by 3048 mm by 3048 mm), unless the ventilation system for this space is sized to remove the expanding gas as it escapes from its container or transport system.

**G101.2.2 Other quantities.** If other quantities are of interest, the numbers obtained can be multiplied or divided to obtain the quantity of interest. For example, to determine the number of cubic feet of argon gas contained in a volume of 1,000 gallons (3785 L) of liquid argon at its normal *boiling point*, multiply 112.45 by 1,000 to obtain 112,450 cubic feet (3184 m<sup>3</sup>).

❖ This example shows that the basic numbers in the table can be used to calculate the effect of any quantity of cryogenic liquid on any given storage or work space.

The table can also be used to calculate needed information about design requirements. Consider this simplified example:

Assume a cryogenic tank that holds 75 gallons (284 L) of liquid oxygen (LOX) and weighs 200 pounds (91 kg) empty. The tank is to be located in a room in an existing retirement home building to fill

portable oxygen bottles for individuals needing breathing assistance. An exhaust hood will be installed over the tank to assist in carrying off any oxygen vapors. To be determined is whether the floor structure of the existing room will carry the added load of the filled tank and also what volume of oxygen gas would have to be exhausted in case of a valve failure.

Table G101.2 shows that 1 gallon (3.785 L) of LOX weighs 9.527 pounds (4.3 kg). The weight of the tank and its contents may then be calculated as follows:

$$\begin{aligned} 75 \text{ gal.} \times 9.527 \text{ lb/gal} &= 714.525 \text{ lb (324.4 kg)} \\ 714.525 \text{ lb} + 200 \text{ lb} &= 915 \text{ lb (415 kg)} \\ \text{Add safety factor of } 2 &= 1,830 \text{ lb (831 kg)} \end{aligned}$$

The floor structure would have to support the added load of the LOX tank and its contents having a weight of approximately 2,000 pounds (1080 kg) [see the commentary to Chapter 16 of the *International Building Code*® (IBC®) for discussion of structural loads].

Table G101.2 also shows that 1 gallon (3.785 L) of LOX will expand to 115.05 cubic feet (3.26 m<sup>3</sup>) of gas. Assuming the tank is full and a valve failure would result in the tank emptying completely in 2 hours, the exhaust hood would have to be able to remove the following volume of gas:

$$\begin{aligned} 75 \text{ gal.} \times 115.05 \text{ cu. ft./gal.} &= 8628.75 \text{ cu. ft.} \\ &= (244.4 \text{ m}^3) \text{ total} \\ 8628.75 \text{ cu. ft.} \div 120 \text{ min.} &= 71.9 \text{ cfm (2 m}^3\text{/min)} \end{aligned}$$

The exhaust hood fan would have to be able to remove 72 cubic feet per minute (cfm) (0.03 m<sup>3</sup>/s) of gas from the room.

This example is obviously a simplified version of a real problem. In real-world terms, more information would be needed about the volume of the room the tank is in, and additional safety features to make sure no spark sources or flammable materials are added where concentrations of oxygen could intensify a fire would need to be considered. But it does serve to show how Table G101.2 can be used to help designers, contractors, inspectors, plans examiners and building owners and tenants determine whether planned installations meet minimum safety requirements.

**TABLE G101.2  
WEIGHT AND VOLUME EQUIVALENTS FOR COMMON CRYOGENIC FLUIDS**

CRYOGENIC FLUID	WEIGHT OF LIQUID OR GAS		VOLUME OF LIQUID AT NORMAL BOILING POINT		VOLUME OF GAS AT NTP	
	Pounds	Kilograms	Liters	Gallons	Cubic feet	Cubic meters
Argon	1.000	0.454	0.326	0.086	9.67	0.274
	2.205	1.000	0.718	0.190	21.32	0.604
	3.072	1.393	1.000	0.264	29.71	0.841
	11.628	5.274	3.785	1.000	112.45	3.184
	10.340	4.690	3.366	0.889	100.00	2.832
	3.652	1.656	1.189	0.314	35.31	1.000
	1.000	0.454	3.631	0.959	96.72	2.739
Helium	2.205	1.000	8.006	2.115	213.23	6.038
	0.275	0.125	1.000	0.264	26.63	0.754
	1.042	0.473	3.785	1.000	100.82	2.855
	1.034	0.469	3.754	0.992	100.00	2.832
	0.365	0.166	1.326	0.350	35.31	1.000
	1.000	0.454	6.409	1.693	191.96	5.436
	2.205	1.000	14.130	3.733	423.20	11.984
Hydrogen	0.156	0.071	1.000	0.264	29.95	0.848
	0.591	0.268	3.785	1.000	113.37	3.210
	0.521	0.236	3.339	0.882	100.00	2.832
	0.184	0.083	1.179	0.311	35.31	1.000
	1.000	0.454	0.397	0.105	12.00	0.342
	2.205	1.000	0.876	0.231	26.62	0.754
	2.517	1.142	1.000	0.264	30.39	0.861
Oxygen	9.527	4.321	3.785	1.000	115.05	3.250
	8.281	3.756	3.290	0.869	100.00	2.832
	2.924	1.327	1.162	0.307	35.31	1.000
	1.000	0.454	0.561	0.148	13.80	0.391
	2.205	1.000	1.237	0.327	30.43	0.862
	1.782	0.808	1.000	0.264	24.60	0.697
	6.746	3.060	3.785	1.000	93.11	2.637
Nitrogen	7.245	3.286	4.065	1.074	100.00	2.832
	2.558	1.160	1.436	0.379	35.31	1.000
	1.000	0.454	1.052	0.278	22.968	0.650
	2.205	1.000	2.320	0.613	50.646	1.434
	0.951	0.431	1.000	0.264	21.812	0.618
	3.600	1.633	3.785	1.000	82.62	2.340
	4.356	1.976	4.580	1.210	100.00	2.832
LNG <sup>a</sup>	11.501	5.217	1.616	0.427	35.31	1.000

For SI: 1 pound = 0.454 kg, 1 gallon = 3.785 L, 1 cubic foot = 0.02832 m<sup>3</sup>, °C = [(°F)-32]/1.8, 1 pound per square inch atmosphere = 6.895 kPa.

a. The values listed for liquefied natural gas (LNG) are "typical" values. LNG is a mixture of hydrocarbon gases, and no two LNG streams have exactly the same composition.



# Appendix H: Hazardous Materials Management Plan (HMMP) and Hazardous Materials Inventory Statement (HMIS) Instructions

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

## General Comments

The requirements for a Hazardous Materials Management Plan (HMMP) or Hazardous Materials Inventory Statement (HMIS) have existed in some form since the 1988 edition of the legacy *Uniform Fire Code*. HMMP and HMIS must be submitted with permit applications when required by the fire code official. Appendix H provides an example format for these documents and clarifies the information to be submitted to the building code official for review of plans to determine compliance with the hazardous material requirements in *International Building Code*® (IBC®) Sections 414 and 415.

Appendix H was developed to provide a standard reporting format for businesses submitting an HMMP or HMIS to the fire or building code official based on the classification and quantities of materials that would be found on site for storage or use. Appendix H is not mandatory unless it is adopted by the jurisdiction. Some jurisdictions have already developed standard formats for submittal of HMMP and HMIS. Appendix H can be amended to provide this information to the regulated community.

Appendix H is divided into four distinct sections:

1. H101: Hazardous Materials Management Plan
2. H102: Hazardous Materials Inventory Statement

3. H103: Emergency Plan

4. H104: Referenced Standards

The sample forms in this appendix and available Material Safety Data Sheets (MSDS) provide the basis for the evaluations. The use of the forms should promote uniformity in the manner that hazardous materials information is provided, stored and used.

## Purpose

Sections 407.5 and 407.6 of the *International Fire Code*® (IFC®) require that HMIS and HMMP be provided. Sections 5001.5.1 and 5001.5.2 specify their contents when these documents are required to be submitted with a permit application by the fire code official. They focus on three important goals. First, the HMIS is formatted so that plan reviewers can determine the correct occupancy classification of the building based on material hazards. Second, the HMMP and HMIS provide hazardous materials storage and use information necessary for inspectors. Third, the HMMP includes information that fire department operations personnel need before and during an emergency response.

The amounts of each hazard class in storage and use and the applicable maximum allowable quantities are provided in the HMIS.

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## SECTION H101 HMMP

❖HMMP have commonly been used as a tool to help facilitate tactical preplanning of Group H occupancies or facilities storing and handling large amounts of hazardous materials, such as petroleum storage terminals. They can be beneficial when preparing tactical preplans, but can be cumbersome if actually used as such. For example, consider a typical water treatment plant that could have large amounts of anhydrous chlorine, sulfur dioxide, sodium hydroxide and hydrofluorosilic acid. To comply with all of the require-

ments of an HMMP for the various storage and process piping drawings, plant layout and process details could easily result in over 100 pages of information that would need to be read and understood. This level of information has not always been beneficial to emergency responders, especially given that Section 5003.9.1.1 requires that the permit holder designate responsible persons to serve as fire department liaisons in the event of an incident. It is expected that these responsible persons have a good understanding of the hazardous materials and the processes involving their storage and use.

**H101.1 Part A** (See Example Format in Figure 1).

1. Fill out items and sign the declaration.
  2. Part A of this section is required to be updated and submitted annually, or within 30 days of a process or management change.
- ❖ The business information portion of the plan is to identify the business, location and responsible people who will interact with the fire department, both during normal review periods and during an emergency incident. Also included is general information regarding the type of process, procedures and storage; and the number of people normally in the facility during each shift and time period the business is open to assist in accounting for them during an emergency. This plan assists not only the fire department, but also the business to establish a listing of employees to be accounted for during an emergency. The plan must be continually reviewed by the company to ensure the information is current and reviewed by the fire department during inspections.

**H101.2 Part B—General Facility Description/Site Plan** (See Example Format in Figure 2).

1. Provide a site plan on 8<sup>1</sup>/<sub>2</sub> by 11 inch (215 mm by 279 mm) paper, showing the locations of all buildings, structures, outdoor chemical control or storage and use areas, parking lots, internal roads, storm and sanitary sewers, wells and adjacent property uses. Indicate the approximate scale, northern direction and date the drawing was completed.
- ❖ The facility description and site plan is a description of what occurs at the facility and where. This form must correlate the processes and procedures with locations on the building and site plans to be provided on Figure 3 (see commentary, Section H101.3).

**H101.3 Part C—Facility Storage Map—Confidential Information** (See Example Format in Figure 3).

1. Provide a floor plan of each building identified on the site plan as containing hazardous materials on 8<sup>1</sup>/<sub>2</sub>-inch by 11-inch (215 mm by 279 mm) paper, identifying the northern direction, and showing the location of each storage and use area.
2. Identify storage and use areas, including hazard waste storage areas.
3. Show the following:
  - 3.1. Accesses to each storage and use area.
  - 3.2. Location of emergency equipment.
  - 3.3. Location where liaison will meet emergency responders.
  - 3.4. Facility evacuation meeting point locations.
  - 3.5. The general purpose of other areas within the building.
  - 3.6. Location of all aboveground and underground tanks to include sumps, vaults, below-grade treatment systems, piping, etc.

- 3.7. Show hazard classes in each area.
- 3.8. Show locations of all Group H occupancies, control areas, and exterior storage and use areas.
- 3.9. Show emergency exits.

- ❖ In creating the facility map, it is usually best to follow the map maker's guide of orientating the site so that North is at the top of the page, identified by the use of a compass arrow pointing toward the top of the page. Wherever possible, standard map symbols should be used. In any event, clear identification of required features is essential to the effectiveness of the map. NFPA 170, *Fire Safety and Emergency Symbols*, may be useful in map preparation.

Identify the use, storage and waste storage using different symbols. With the areas identified, it is important to identify the access to each area and emergency exits, and the location of emergency equipment that is available for the hazard. The designated location for the facility liaison to meet the fire department is important for the prompt exchange of information regarding the facility and as a location where employees are to go to be safe and out of the way of emergency responders.

The location of tanks at the facility, especially the underground tanks, piping and valves, and the material classes are needed in addition to the control areas or Group H occupancies within the buildings. Exterior storage and use areas also need to be clearly identified.

**SECTION H102  
HMIS**

- ❖ HMIS are commonly used for determining a building's occupancy classification and to satisfy the requirements in Section 105 for operational permits to store, handle, dispense and use hazardous materials. Section 5001.5.2 previously required that product information, the MSDS for each product, the hazard classification of the material using the criteria in Section 5001.2.2 and the maximum quantity stored on site be reported. While this information is helpful in understanding the hazards that may be associated with a particular occupancy or premises, it does not require reporting amounts in open or closed systems or the identification of the control areas locations.

**H102.1 Inventory statement contents.**

1. HMIS Summary Report (see Example Format in Figure 4).
  - 1.1. Complete a summary report for each control area and Group H occupancy.
  - 1.2. The storage summary report includes the HMIS Inventory Report amounts in storage, use-closed and use-open conditions.
  - 1.3. Provide separate summary reports for storage, use-closed and use-open conditions.

- 1.4. IBC/IFC Hazard Class.
  - 1.5. Inventory Amount. [Solid (lb), Liquid (gal), Gas (cu ft, gal or lbs)].
  - 1.6. IBC/IFC Maximum Allowable Quantity per control area (MAQ). (If applicable, double MAQ for sprinkler protection and/or storage in cabinets. For wholesale and retail sales occupancies, go to Tables 5003.11.1 and 5704.3.4.1 of the *International Fire Code* for MAQs.)
2. HMIS Inventory Report (see Example Format in Figure 5).
    - 2.1. Complete an inventory report by listing products by location.
    - 2.2. Product Name.
    - 2.3. Components. (For mixtures specify percentages of major components if available.)
    - 2.4. Chemical Abstract Service (CAS) Number. (For mixtures list CAS Numbers of major components if available.)
    - 2.5. Location. (Identify the control area or, if it is a Group H occupancy, provide the classification, such as H-2, H-3, etc.)
    - 2.6. Container with a capacity of greater than 55 gallons (208 L). (If product container, vessel or tank could exceed 55 gallons, indicate yes in column.)
    - 2.7. Hazard Classification. (List applicable classifications for each product.)
    - 2.8. Stored. (Amount of product in storage conditions.)
    - 2.9. Closed. (Amount of product in use-closed systems.)
    - 2.10. Open. (Amount of product in use-open systems.)

Facilities that have prepared, filed and submitted a Tier II Inventory Report required by the U.S. Environmental Protection Agency (USEPA) or required by a state that has secured USEPA approval for a similar form shall be deemed to have complied with this section.

- ❖ Facilities that have prepared, filed and submitted a Tier II Inventory Report required by the U.S. Environmental Protection Agency (U.S. EPA) or required by a state which has secured U.S. EPA approval for a similar form shall be deemed to have complied with this section.

The HMIS Report is a comprehensive summary of the hazardous materials to be found at the facility for each control area or Group H occupancy area, and is to contain all of the information listed in Items 1 and 2 of this section (see also Section 5001.5.2). Note that this section of the HMIS is only needed if a SARA Tier II Report has not been filed.

### SECTION H103 EMERGENCY PLAN

1. Emergency Notification. (See Example Format in Figure 6.)
  2. Where OSHA or state regulations require a facility to have either an Emergency Action Plan (EAP) or an Emergency Response Plan (ERP), the EAP or ERP shall be included as part of the HMMP.
- ❖ When state or Occupational Safety and Health Administration (OSHA) regulations require an Emergency Action Plan or Emergency Response Plan, the plan must provide contact information for liaisons of the business to the appropriate response agencies.

### SECTION H104 REFERENCED STANDARDS

ICC	IBC—15 International Building Code	H102.1
ICC	IFC—15 International Fire Code	H102.1

**FIGURE 1  
HAZARDOUS MATERIALS MANAGEMENT PLAN  
SECTION I: FACILITY DESCRIPTION**

1. Business Name: \_\_\_\_\_ Phone: \_\_\_\_\_  
Address: \_\_\_\_\_

2. Person Responsible for the Business  
Name: \_\_\_\_\_ Title: \_\_\_\_\_ Phone: \_\_\_\_\_

3. Emergency Contacts:

Name:	Title:	Home Number:	Work Number:
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

4. Person Responsible for the Application/Principal Contact:  
Name: \_\_\_\_\_ Title: \_\_\_\_\_ Phone: \_\_\_\_\_

5. Principal Business Activity:  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

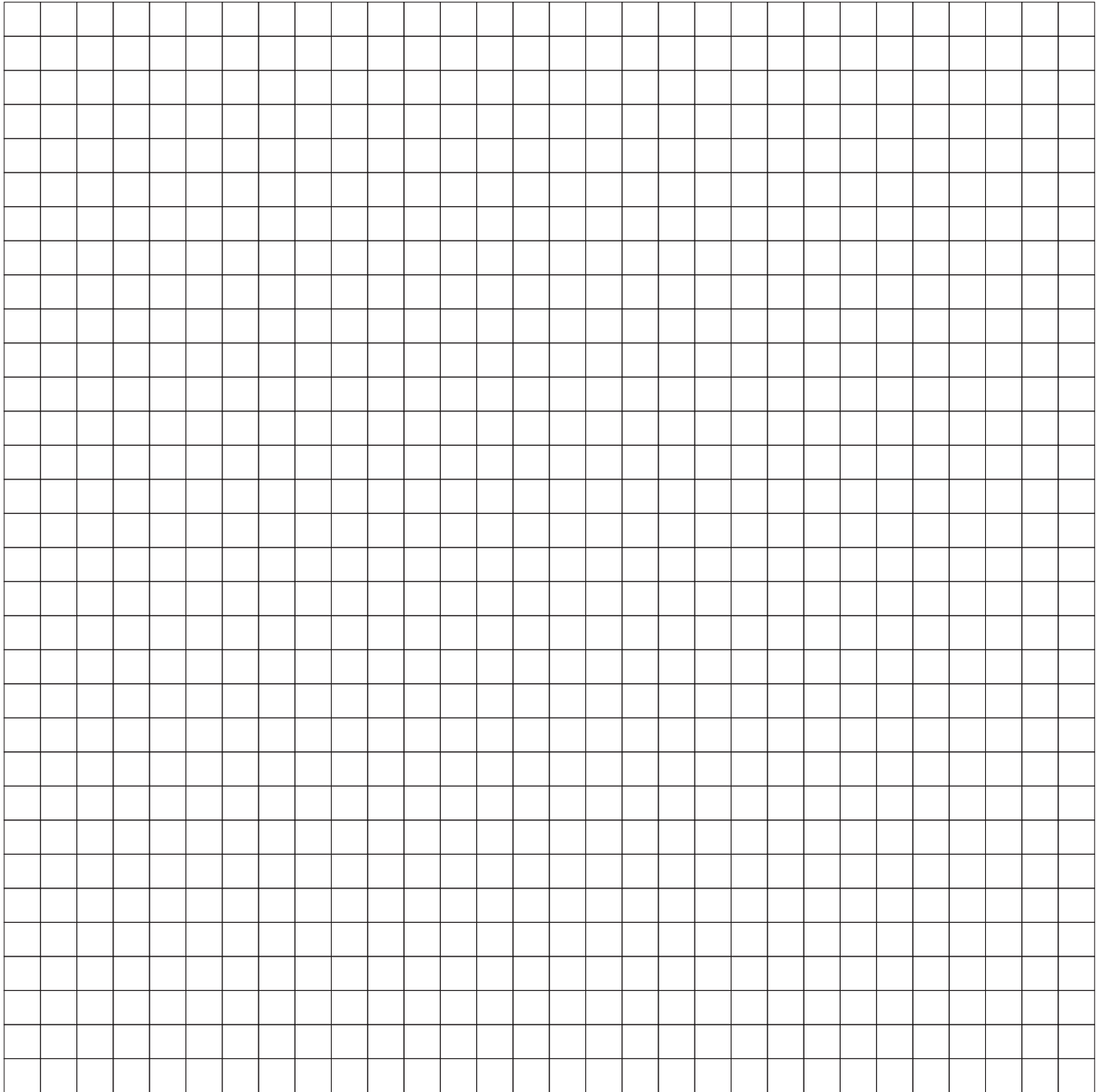
6. Number of Employees: \_\_\_\_\_

7. Number of Shifts: \_\_\_\_\_  
a. Number of Employees per Shift:  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

8. Hours of Operation: \_\_\_\_\_



**FIGURE 3**  
**HAZARDOUS MATERIALS MANAGEMENT PLAN SECTION I: FACILITY DESCRIPTION PART C—FACILITY MAP**



<b>Business Name</b>	<b>Date</b>
<b>Address</b>	<b>Page of</b>

**FIGURE 4**  
**SECTION II—HAZARDOUS MATERIALS INVENTORY STATEMENT (HMIS) HMIS SUMMARY REPORT<sup>a</sup> (Storage<sup>b</sup> Conditions)<sup>c</sup>**

IBC/IFC HAZARD CLASS	HAZARD CLASS (Abbrev)	INVENTORY AMOUNT			IBC/IFC MAXIMUM ALLOWABLE QUANTITY <sup>d</sup>		
		Solid (lb)	Liquid (gal)	Gas (cu ft, gal, lb)	Solid (lb)	Liquid (gal)	Gas (cu ft, gal, lb)
Combustible Liquid	C2		5			120	
	C3A					330	
	C3B		6			13,200	
Combustible Fiber	Loose/Baled						
Cryogenics, Flammable	Cryo-Flam					45	
Cryogenic, Oxidizing	Cryo-OX					45	
Flammable Gas	FLG						
(Gaseous)				150			1,000
(Liquefied)						30	
Flammable Liquid	F1A					30	
	F1B & F1C		5			120	
Combination (1A, 1B, 1C)			5			120	
Flammable Solid	FLS				125		
Organic Peroxide	OPU				0		
	OP1				5		
	OP2				50		
	OP3				125		
	OP4				NL		
	OP5				NL		
Oxidizer	OX4				0		
	OX3				10		
	OX2				250		
	OX1				4,000		

- a. Complete a summary report for each control area and Group H occupancy.  
b. Storage = storage + use-closed + use-open systems.  
c. Separate reports are required for use-closed and use-open systems.  
d. Include increases for sprinklers or storage in cabinets, if applicable.  
**(This is an example; add additional hazard classes as needed.)**

**FIGURE 5**  
**SECTION II — HAZARDOUS MATERIALS INVENTORY STATEMENT (HMIS) HMIS INVENTORY REPORT**  
*(Sort Products Alphabetically by Location of Product and then Alphabetically by Product Name)*

Product Name (Components) <sup>c</sup>	CAS Number	Location <sup>a</sup>	Container > 55 gal <sup>b</sup>	Haz Class 1	Haz Class 2	Haz Class 3	Stored (lbs)	Stored (gal)	Stored (gas) <sup>d</sup>	Closed (lbs)	Closed (gal)	Closed gas <sup>d</sup>	Open (lbs)	Open (gal)
<b>ACETYLENE</b> (Acetylene gas)	74-86-2	Control Area 1		FLG	UR2				150					
<b>BLACK AEROSOL SPRAY PAINT</b> (Mixture)	Mixture	Control Area 1		A-L3			24							
<b>GASOLINE, UNLEADED</b> (Gasoline-Mixture) Methyl-t-Butyl-Ether-15% Diisopropyl Ether-7% Ethanol-11% Toluene-12% Xylene-11%	8006-61-9 1634-04-4 108-20-3 64-17-5 108-88-3 1330-20-7	Control Area 1		F1B				5						
<b>MOTOR OIL-10W40</b> (Hydrotreated Heavy Paraffinic Distillate-85%; Additives-20%)	64742-54-7 Mixture	Control Area 1		C3B				3						
<b>DIESEL</b> (Diesel-99-100%; Additives)	68476-34-6 Proprietary	Control Area 2	Yes	C2				225						
<b>TRANSMISSION FLUID</b> (Oil-Solvent-Neutral; Performance Additives)	64742-65-0	Control Area 2		C3B				3						
<b>OXYGEN, GAS</b> (Oxygen)	7782-44-7	H-3		OXG					5,000					

- a. Identify the control area or, if it is a Group H occupancy, provide the classification, such as H-2, H-3, etc.
- b. If the product container, vessel or tank could exceed 55 gallons, indicate yes in the column.
- c. Specify percentages of main components if available.
- d. In cubic feet, gallons or pounds.

**(This is an example; add additional hazard classes as needed.)**

**FIGURE 6  
HAZARDOUS MATERIALS MANAGEMENT PLAN  
SECTION III: EMERGENCY PLAN**

1. In the event of an emergency, the following shall be notified:

a. Facility Liaison

Name	Title _____	Home Number	Work Number
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

b. Agency

Agency	Contact	Phone Number
Fire Department	_____	_____
LEPC	_____	_____
Other	_____	_____



# Appendix I: Fire Protection Systems— Noncompliant Conditions

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

## General Comments

Appendix I addresses unsafe conditions for fire protection systems. This particular appendix was developed by the ICC Hazard Abatement in Existing Buildings Committee to help building owners and fire code officials improve their awareness of fire protection system deficiencies that have a high probability of causing a system to be inoperative.

Appendix I does not contain any requirements for identifying unsafe conditions in alternative fire-extinguishing systems such as dry chemical, carbon dioxide or clean agent systems or wet chemical alternative fire extinguishing systems designed to protect commercial kitchen cooking activities.

While it is not a comprehensive list of inspection and maintenance requirements for fire protection systems, Appendix I is intended to identify problems that are readily observable during fire inspections and can be used in conjunction with Chapter 9 of the and the applicable NFPA standards for the indicated fire protection equipment and systems and their maintenance. For example, water supply reliability data for water-based fire protection systems show that the major causes for failure of automatic sprinkler systems include shutting

off the source of the water supply, not extending sprinkler protection into rooms or areas that are not protected, or the introducing goods or commodities that cannot be controlled based on the sprinkler system's discharge density.

Excluding the general provision in Section I101.1, the appendix is divided into two sections. Section I101.2 addresses noncompliant conditions that require the replacement of sprinklers and system gauges, including sprinklers that are damaged, painted or improperly oriented. It also requires sprinklers manufactured in 1919 or earlier to be replaced. Section I101.3 addresses noncompliant conditions for automatic sprinkler systems, standpipes, their fire department connections, fire pumps, fire alarm and detections systems and portable fire extinguishers.

## Purpose

The requirements in Appendix I focus on the identification of unsafe conditions for water-based fire protection systems including automatic sprinkler systems, standpipes, fire pumps and automatic fire detection and signaling systems. It also identifies unsafe conditions for portable fire extinguishers.

## SECTION I101 NONCOMPLIANT CONDITIONS

**I101.1 General.** This appendix is intended to identify conditions that can occur where fire protection systems are not properly maintained or components have been damaged. This appendix is not intended to provide comprehensive inspection, testing and maintenance requirements, which are found in NFPA 10, 25 and 72. Rather, its intent is to identify problems that are readily observable during fire inspections.

❖ During inspections, it is important to observe and report conditions that may lead to failure of fire protection systems. Section 901.6 references the system installation standards that refer to maintenance of the equipment and or system(s) being reviewed. This section lists items to be included. Note the list includes some, but not all, of the items that might need review. The ICC has published a document, *Fire Plan Review and Inspection Guidelines*, that provides a more comprehensive look at this issue.

**I101.2 Noncompliant conditions requiring component replacement.** The following conditions shall be deemed noncompliant and shall cause the related component(s) to be replaced to comply with the provisions of this code:

1. Sprinkler heads having any of the following conditions:
  - 1.1. Signs of leakage.
  - 1.2. Paint or other ornamentation that is not factory applied.
  - 1.3. Evidence of corrosion including, but not limited to, discoloration or rust.
  - 1.4. Deformation or damage of any part.
  - 1.5. Improper orientation of sprinkler head.
  - 1.6. Empty glass bulb.
  - 1.7. Sprinkler heads manufactured prior to 1920.
  - 1.8. Replacement sprinkler heads that do not match existing sprinkler heads in orifice size, K-factor temperature rating, coating or deflector type.

## APPENDIX I

- 1.9. Sprinkler heads for the protection of cooking equipment that have not been replaced within one year.
  2. Water pressure and air pressure gauges that have been installed for more than 5 years and have not been tested to within 3 percent accuracy.
- ❖ Item 1 addresses sprinkler heads only, as they are the component that is replaced in the system after activation and where an error may be made in the process replacing of a sprinkler head. Note that some of the items are easily found by a visual inspection, while others will require a review of the inspection file (1.7, 1.8, and 1.9) to determine if the sprinkler heads are in compliance. Item 2 also belongs to the group that will need to be validated from information in the inspection file.
- I101.3 Noncompliant conditions requiring component repair or replacement.** The following shall be deemed non-compliant conditions and shall cause the related component(s) to be repaired or replaced to comply with the provisions of this code:
1. Sprinkler and standpipe system piping and fittings having any of the following conditions:
    - 1.1. Signs of leakage.
    - 1.2. Evidence of corrosion.
    - 1.3. Misalignment.
    - 1.4. Mechanical damage.
  2. Sprinkler piping support having any of the following conditions:
    - 2.1. Materials resting on or hung from sprinkler piping.
    - 2.2. Damaged or loose hangers or braces.
  3. Class II and Class III standpipe systems having any of the following conditions:
    - 3.1. No hose or nozzle, where required.
    - 3.2. Hose threads incompatible with fire department hose threads.
    - 3.3. Hose connection cap missing.
    - 3.4. Mildew, cuts, abrasions and deterioration evident.
    - 3.5. Coupling damaged.
    - 3.6. Gaskets missing or deteriorated.
    - 3.7. Nozzle missing or obstructed.
  4. Hose racks and cabinets having any of the following conditions:
    - 4.1. Difficult to operate or damaged.
    - 4.2. Hose improperly racked or rolled.
    - 4.3. Inability of rack to swing 90 degrees (1.57 rad) out of the cabinet.
    - 4.4. Cabinet locked, except as permitted by this code.
    - 4.5. Cabinet door will not fully open.
    - 4.6. Door glazing cracked or broken.
  5. Portable fire extinguishers having any of the following conditions:
    - 5.1. Broken seal or tamper indicator.
    - 5.2. Expired maintenance tag.
    - 5.3. Pressure gauge indicator in “red.”
    - 5.4. Signs of leakage or corrosion.
    - 5.5. Mechanical damage, denting or abrasion of tank.
    - 5.6. Presence of repairs such as welding, soldering or brazing.
    - 5.7. Damaged threads.
    - 5.8. Damaged hose assembly, couplings or swivel joints.
  6. Fire alarm and detection control equipment, initiating devices and notification appliances having any of the following conditions:
    - 6.1. Corroded or leaking batteries or terminals.
    - 6.2. Smoke detectors having paint or other ornamentation that is not factory-applied.
    - 6.3. Mechanical damage to heat or smoke detectors.
    - 6.4. Tripped fuses.
  7. Fire department connections having any of the following conditions:
    - 7.1. Fire department connections are not visible or accessible from the fire apparatus access road.
    - 7.2. Couplings or swivels are damaged.
    - 7.3. Plugs and caps are missing or damaged.
    - 7.4. Gaskets are deteriorated.
    - 7.5. Check valve is leaking.
    - 7.6. Identification signs are missing.
  8. Fire pumps having any of the following conditions:
    - 8.1. Pump room temperature is less than 40°F (4.4°C).
    - 8.2. Ventilating louvers are not freely operable.
    - 8.3. Corroded or leaking system piping.
    - 8.4. Diesel fuel tank is less than two-thirds full.
    - 8.5. Battery readings, lubrication oil or cooling water levels are abnormal.
- ❖ This section lists inspection items for components in various types of fire protection systems. All of these are visual or manipulative items that can be easily verified during an inspection.

**SECTION I102  
REFERENCED STANDARDS**

NFPA 10—13	Standard for Portable Fire Extinguishers	I101.1
NFPA 25—13	Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems	I101.1
NFPA 72—13	National Fire Alarm and Signaling Code	I101.1



# Appendix J: Building Information Signs

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

## General Comments

Prefire or preincident planning is a long-standing operational tool wherein information is collected by fire code officials and fire department personnel to assist in identifying hazards and the equipment, supplies, personnel, skills and procedures needed to deal with a potential incident in a building.

## Purpose

The purpose of Appendix J is to establish standard guidelines for prefire plans. It sets forth requirements for a building information sign (BIS) that may be useful to fire fighters in understanding basic information about the building where the sign is posted. The provisions provide a uniform format so that the type of information provided to emergency responders is consistent across the jurisdiction's territory.

## SECTION J101 GENERAL

**J101.1 Scope.** New buildings shall have a building information sign(s) that shall comply with Sections J101.1.1 through J101.7. Existing buildings shall be brought into conformance with Sections J101.1 through J101.9 when one of the following occurs:

1. The fire department conducts an annual inspection intended to verify compliance with this section, or any required inspection.
2. When a change in use or occupancy has occurred.

### Exceptions:

1. Group U occupancies.
2. One- and two-family dwellings.

❖ Because building information is critical to executing an effective fire attack, with the exception of one- and two-family dwellings and Group U occupancies, the provisions in Section J101.1 are applicable to all new buildings and are retroactive to any building that undergoes a fire inspection or change of occupancy.

**J101.1.1 Sign location.** The building information sign shall be placed at one of the following locations:

1. Upon the entry door or sidelight at a minimum height of 42 inches (1067 mm) above the walking surface on the address side of the building or structure.
2. Upon the exterior surface of the building or structure on either side of the entry door, not more than 3 feet (76 mm) from the entrance door, at a minimum height of 42 inches (1067 mm) above the walking surface on the address side of the building or structure.

3. Conspicuously placed inside an enclosed entrance lobby, on any vertical surface within 10 feet (254 mm) of the entrance door at a minimum height of 42 inches (1067 mm) above the walking surface.
4. Inside the building's fire command center.
5. On the exterior of the fire alarm control unit or on the wall immediately adjacent to the fire alarm control unit door where the alarm panel is located in the enclosed main lobby.

❖ Acceptable sign locations are specified in Section J101.1.1 and include the entrance to a building on the side that has the posted address, the interior of a building's enclosed entrance lobby, the fire command center or at a building's fire alarm control unit. The chosen location should be approved by both the fire code official and the fire chief so that it is consistent with the tactical approaches to the building.

**J101.1.2 Sign features.** The building information sign shall consist of all of the following:

1. White reflective background with red letters.
2. Durable material.
3. Numerals shall be Roman or Latin numerals, as required, or alphabet letters.
4. Permanently affixed to the building or structure in an approved manner.

❖ Section J101.1.2 specifies the materials of construction of the BIS and requires that it be permanently attached to the building in a manner acceptable to the fire code official based on the materials of construction of the building.

**J101.1.3 Sign shape.** The building information sign shall be a Maltese cross as shown in Figure J101.1.3.

❖ The BIS is configured as a Maltese cross which is a traditional symbol universally recognized by the U.S. fire service.

**J101.1.4 Sign size and lettering.** The minimum size of the building information sign and lettering shall be in accordance with the following:

1. The width and height shall be 6 inches by 6 inches (152 mm by 152 mm).
2. The height or width of each Maltese cross wing area shall be 1<sup>1</sup>/<sub>8</sub> inches (29 mm) and have a stroke width of 1/2 inch (13 mm).
3. The center of the Maltese cross, a circle or oval, shall be 3 inches (76 mm) in diameter and have a stroke width of 1/2 inch (6 mm).
4. All Roman numerals and alphabetic designations, shall be 1<sup>1</sup>/<sub>4</sub> inch (32 mm) height and have a stroke width of 1/4 inch (6 mm).

❖ The BIS must meet the dimensional requirements in Section J101.1.4 and be assembled using reflective materials that are visible in the dark (see Section J101.1.2).

**J101.2 Sign designations.** Designations shall be made based upon the construction type, content, hazard, *fire protection systems*, life safety and occupancy. Where multiple designations occur within a classification category, the designation used shall be based on the greatest potential risk.

❖ Section J101.2 requires the sign to convey pertinent information about the building to assist the incident commander in sizing up the incident and deploying resources safely and effectively.

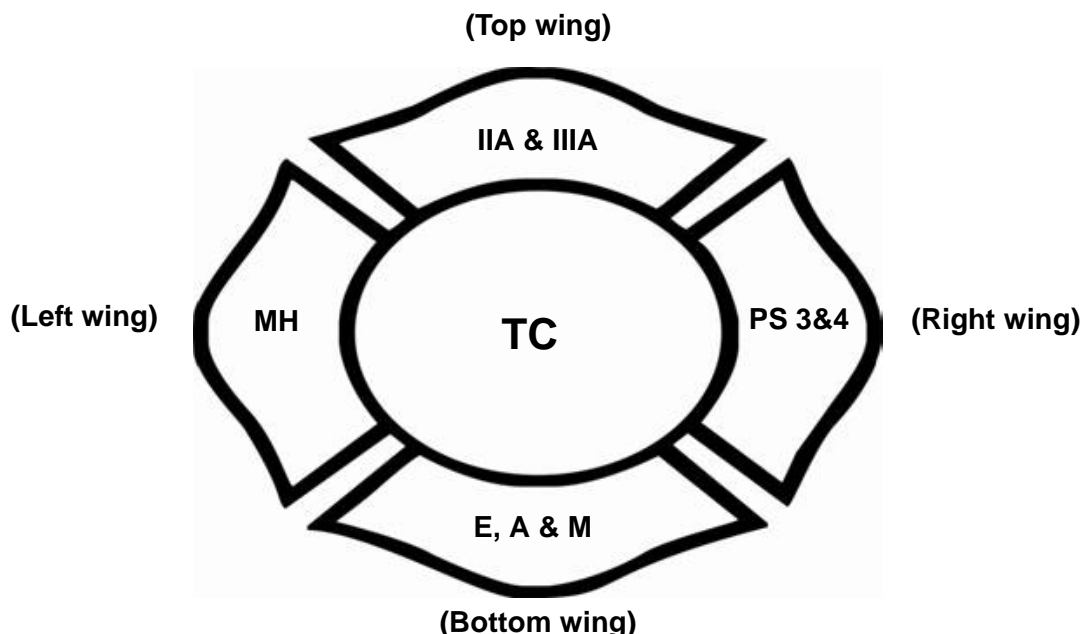
**J101.3 Construction type (top wing).** The construction types shall be designated by assigning the appropriate Roman numeral, and letter, placed inside the top wing of the Maltese cross. The hourly rating provided is for the structural framing in accordance with Table 601 of the *International Building Code*.

CONSTRUCTION TYPE	FIRE-RESISTANCE RATING
IA—Noncombustible	3 Hours
IB—Noncombustible	2 Hours
IIA—Noncombustible	1 Hour
IIB—Noncombustible	0 Hours
IIIA—Noncombustible/combustible	1 Hour
IIIB—Noncombustible/combustible	0 Hours
IV—Heavy timber (HT)	HT
VA—Combustible	1 Hour
VB—Combustible	0 Hours

❖ Section J101.3 requires the sign to convey the building's construction type based on its *International Building Code*® (IBC®) construction classification. See Chapter 6 of the IBC for detailed descriptions of the construction types.

**J101.4 Fire protection systems (right wing).** The *fire protection system* shall be designated by determining its level of protection and assigning the appropriate designation to the right wing of the Maltese cross. Where multiple systems are provided, all shall be listed:

- AS Automatic sprinkler system installed throughout
- DS Dry sprinkler system and designated areas
- FA Fire alarm system



**FIGURE J101.1.3**  
**EXAMPLE OF COMPLETED BUILDING INFORMATION SIGN**

FP	Fire pump
FW	<i>Fire wall</i> and designated areas
PAS	Pre-action sprinkler system and designated floor
PS	Partial <i>automatic sprinkler system</i> , and designate floor
CES	Chemical extinguishing system and designated area
CS	Combination sprinkler and standpipe system
S	Standpipe system
NS	No system installed

- ❖ Section J101.4 requires the sign to convey the type of fire protection systems in the building. If a building, even a nonsprinklered building, is partially protected by an automatic sprinkler system, the areas or floors of the building that are protected must be identified.

**J101.5 Occupancy type (bottom wing).** The occupancy of a building or structure shall be designated in accordance with the occupancy classification found in Section 302.1 of the *International Building Code* and the corresponding designation shall be placed in the bottom wing of the Maltese cross. Where a building or structure contains a mixture of uses and occupancies; all uses and occupancies shall be identified.

A	Assembly
B	Business
E	Educational
F	Factory or Industrial
H	High Hazard
I	Institutional
M	Mercantile
R	Residential

- ❖ Section J101.5 requires the sign to convey the occupancy classification. In mixed-occupancy buildings all occupancy groups are required to be identified on the sign. See the definitions of "Occupancy classification" in Chapter 2 of the code or Chapter 3 of the IBC.

**J101.6 Hazards of content (left wing).** The hazards of building contents shall be designated by one of the following classifications as defined in NFPA 13 and the appropriate designation shall be placed inside the left wing of the Maltese cross:

LH	Light hazard
MH	Moderate hazard
HH	High hazard

- ❖ Section J101.6 requires the sign to convey an estimation of the building's fuel load using the hazard classification criteria of NFPA 13 for light, ordinary and extra-hazard occupancies. The section does not align the classifications with the NFPA 13 definitions for occupancy hazard classifications; however, the intent is to provide a standard method for estimating a

building's fuel load. Fire code officials should ensure that the selected fuel load classification system is consistent so its application in applying a designation to the information sign is uniform to avoid confusion among emergency responders.

**J101.7 Tactical considerations (center circle).** The center circle shall include the name of the local fire service and when required the letters TC for tactical considerations. Where fire fighters conduct preplan operations, a unique situation(s) for tactical considerations shall be identified and the information provided to the fire dispatch communications center to further assist fire fighters in identifying that there is special consideration(s) for this occupancy. Special consideration designations include, but are not limited to:

1. Impact-resistant drywall.
2. Impact-resistant glazing, such as blast or hurricane-type glass.
3. All types of roof and floor structural members including but not limited to post-tension concrete, bar joists, solid wood joists, rafters, trusses, cold-formed galvanized steel, I-joists and I-beams; green roof with vegetation, soil and plants.
4. Hazardous materials (explosives, chemicals, plastics, etc.).
5. Solar panels and DC electrical energy.
6. HVAC system; and smoke management system for pressurization and exhaust methods.
7. Other unique characteristic(s) within the building that are ranked according to a potential risk to occupants and fire fighters.

- ❖ Section J101.7 requires the sign to convey relevant tactical information that can be used by fire fighters prior to commencing an interior fire attack. This could include the use of terrorism-resistant building materials; impact-resistant glazing or construction; the storage or use of hazardous materials; certain types of structural components that may have a propensity for rapid failure under fire exposure or any other potential hazards that could impact the health and safety of emergency responders.

**J101.8 Sign classification maintenance, building information.** Sign maintenance shall comply with each of the following:

1. Fire departments in the jurisdiction shall define the designations to be placed within the sign.
2. Fire departments in the jurisdiction shall conduct annual inspections to verify compliance with this section of the code and shall notify the *owner*, or the *owner's* agent, of any required updates to the sign in accordance with fire department designations and the *owner*, or the *owner's* agent, shall comply within 30 days.

APPENDIX J

3. The owner of a building shall be responsible for the maintenance and updates to the sign in accordance with fire department designations.

❖ Prior to implementing the requirements for building information signs, Section J101.8 requires that the fire department define unique or special designations required on signs. If a building warrants this particular sign, the owner has 30 days to provide and install it. As with other warning signage and markings required throughout the code, this section also requires that the BIS be maintained so that it continues to be effective in providing important tactical information to first responders.

**J101.9 Training.** Jurisdictions shall train fire department personnel on Sections J101.1 through J101.9.

❖ Section J101.9 requires the jurisdiction to train all fire department personnel on the provisions in Appendix J to maximize the effectiveness of the BIS. Jurisdictions should also consider cross-training with neighboring fire departments that are part of the area's mutual-aid network.

**SECTION J102  
REFERENCED STANDARDS**

ICC	IBC—15	International Building Code	J101.3, J101.5
NFPA	13—13	Standard for the Installation of Sprinkler Systems	J101.6

# Appendix K: Construction Requirements for Existing Ambulatory Care Facilities

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

## General Comments

This is an especially important option for federal authorities having jurisdiction (AHJ), which have long-standing minimum fire and life safety standards for ambulatory care facilities. Those federal standards were applied to new and existing construction long before the creation of the ambulatory care facility use that currently exists in the *International Building Code*<sup>®</sup> (IBC<sup>®</sup>). Therefore, we have a situation where some (but not all) ambulatory care facilities were built with very specific defend-in-place features. This subset of facilities were certified by the federal government as “ambulatory surgical facilities.” Many other medical facilities that would be classified today as ambulatory care were not required to have defend-in-place features, such as smoke compartmentation. The federal AHJ highly value these defend-in-place concepts and need retroactive requirements.

This appendix would also be useful for those local and state jurisdictions that are specifically focused on ensuring safety for existing ambulatory care facilities. Surgery centers constructed as recently as 2009 would not have defend-in-place features required by the ICC family of codes. This appendix could be used to assess

post-2009 surgery centers and freestanding emergency departments. It could also be used to bring those earlier facilities into compliance with current standards at the discretion of the adopting jurisdiction.

The technical requirements are based on current IBC language. The significant difference from the IBC is a relaxation of the sprinkler requirement for existing facilities. This appendix would only require retroactive sprinkling of unprotected construction, which is consistent with the overall concept of current federal requirements.

## Purpose

This section is intended to provide jurisdictions an option for assessing minimum fire and life safety requirements for buildings containing ambulatory care facilities. While this appendix is written with the intent to apply retroactive minimum standards, it is recognized that ambulatory care requirements are relatively recent additions to the code. For that reason, these requirements are presented as an appendix, so that the adopting authority can exercise judgment in the adoption and application of this section.

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## SECTION K101 GENERAL

**K101.1 Scope.** The provisions of this chapter shall apply to existing buildings containing ambulatory care facilities in addition to the requirements of Chapter 11 of the *International Fire Code*. Where the provisions of this chapter conflict with either the construction requirements in Chapter 11 of the *International Fire Code* or the construction requirements that applied at the time of construction, the most restrictive provision shall apply.

❖ These provisions are similar in application to those found in Chapter 11 for Group I-2 occupancies. In other words, they are construction requirements for existing buildings. Chapter 11 provides various requirements that apply to a number of different occupancy classifications for existing buildings. Section 1105 is unique to Group I-2 occupancies. This appen-

dix is focused on ambulatory care facilities and helps those jurisdictions that want such facilities to be consistent with federal requirements. This section basically states that compliance with Chapter 11 and this appendix is necessary to fully address existing ambulatory care facilities. If there is a conflict, the most restrictive provision would apply.

It should be noted that the *International Existing Building Code*<sup>®</sup> (IEBC<sup>®</sup>) work-area method would specifically require compliance with IBC Section 422 where the change of occupancy (whether use or occupancy classification) is to an ambulatory care facility. In other words, if an office building was changed to an ambulatory care facility, IBC Section 422, which is more restrictive than this appendix, would apply.

**K101.2 Intent.** The intent of this appendix is to provide a minimum degree of fire and life safety to persons occupying

and existing buildings containing ambulatory care facilities where such buildings do not comply with the minimum requirements of the *International Building Code*.

- ❖ This appendix is primarily applicable to ambulatory care facilities that were not regulated by the federal requirements for healthcare and built prior to publication of the 2009 IBC. Most ambulatory care facilities will already meet these minimum requirements and no changes will be necessary.

## SECTION K102 FIRE SAFETY REQUIREMENTS FOR EXISTING AMBULATORY CARE FACILITIES

**K102.1 Separation.** Ambulatory care facilities where the potential exists for four or more care recipients to be incapable of self-preservation at any time, whether rendered incapable by staff or staff has accepted responsibility for a care recipient already incapable, shall be separated from adjacent spaces, corridors or tenants with a fire partition installed in accordance with Section 708 of the *International Building Code*.

- ❖ This section is consistent with IBC Section 422.2. Many existing facilities may already meet this requirement. This applies only to those that were not addressed by the CMS program standards.

**K102.2 Smoke compartments.** Where the aggregate area of one or more ambulatory care facilities is greater than 10,000 square feet (929 m<sup>2</sup>) on one story, the story shall be provided with a *smoke barrier* to subdivide the *story* into no fewer than two *smoke compartments*. The area of any one such *smoke compartment* shall be not greater than 22,500 square feet (2092 m<sup>2</sup>). The travel distance from any point in a *smoke compartment* to a *smoke barrier* door shall be not greater than 200 feet (60 960 mm). The *smoke barrier* shall be installed in accordance with Section 709 of the *International Building Code* with the exception that *smoke barriers* shall be continuous from an outside wall to an outside wall, a floor to a floor, or from a *smoke barrier* to a *smoke barrier* or a combination thereof.

- ❖ This section is the same as that required for new ambulatory care facilities in IBC Section 422.3.

**K102.2.1 Refuge area.** Not less than 30 net square feet (2.8 m<sup>2</sup>) for each nonambulatory care recipient shall be provided within the aggregate area of *corridors*, care recipient rooms, treatment rooms, lounge or dining areas and other low-hazard areas within each *smoke compartment*. Each occupant of an ambulatory care facility shall be provided with access to a refuge area without passing through or utilizing adjacent tenant spaces.

- ❖ As with smoke compartments and separation, this requirement is the same as that for a new building. The requirements are the same as IBC Section 422.3.2.

**K102.2.2 Independent egress.** A *means of egress* shall be provided from each *smoke compartment* created by smoke barriers without having to return through the *smoke compartment* from which *means of egress* originated.

- ❖ This section is the same as that required for new buildings. It would not be appropriate to have to egress back through the smoke compartment of egress origin. IBC Section 422.3.3 provides the same limitation.

**K102.3 Automatic sprinkler systems.** An *automatic sprinkler system* shall be provided throughout the entire floor containing an ambulatory care facility in Type IIB, IIIB and VB construction where either of the following conditions exist at any time:

1. Four or more care recipients are incapable of self-preservation, whether rendered incapable by staff or staff has accepted responsibility for care recipients already incapable.
2. One or more care recipients that are incapable of self-preservation are located at other than the *level of exit discharge* serving such a facility.

In buildings where ambulatory care is provided on levels other than the *level of exit discharge*, an *automatic sprinkler system* shall be installed throughout the entire floor where such care is provided and all floors below, and all floors between the level of ambulatory care and the nearest *level of exit discharge*, including the *level of exit discharge*.

- ❖ This section is less restrictive than Section 903.2.2. It focuses on combustible construction and whether the ambulatory care facility is located on a level other than the level of exit discharge. Unlike Group I-2 occupancies, ambulatory care facilities can often be located in buildings housing other types of occupancies. Therefore, compliance with retroactive sprinkler requirements becomes more difficult. If, at a minimum, combustible construction and ambulatory care facilities located on other than the level of exit discharge are addressed, compliance with federal requirements is addressed.

**K102.4 Automatic fire alarm system.** *Fire areas* containing ambulatory care facilities shall be provided with an electronically supervised automatic smoke detection system installed within the ambulatory care facility and in public use areas outside of tenant spaces, including *public corridors* and elevator lobbies.

**Exception:** Buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 of the *International Fire Code*, provided the occupant notification appliances will activate throughout the notification zones upon sprinkler waterflow.

- ❖ These requirements for smoke detection systems are the same as those in Section 907.2.2.1. The retroactive installation of a fire alarm system is more feasible than an automatic sprinkler system.

### SECTION K103 INCIDENTAL USES IN EXISTING AMBULATORY CARE FACILITIES

**K103.1 General.** Incidental uses associated with and located within existing ambulatory care facilities required to be separated by Section 422 in the *International Building Code*, and that generally pose a greater level of risk to such occupancies, shall comply with the provisions of Sections K103.2 through K103.4.2.1. Incidental uses in ambulatory care facilities required to be separated by Section 422 of the *International Building Code* are limited to those listed in Table K103.1.

❖ Incidental use area provisions are applicable to new construction in IBC Section 509; however, similar provisions are needed for existing ambulatory care facilities since the hazards posed by such rooms or spaces are no different than in new buildings. Section and Table K103.1 are very similar to and based upon IBC Section and Table 509, except that references to occupancies other than ambulatory care are not included. The basic requirements proposed for incidental uses in existing healthcare occupancies rely upon the provisions of the IBC for the specifics of construction and protection. Sections K103.2 through K103.4.2.1 are based on IBC Sections 509.2 through 509.4.2.1. These provisions will provide correlation with not only the IBC but also with the operational and CMS program standards for existing ambulatory care facilities.

This section establishes the scope of Section K103 and its applicability to ambulatory care facilities. Incidental uses are rooms or areas that constitute special hazards or risks to life safety not typically addressed by the provisions for the occupancy group in which they occur, even though such rooms or areas may functionally be an extension of the primary use. Only those rooms or areas indicated in Table K103.1 are to be regulated as incidental uses. Incidental uses can be located in both single- and mixed-occupancy

buildings. The concern is that those areas designated as incidental uses pose a risk to the remainder of the building and, as such, some degree of protection is required. The nature of these incidental uses is such that they are small areas not frequented by building occupants in which a fire could start and go unnoticed for a longer time than in a part of the building that is constantly occupied.

**K103.2 Occupancy classification.** Incidental uses shall not be individually classified in accordance with Section 302.1 of the *International Building Code*. Incidental uses shall be included in the building occupancies in which they are located.

❖ Consistent with the IBC, this section expressly states that incidental uses are not considered as separate and distinct occupancy classifications but, rather, are classified the same as the occupancies in which they are located. For example, a waste and linen collection room in an ambulatory care facility would be classified as a portion of the ambulatory care facility even though it may present a level of hazard more akin to a Group S-1 occupancy if it were to be classified separately.

**K103.3 Area limitations.** Incidental uses shall not occupy more than 10 percent of the building area of the story in which they are located.

❖ The proposed floor-area limitation of 10 percent for incidental uses emphasizes the ancillary nature of such rooms and areas and correlates with the IBC. Each incidental use would be limited to a maximum of 10 percent of the floor area of the story in which it is located. Where there are two or more tenants located on the same story, the 10-percent limitation is based upon the floor area of each individual tenant space rather than that of the entire story. The application of the limit on a tenant-by-tenant basis is consistent with the concept of incidental uses typically being ancillary

TABLE K103.1  
INCIDENTAL USES IN EXISTING AMBULATORY CARE FACILITIES

ROOM OR AREA	SEPARATION AND/OR PROTECTION
Furnace room where any piece of equipment is over 400,000 Btu per hour input	1 hour or provide automatic sprinkler system
Rooms with boilers where the largest piece of equipment is over 15 psi and 10 horsepower	1 hour or provide automatic sprinkler system
Refrigerant machinery room	1 hour or provide automatic sprinkler system
Hydrogen fuel gas rooms, not classified as Group H	1 hour in ambulatory care facilities
Incinerator rooms	2 hours and provide automatic sprinkler system
Laboratories not classified as Group H	1 hour or provide automatic sprinkler system
Laundry rooms over 100 square feet	1 hour or provide automatic sprinkler system
Waste and linen collection rooms with containers with total volume of 10 cubic feet or greater	1 hour or provide automatic sprinkler system
Storage rooms greater than 100 square feet	1 hour or provide automatic sprinkler system
Stationary storage battery systems having a liquid electrolyte capacity of more than 50 gallons for flooded lead-acid, nickel cadmium or VRLA, or more than 1,000 pounds for lithium-ion and lithium metal polymer used for facility standby power, emergency power or uninterruptible power supplies	1 hour in ambulatory care facilities

For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square inch (psi) = 6.9 kPa, 1 British thermal unit (Btu) per hour = 0.293 watts, 1 horsepower = 746 watts, 1 gallon = 3.785 L.

only to a portion of the building, i.e., the specific tenant occupancy.

**K103.4 Separation and protection.** The incidental uses listed in Table K103.1 shall be separated from the remainder of the building or equipped with an *automatic sprinkler system*, or both, in accordance with the provisions of that table.

❖ In addition to identifying those rooms or areas that warrant regulation as incidental uses, Table K103.1 also indicates the required degree of protection or separation. The requirements identified in Table K103.1 vary depending on the incidental use. In some cases, a specific type of separation and/or protection is required, while in others there is an option.

**K103.4.1 Separation.** Where Table K103.1 specifies a fire-resistance-rated separation, the incidental uses shall be separated from the remainder of the building in accordance with Section 509.4.1 of the *International Building Code*.

❖ Where a fire-resistance rated separation would be required, the incidental use would need to be separated from other portions of the building in accordance with assemblies complying with the IBC.

**K103.4.2 Protection.** Where Table K103.1 permits an *automatic sprinkler system* without a fire-resistance-rated separation, the incidental uses shall be separated from the remainder of the building by construction capable of resisting the passage of smoke in accordance with Section 509.4.2 of the *International Building Code*.

❖ In this section, where Table K103.1 would allow protection by an automatic sprinkler system without a fire-resistance-rated separation, the construction enclosing the incidental use would still need to resist the passage of smoke. Construction details for resisting the passage of smoke are provided in the IBC. Note that this requirement is not specifying a smoke partition. IBC Section 710 provides specific smoke partition requirements that must be directly referenced.

**K103.4.2.1 Protection limitation.** Except as otherwise specified in Table K103.1 for certain incidental uses, where an *automatic sprinkler system* is provided in accordance with Table K103.1, only the space occupied by the incidental use need be equipped with such a system.

❖ This section makes it clear that the sprinkler systems stipulated in Table K103.1 are required for the incidental use area only.

## SECTION K104 MEANS OF EGRESS REQUIREMENTS FOR EXISTING AMBULATORY CARE FACILITIES

**K104.1 Size of doors.** The minimum width of each door opening shall be sufficient for the *occupant load* thereof and shall provide a clear width of not less than 28 inches (711 mm). Where this section requires a minimum clear width of 28 inches (711 mm) and a door opening includes two door leaves without a mullion, one leaf shall provide a clear opening width of 28 inches (711 mm). In ambulatory care facili-

ties, doors serving as *means of egress* from patient treatment rooms shall provide a clear width of not less than 32 inches (813 mm). The maximum width of a swinging door leaf shall be 48 inches (1219 mm) nominal. The height of doors openings shall be not less than 80 inches (2032 mm).

### Exceptions:

1. Door openings to storage closets less than 10 square feet (0.93 m<sup>2</sup>) in area shall not be limited by the minimum width.
2. Width of door leaves in revolving doors that comply with Section 1008.1.4.1 shall not be limited.
3. *Exit access* doors serving a room not larger than 70 square feet (6.5 m<sup>2</sup>) shall be not less than 24 inches (610 mm) in door width.
4. Door closers and door stops shall be permitted to be 78 inches (1980 mm) minimum above the door.

❖ This section is quite similar to Section 1104.7 and generally these requirements would therefore already be applicable without this appendix. However, the exceptions are specific to ambulatory care facilities. The height is also consistent with Section 1010.1.1 for new buildings.

**K104.2 Corridor and aisle width.** *Corridor* width shall be as determined in Section 1005.1 of the *International Fire Code* and this section. The minimum width of *corridors* and *aisles* that serve gurney traffic in areas where patients receive care that causes them to be incapable of self-preservation shall be not less than 72 inches (1829 mm).

❖ This section is consistent with new building requirements. Reference is made to Section 1005.1 and a corridor width of 72 inches is prescribed. Table 1020.2 requires a 72-inch width for corridors and areas serving stretcher traffic in ambulatory care facilities.

**K104.3 Existing elevators.** Existing elevators, escalators, dumbwaiters and moving walks shall comply with the requirements of Sections K104.3.1 and K104.3.2.

❖ Sections K104.3.1 and K104.3.2 set forth some minimum requirements for existing elevators. Of primary importance are the emergency operation features.

**K104.3.1 Elevators, escalators, dumbwaiters and moving walks.** Existing elevators, escalators, dumbwaiters and moving walks in ambulatory care facilities required to be separated by Section 422 of the *International Building Code* shall comply with ASME A17.3.

❖ Not only are existing elevators required to comply with ASME A17.3, but escalators and moving walks must also comply. Note that IBC Section 3001.2 requires ongoing maintenance of all elevators and conveying systems. This section specifically calls out ASME A17.3 for such maintenance.

The healthcare industry has historically been required to comply with regulations set forth by accreditation and certification agencies, such as The Joint Commission. ASME A17.3 has been referenced by guidelines adopted by The Joint Commission for

more than a decade and this code change will correlate the IFC with the mandated healthcare industry standard.

Adding a reference to ASME A17.3 will require that existing elevators, escalators and moving walks and their related operating equipment in ambulatory care facilities comply with a minimum level of safety. Because the occupants of these types of facilities are often incapable of self-preservation, this reference provides important features essential for occupant safety, including escalator and moving walk emergency stop buttons and automatic skirt obstruction stop features.

**K104.3.2 Elevator emergency operation.** Existing elevators with a travel distance of 25 feet (7620 mm) or more above or below the main floor or other level of a building and intended to serve the needs of emergency personnel for fire-fighting or rescue purposes shall be provided with emergency operation in accordance with ASME A17.3.

❖ This section is consistent with Section 1103.3.2, which applies to any elevator that travels 25 feet or more above or below the main floor or other level of a building. It should be noted, however, that the exceptions found in Section 1103.3.2 are not located in this appendix. Therefore, there are no specific exceptions to this requirement.

#### SECTION K105 REFERENCED STANDARDS

ICC	IBC—15	International Building Code	K101.2, K102.1, K102.2, K103.1, K103.2, K103.4.1, K103.4.2, K104.3.1,
ICC	IFC—15	International Fire Code	K101.1, K102.4, K104.2
ASME A17.3-08			K104.3.1, K104.3.2



# Appendix L: Requirements for Fire Fighter Air Replenishment Systems

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

## General Comments

Breathing air is critical for fire-fighting operations. Historically, fire departments have supplied air bottles by means of a “bottle brigade,” whereby fire fighters manually transport air bottles up stairways. This is usually accomplished by stationing a fire fighter on alternating floors, and each fire fighter carries two to four bottles at a time up two floors, passes them to the next fire fighter, then goes down two flights of stairs and receives more air bottles from the fire fighter stationed below. This process is extraordinarily fire-fighter intensive, and takes fire fighters away from their primary mission of rescue and fire fighting. Even when fires are insignificant or controlled by sprinklers, copious amounts of smoke and other combustion byproducts require the use of self-contained breathing apparatus (SCBA) for extended periods of time to conduct search, rescue, suppression and overhaul. These extended missions require a large number of air bottles to be transported to support the operation. Transporting bottles is not the highest and best use of highly trained fire fighters. It is a costly solution to a serious problem that can be addressed by installing fire fighter air replenishment systems.

Technology exists at this point in time to address the issue using in-building air supply systems. Fire fighter Breathing Air Systems were introduced in the late 1980’s. These systems are now required in a number of communities throughout the United States, and several

hundred systems have been installed and are now operational. The system has been called a “standpipe for air,” which is an accurate description. The system consists of stainless steel, high-pressure piping that is supplied by on-site air storage, fire department air supply units, or both; a few systems have breathing air compressors installed. Air filling stations are then strategically located throughout the building, using either quick fill connections or rupture containment fill stations complying with NFPA 1901. These systems allow fire fighters to refill breathing air cylinders inside the fire building, negating the required “bottle brigade”, and making more fire fighters available for search, rescue, and fire suppression operations.

## Purpose

While not every jurisdiction will necessarily embrace this technology, there is a need to standardize the installation criteria in jurisdictions that determine the systems are needed. It is now being recognized as a basic principle of fire protection that, once a community has identified an unacceptable risk, risk mitigation must occur to reduce that risk to a level that allows the fire department to be both efficient and effective in coping with it. Therefore, this appendix provides model requirements to jurisdictions considering fire fighter air replenishment systems.

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## SECTION L101 GENERAL

**L101.1 Scope.** Fire fighter air replenishment systems (FARS) shall be provided in accordance with this appendix. The adopting ordinance shall specify building characteristics or special hazards that establish thresholds triggering a requirement for the installation of a FARS. The requirement shall be based upon the fire department’s capability of replenishing fire fighter breathing air during sustained emergency operations. Considerations shall include:

1. Building characteristics, such as number of stories above or below grade plane, floor area, type of construction and fire-resistance of the primary structural *frame* to allow sustained fire-fighting operations based on a rating of not less than 2 hours.

2. Special hazards, other than buildings, that require unique accommodations to allow the fire department to replenish fire fighter breathing air.
  3. Fire department staffing level.
  4. Availability of a fire department breathing air replenishment vehicle.
- ❖ This section clarifies that such systems are required when the appendix is adopted. The adopting ordinance must specify when such systems are required. Many buildings (e.g., a two-story Group B occupancy) would not need such systems. Therefore, the applicability must clearly be provided. Suggestions are provided as to what types of buildings and facilities may need such systems.

## SECTION L102 DEFINITIONS

**L102.1 Definitions.** For the purpose of this appendix, certain terms are defined as follows:

**FIRE FIGHTER AIR REPLENISHMENT SYSTEM (FARS).** A permanently installed arrangement of piping, valves, fittings and equipment to facilitate the replenishment of breathing air in self contained breathing apparatus (SCBA) for fire fighters engaged in emergency operations.

- ❖ This definition describes what is considered part of the fire fighter air replenishment systems (FARS) as far as the code is concerned. It also explains that the purpose of such systems is to provide breathing air to fire fighters.

## SECTION L103 PERMITS

**L103.1 Permits.** Permits shall be required to install and maintain a FARS. Permits shall be in accordance with Sections L103.2 and L103.3.

- ❖ These systems need to be installed and modified appropriately and be maintained for the successful long term use of such systems. Permits facilitate these activities occurring.

**L103.2 Construction permit.** A construction permit is required for installation of or modification to a FARS. The construction permit application shall include documentation of an acceptance and testing plan as specified in Section L105.

- ❖ This permit is for the initial installation and for modifications to such systems. This will include documentation to demonstrate that they have been appropriately tested and installed as designed.

**L103.3 Operational permit.** An operational permit is required to maintain a FARS.

- ❖ Quality installation and modifications to the system are important but just as important is the long term maintenance of such systems to make sure they remain in operating condition. This also reminds the fire department that such systems are provided at those locations.

## SECTION L104 DESIGN AND INSTALLATION

**L104.1 Design and installation.** A FARS shall be designed and installed in accordance with Sections L104.2 through L104.15.

- ❖ These sections contain the various design criteria, standards and other considerations such as location, security measures and compatibility with the fire departments equipment.

**L104.2 Standards.** Fire fighter air replenishment systems shall be in accordance with Sections L104.2.1 and L104.2.2.

- ❖ Sections L104.2.1 and L104.2.2 set out the basic design standards for such systems within the building. Later sections will prescribe standard for onsite stored pressure air supply.

**L104.2.1 Pressurized system components.** Pressurized system components shall be designed and installed in accordance with ASME B31.3.

- ❖ This standard reference addresses the quality of the piping and connections used.

**L104.2.2 Air quality.** The system shall be designed to convey breathing air complying with NFPA 1989.

- ❖ Such systems in order to be of assistance to the fire service must meet minimum air quality standards. NFPA 1989 provides these minimum requirements. This standard prescribes the type of pipes such air can be conveyed through.

**L104.3 Design and operating pressure.** The minimum design pressure shall be 110 percent of the fire department's normal SCBA fill pressure. The system design pressure shall be marked in an approved manner at the supply connections, and adjacent to pressure gauges on any fixed air supply components. Pressure shall be maintained in the system within 5 percent of the design pressure.

- ❖ This section sets the minimum design pressure for the system to ensure that the appropriate pressurized air can be provided during refills. There is a 10-percent level of flexibility provided at any time in the system.

**L104.4 Cylinder refill rate.** The FARS shall be capable of refilling breathing air cylinders of a size and pressure used by the fire department at a rate of not less than two empty cylinders in 2 minutes.

- ❖ For practical use of such systems, the FARS must be able to fill two empty cylinders in a defined amount of time. This must be tested once the installation is complete (see Section L105.1).

**L104.5 Breathing air supply.** Where a fire department mobile air unit is available, the FARS shall be supplied by an external mobile air connection in accordance with Section L104.14. Where a fire department mobile air unit is not available, a stored pressure air supply shall be provided in accordance with Section L104.5.1. A stored pressure air supply shall be permitted to be added to a system supplied by an external mobile air connection provided that a means to bypass the stored pressure air supply is located at the external mobile air connection.

- ❖ There are two sources from which breathing air can originate: a mobile air unit or an on-site stored pressure air supply.

**L104.5.1. Stored pressure air supply.** A stored pressure air supply shall be designed based on Chapter 24 of NFPA 1901

except that provisions applicable only to mobile apparatus or not applicable to system design shall not apply. A stored pressure air supply shall be capable of refilling not less than 50 empty breathing air cylinders of a size and pressure used by the fire department.

- ❖ The design standard for on-site pressure air supply along with the capacity of storage is specified in this section. The stored supply must fill a minimum of 50 cylinders based upon the type the fire department uses.

**L104.5.2. Retrofit of external mobile air connection.** A FARS not initially provided with an external mobile air connection due to the lack of a mobile air unit shall be retrofitted with an external mobile air connection where a mobile air unit becomes available. Where an external mobile air connection is provided, a means to bypass the stored pressure air supply shall be located at the external mobile air connection. The retrofit shall be completed not more than 12 months after notification by the *fire code official*.

- ❖ This section mandates a mobile air connection to be provided to a system that was initially only designed for on-site pressure air when such units become available. This also involves some reworking of the system to provide a bypass of the on-site air. Flexibility is provided to building owners to comply with this based upon notice from the fire code official.

**L104.6 Isolation valves.** System isolation valves that are accessible to the fire department shall be installed on the system riser to allow piping beyond any air cylinder refill panel to be blocked.

- ❖ This section requires that isolation of the system in terms of valving is provided.

**L104.7 Pressure relief valve.** Pressure relief valves shall be installed at each point of supply and at the top or end of every riser. The relief valve shall meet the requirements of CGA S-1.3 and shall not be field adjustable. Pressure relief valves shall discharge in a manner that does not endanger personnel who are in the area. Valves, plugs or caps shall not be installed in the discharge of a pressure relief valve. Where discharge piping is used the end shall not be threaded.

- ❖ It is necessary for such systems to provide pressure relief valves. This specifies where they are to be located and that they cannot be adjusted in the field.

**L104.8 Materials and equipment.** Pressurized system components shall be *listed* or *approved* for their intended use and rated for the maximum allowable design pressure in the system. Piping and fittings shall be stainless steel.

- ❖ This section prevents system failure based on inappropriately rated piping and fittings. Stainless steel is necessary for air quality purposes.

**L104.9 Welded connections.** Piping connections that are concealed shall be welded.

- ❖ Welded connections are less likely to fail than threaded connections. When located within a wall, where failures can go undetected, this is critical.

**L104.10 Protection of piping.** System piping shall be protected from physical damage in an *approved* manner.

- ❖ This section provides protection from physical damage that can occur to elements of a building and its systems due to human error.

**L104.11 Compatibility.** Fittings and connections intended to be used by the fire department shall be compatible with the fire department's equipment.

- ❖ This section ensures that the wide variety of fire-fighting components associated with buildings will be compatible with the building's fittings and connections. Section 912 addresses similar concerns.

**L104.12 Security.** Connections to a FARS shall be safeguarded from unauthorized access in an *approved* manner.

- ❖ This section addresses intentional damage inflicted on or general unauthorized use of such systems. Some type of safeguard is necessary to protect such systems. However, such protection must take into account how the fire department can access such systems. A specific method is not prescribed. The term "approved manner" acknowledges that safeguarding methods will vary based on each situation.

**L104.13 Fill stations.** Fire fighter air replenishment fill stations shall comply with Section L104.13.1 through L104.13.3.

- ❖ The next several sections address the location and features of the fire fighter interface with such systems.

**L104.13.1 Location.** Fill stations for refilling breathing air cylinders shall be located as follows:

1. Fill stations shall be provided at the fifth floor above and below the ground level floor and every third floor level thereafter.
2. On floor levels requiring fill stations, one fill station shall be provided adjacent to a required exit stair at a location designated by the *fire code official*. In buildings required to have three or more exit stairs, additional fill stations shall be provided at a ratio of one fill station for every three stairways.

- ❖ This section details where filling stations must be located both vertically (see Commentary Figure L104.13) and on any floor in a building. In most buildings where the floor must be provided with a filling station only one will be required. The filling station must be located next to a required interior exit stairway. In buildings with many stairways, one filling station is required for each three interior exit stairways.

**L104.13.2 Design.** Fill stations for breathing air cylinders shall be designed to meet the following requirements:

1. A pressure gauge and pressure-regulating devices and controls shall be provided to allow the operator to control the fill pressure and fill rate on each cylinder fill hose.
2. Valves controlling cylinder fill hoses shall be slow-operating valves.

APPENDIX L

3. A separate flow restriction device shall be provided on each fill hose.
4. A method shall be provided to bleed each cylinder fill hose.
5. The fill station shall be designed to provide a containment area that fully encloses any cylinder being filled and flexible cylinder fill hoses, and directs the energy from a failure away from personnel. Fill stations shall be designed to prohibit filling of cylinders that are not enclosed within the containment area.

**Exception:** Where required or *approved* by the fire chief, fill stations providing for the direct refilling of the fire fighters' breathing air cylinders using Rapid Intervention Crew/Company Universal Air Connection (RIC/UAC) fittings shall be used in lieu of cylinder fill stations that utilize containment areas.

- ❖ This section provides specific design specifications for fill stations. This addresses the various features needed, such as slow-operating valves and the ability to bleed each cylinder fill hose. All of these features

must be verified during the design and installation process.

**L104.13.3 Cylinder refill rate.** Fill stations shall be capable of simultaneously filling two or more empty breathing air cylinders equivalent to those used by the fire department to the cylinders' design pressure within 2 minutes.

- ❖ This section echoes the design criteria in Section L104.4, which mandates the ability to fill two cylinders within 2 minutes. Speed is essential fire fighting and filling the cylinders should be a quick process. The overall intent of such systems is to make obtaining breathing air faster and less labor intensive.

**L104.14 External mobile air connection.** An external mobile air connection shall be provided for fire department mobile air apparatus where required by Section L104.5 to supply the system with breathing air.

- ❖ This section requires that the mobile air apparatus can be connected to the system. This is similar to the concept of a standpipe connection for a standpipe

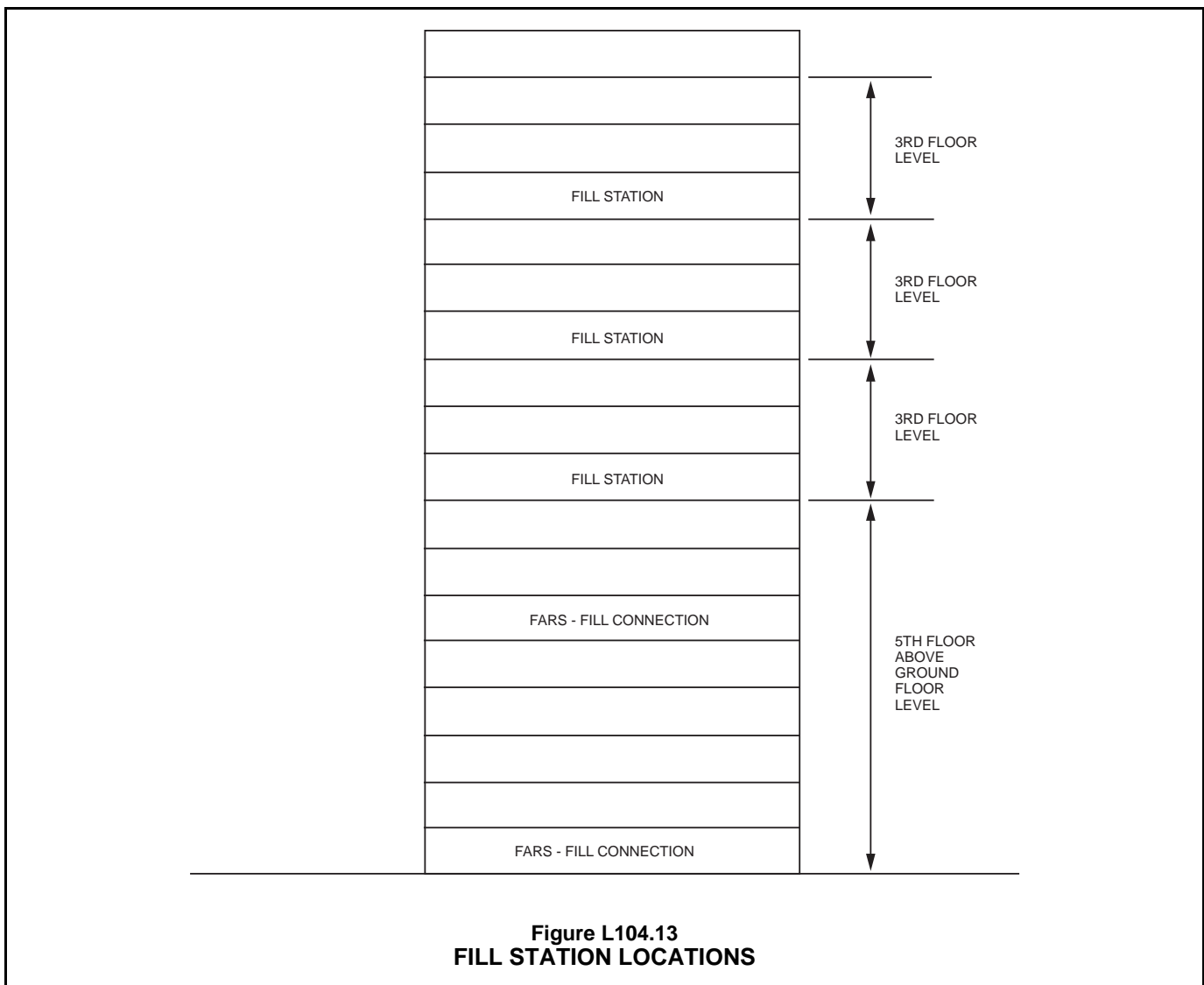


Figure L104.13  
FILL STATION LOCATIONS

system except that this system supplies critical breathing air rather than fire-fighting water.

**L104.14.1 Location.** The location of the external mobile air connection shall be accessible to mobile air apparatus and *approved* by the fire chief.

❖ The FARS is critical to fire-fighting operations. The connection must be located where it is feasible for the mobile air apparatus to make a connection. Approval from the fire chief is specifically called out as this is a fire-fighter operations issue.

**L104.14.2 Protection from vehicles.** A means of vehicle impact protection in accordance with Section 312 shall be provided to protect mobile air connections that are subject to vehicular impact.

❖ Similar requirements are found for other building connections related to fire department connections. Impact protection helps to ensure that connections will be in usable condition to make a proper connection to the mobile air apparatus.

**L104.14.3 Clear space around connections.** A working space of not less than 36 inches (914 mm) in width, 36 inches (914 mm) in depth and 78 inches (1981 mm) in height shall be provided and maintained in front of and to the sides of external mobile air connections.

❖ This section is very similar to Section 912.4 for access to fire department connections. Space must be provided to manipulate equipment and make proper connections.

**L104.15 Air monitoring system.** An *approved* air monitoring system shall be provided. The system shall automatically monitor air quality, moisture and pressure on a continual basis. The air monitoring system shall be equipped with not less than two content analyzers capable of detecting carbon monoxide, carbon dioxide, nitrogen, oxygen, moisture and hydrocarbons.

❖ In addition to the testing and maintenance required by Section L106.1, this section requires monitoring of the air at all times. The focus is on making sure that the air is of the correct quality, moisture content and pressure. Sections L105.15.1 through L105.15.3 focus on the actual alarm system requirements. The requirements address what creates an alarm condition (L104.15.1), where notification of a problem is communicated (L104.15.2) and that air quality status shall be visually communicated at the mobile air connection to let fire fighters know of any problem (L105.15.3).

**L104.15.1 Alarm conditions.** The air monitoring system shall transmit a supervisory signal when any of the following levels are detected:

1. Carbon monoxide exceeds 5 ppm.
2. Carbon dioxide exceeds 1,000 ppm.
3. An oxygen level below 19.5 percent or above 23.5 percent.

4. A nitrogen level below 75 percent or above 81 percent.
5. Hydrocarbon (condensed) content exceeds 5 milligrams per cubic meter of air.
6. The moisture concentration exceeds 24 ppm by volume.
7. The pressure falls below 90 percent of the maintenance pressure specified in Section L104.3.

❖ This section simply provides the criteria as to what constitutes a hazard and should initiate an alarm.

**L104.15.2 Alarm supervision, monitoring and notification.** The air monitoring system shall be electrically supervised and monitored by an *approved* supervising station, or where *approved*, shall initiate audible and visual supervisory signals at a constantly attended location.

❖ This section requires supervision and monitoring but does not mandate an audible or visual alarm. If approved, in place of a supervising station a local audible and visual signal may be provided at a constantly attended location. This could be in a security office within a building that is staffed 24 hours.

**L104.15.3 Air quality status display.** Air quality status shall be visually displayed at the external mobile air connection required by Section L104.14.

❖ In addition to monitoring and supervision at the connection for the mobile air apparatus, a visual display of current air quality is required. This is a location easily identified by the fire department.

## SECTION L105 ACCEPTANCE TESTS

**L105.1 Acceptance tests.** Upon completion of the installation, a FARS shall be acceptance tested to verify compliance with equipment manufacturers' instructions and design documents. Oversight of the acceptance tests shall be provided by a registered design professional. Acceptance testing shall include all of the following:

1. A pneumatic test in accordance with ASME B31.3 of the complete system at a minimum test pressure of 110 percent of the system design pressure using oil free dry air, nitrogen or argon shall be conducted. Test pressure shall be maintained for not less than 24 hours. During this test, all fittings, joints and system components shall be inspected for leaks. Defects in the system or leaks detected shall be documented and repaired.
2. A cylinder-filling performance test shall be conducted to verify compliance with the required breathing air cylinder refill rate from the exterior mobile air connection and, where provided, a stored air pressure supply system.
3. The air quality monitoring system shall be tested to verify both of the following conditions:
  - 3.1. Visual indicators required by Section L104.15.1 function properly.

3.2. Supervisory signals are transmitted as required by Section L104.15.2 for each sensor based on a sensor function test.

4. Connections intended for fire department use shall be confirmed as compatible with the fire department's mobile air unit, SCBA cylinders and, where provided, RIC/UAC connections.
  5. Air samples shall be taken from not less than two fill stations and submitted to an *approved* gas analysis laboratory to verify compliance with NFPA 1989. The FARS shall not be placed into service until a written report verifying compliance with NFPA 1989 has been provided to the *fire code official*.
- ❖ This section provides specific testing requirements regarding the installation and modification of such systems. Section L103.2 requires a construction permit along with documentation to show compliance with this section.

**SECTION L106  
INSPECTION, TESTING AND MAINTENANCE**

**L106.1 Periodic inspection, testing and maintenance.** A FARS shall be continuously maintained in an operative condition and shall be inspected not less than annually. Not less than quarterly, an air sample shall be taken from the system and tested to verify compliance with NFPA 1989. The laboratory test results shall be maintained on site and readily available for review by the *fire code official*.

- ❖ Ongoing maintenance is critical to the success of the air replenishment systems, which rely on consistent air quality and pressure. Operational permits help ensure that quarterly air samples are taken and annual inspections made.

**SECTION L107  
REFERENCED STANDARDS**

ASME B31.3—2012	Process Piping	L104.2.1, L105.1
CGA S-1.3—2008	Pressure Relief Device Standards – Part 3 Stationary Storage Containers for Compressed Gases	L104.7
NFPA 1901—09	Standard for Automotive Fire Apparatus	L104.5.1,
NFPA 1989—13	Breathing Air Quality for Fire Emergency Services Respiratory Protection	L104.2.2, L105.1, L106.1

# Appendix M: High-rise Buildings—Retroactive Automatic Sprinkler Requirement

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

## General Comments

Modern fire and building codes require complete automatic fire sprinkler protection and a variety of other safety features in new high-rise construction. Many older high-rise buildings lack automatic fire sprinkler protection and other basic fire protection features necessary to protect occupants, emergency responders, and the structure itself. Without complete automatic fire sprinkler protection, fire departments cannot provide the level of protection that high-rise buildings demand.

Existing high-rise buildings that are not protected with fire sprinklers represent a significant hazard to occupants and fire fighters. Additionally, high-rise fires can significantly impact a community's infrastructure and economic viability.

Between 2003 and 2006, there was an average of 13,400 reported structure fires in high-rise buildings annually. These incidents resulted in 62 civilian deaths, 490 civilian injuries, and \$179 million in direct property damage per year. Furthermore, from 1977 to 2009, 25 fire fighters died from nonstress-related cardiac death during fire suppression operations in high-rise buildings.

By their very nature, high-rise fires present unique fire-fighting challenges that are extremely difficult for fire fighters to mitigate without the presence of automatic sprinkler systems. Some of these challenges include:

- High-rise structure fires require significantly more resources, such as personnel and equipment, to extinguish than do fires in other types of occupancies. This further strains the responding fire department and fire fighters.
- Due to their height, smoke movement in high-rise structures is very different from that of other structures. Temperature gradients result in varying pressures throughout the structure, which can allow for the rapid, uncontrolled movement of smoke and flame (known as the "stack effect"). By design, exits from high-rise structures are limited.

In an emergency, the movement of people out of a building is particularly difficult. A prime example of this hazard is the One Meridian Plaza fire. This fire occurred on the 22nd floor of the 38-story Meridian Bank Building and was reported to the Philadelphia Fire Department on February 23, 1991 and burned for more than 19 hours. The fire caused three fire-fighter fatalities and injuries to 24 fire fighters. The 12 alarms brought 51 engine companies, 15 ladder companies, 11 specialized units, and more than 300 fire fighters to the scene. It was the largest high-rise office building fire in modern American history, completely consuming eight floors of the building, and was only controlled only when it reached a floor that was protected by automatic sprinklers. In 1999, the building was torn down amidst a storm of litigation.

- The HVAC and other utilities in some high-rises service multiple levels and can facilitate the spread of smoke and flame through a building.
- Due to the height of the building, response times for the fire department to reach the actual fire itself are extended, contributing to larger fire growth and more extensive smoke spread.

## Purpose

This appendix provides model code text for adoption by jurisdictions that choose to require existing high-rise buildings to be retrofitted with fire sprinklers. It is recognized that not all jurisdictions may choose to or have legal authority to enact a retroactive construction requirement of this nature, so an adoptable appendix has been provided. This appendix will provide the basic tools to those jurisdictions that have the ability to adopt such requirements. The appendix contains the basic automatic sprinkler system requirements and provides reasonable timeframes for building owners to meet such requirements.

### SECTION M101 SCOPE

**M101.1 Scope.** An *automatic sprinkler system* shall be installed in all existing high-rise buildings in accordance with the requirements and compliance schedule of this appendix.

- ❖ This section provides a tool for jurisdictions to implement a retroactive requirement for the installation of an automatic sprinkler system in high-rise buildings. This appendix also provides a method for building owners to file a compliance schedule for their building.

### SECTION M102 WHERE REQUIRED

**M102.1 High-rise buildings.** An *automatic sprinkler system* installed in accordance with Section 903.3.1.1 of the *International Fire Code* shall be provided throughout existing high-rise buildings.

#### Exceptions:

1. Airport traffic control towers.
  2. Open parking structures.
  3. Group U occupancies.
  4. Occupancies in Group F-2.
- ❖ This section contains the focus of the appendix, which is the enabling language for a jurisdiction to require an NFPA 13 automatic sprinkler system to be installed in existing high-rise buildings. In jurisdictions that use this appendix, the enabling language will be consistent. Several exceptions are similar to the exceptions in Section 403.1 addressing the applicability of the high-rise special use requirements.

### SECTION M103 COMPLIANCE

**M103.1 Compliance schedule.** Building owners shall file a compliance schedule with the *fire code official* not later than 365 days after the first effective date of this code. The compliance schedule shall not exceed 12 years for an *automatic sprinkler system* retrofit.

- ❖ The requirement for the retroactive installation of a sprinkler system in a high-rise building is one that is costly and often a disruption to the use of the building. This is understood and flexibility is built into the appendix to ease the burden and recognize such installations cannot occur overnight. Instead, it provides some reasonable limits as to when a compliance schedule is to be provided to a jurisdiction (1 year after effective date). Additionally, this section allows up to 12 years for the installation process to be completed. The owners may prioritize based, for example, on changing tenants or planned renovations as to which portion of the building will be retrofitted first.

### SECTION M104 REFERENCED STANDARD

ICC IFC—15 International Fire Code M102.1

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