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Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems[1]

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1. Scope

1.1 These practices cover standardized techniques for locating air leakage sites in building envelopes and air barrier systems.

1.2 These practices offer a choice of means for determining the location of air leakage sites with each offering certain advantages for specific applications.

1.3 Some of the practices require a knowledge of infrared scanning, building and test chamber pressurization and depressurization, smoke generation techniques, sound generation and detection, and tracer gas concentration measurement techniques.

1.4 The practices described are of a qualitative nature in determining the air leakage sites rather than determining quantitative leakage rates.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements, see Section 6.

2. Referenced Documents

2.1 *ASTM Standards:*

E 631 Terminology of Building Constructions[2]

E 741 Test Method for Measuring Air Leakage Rate by Tracer Dilution[2]

E 779 Test Method for Determining Air Leakage Rate by Fan Pressurization[2]

2.2 *Other Standards:*

ANSI-ASHRAE Standard 101 Application of Infrared Sensing Devices to the Assessment of Building Heat Loss Characteristics[3]

ISO Standard 6781 Thermal Insulation—Qualitative Detection of Thermal Irregularities in Building Envelopes—Infrared Method[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *air leakage rate, n*—the volume of air movement per unit time across the building envelope or air barrier system, including flow through joints, cracks, and porous surfaces, or combinations thereof, in which the driving force for such air leakage in buildings is either mechanical pressurization or evacuation, natural wind pressures, or air temperature differences between the building interior and the outdoors, or combinations thereof.

3.1.2 *air leakage site, n*—a location on the building envelope or air barrier system where air can move between the building interior and the outdoors.

3.1.3 *air infiltration, n*—air leakage into the building.

3.1.4 *air exfiltration, n*—air leakage out of the building.

3.1.5 *building envelope, n*—the boundary or barrier separating the interior volume of a building from the outside environment.

3.1.5.1 *Discussion*—For the purpose of these practices, the interior volume is the deliberately conditioned space within a building generally not including the attic space, basement space, and attached structures, unless such spaces are connected to the heating and air conditioning system, such as a crawl space plenum. The actual building envelope may extend beyond these boundaries because of ducting or other construction features.

3.1.6 *air barrier system, n*—a system in building construction that is designed and installed to reduce air leakage either into or through the building envelope.

3.1.7 *test specimen, n*—the part of the air barrier system on the building to be tested that may consist of the selected areas of materials comprising the principle resistance to airflow, joints between such materials and joints between the materials and structural, mechanical or other penetrations through such materials, and excludes any material which does not form an integral part of the air barrier system.

3.2 For other definitions, see Terminology E 631.

[1] These practices are under the jurisdiction of ASTM Committee E06 on Performance of Buildings and are the direct responsibility of Subcommittee E06.41 on Air Leakage and Ventilation.

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[2] *Annual Book of ASTM Standards*, Vol 04.11.

[3] Available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

4. Summary of Practice

4.1 This standard presents the following seven practices for detecting air leakage sites in building envelopes:

4.1.1 Combined building depressurization (or pressurization) and infrared scanning,

4.1.2 Building depressurization (or pressurization) and smoke tracers,

4.1.3 Building depressurization (or pressurization) and airflow measuring devices,

4.1.4 Generated sound and sound detection,

4.1.5 Tracer gas detection,

4.1.6 Chamber depressurization (or pressurization) and smoke tracers, and

4.1.7 Chamber depressurization and leak detection liquids.

4.2 These practices are described as follows:

4.2.1 *Building Depressurization (or Pressurization) with Infrared Scanning Techniques*—This practice relies on the existence of an indoor–outdoor temperature difference of at least 5 °C. In most geographic locations, this condition is met during some portion of the day over a large fraction of the year. Outdoor air is moved through the building envelope by depressurizing the building interior with a fan (see Test Method E 779) or using the mechanical system in the building. Because the infiltrating air is at a different temperature than the interior surfaces of the building envelope, local interior surface temperature changes take place which can be detected by infrared scanning equipment. The infrared pattern resulting from air leakage is different from that associated with varied levels of thermal conductance in the envelope, allowing air leakage sites to be identified. This practice can also be performed by pressurizing the building and scanning the exterior of the building envelope.

4.2.2 *Smoke Tracer in Conjunction With Building Pressurization or Depressurization*—This practice consists of pressurizing or depressurizing the building using a fan or the mechanical system in the building and moving a smoke tracer source over the interior or the exterior surface of the building envelope. If the building is pressurized and the smoke tracer source is moved over the interior of the building envelope, air exfiltration through air leakage sites will draw smoke from the tracer source to the site, revealing its location visually. Alternatively, if the building is depressurized and the smoke tracer source is moved over the interior of the building envelope surface, then air jets at each air leakage site will cause the smoke to move rapidly inward. Similarly, the smoke tracer source can be employed on the exterior of the building envelope.

4.2.3 *Building Depressurization (or Pressurization) in Conjunction With Airflow Measurement Devices, or Anemometers*—This practice consists of depressurizing or pressurizing the building using a fan or the building's mechanical systems and moving an anemometer over the interior building envelope surface. If the building is depressurized, air jets will be present within the building at each air leakage site. As the anemometer is moved over the building envelope surface, it will register an air velocity peak at the location of the air leakage site. If the building is pressurized, interior air will flow toward each air leakage site. In this case, the resulting measured air velocity peak will be less distinct.

4.2.4 *Generated Sound in Conjunction With Sound Detection*—This practice consists of locating a sound generator within the building and moving a sound detection device over the exterior of the building envelope. Increased sound intensity is indicative of an air leakage site. Alternatively, the sound generator can be located outside the building and the interior surface of the building envelope can be surveyed using the sound detection device.

4.2.5 *Tracer Gas*—This practice consists of releasing a tracer gas on one side of the building envelope and using a tracer gas detector to measure the concentration of the tracer gas on the other side. A measurable tracer gas concentration indicates the location of an air leakage site. Pressurizing or depressurizing the building envelope using a fan or the building's mechanical system improve the results obtained by this method.

4.2.6 *Chamber Pressurization or Depressurization in Conjunction With Smoke Tracers*—This practice consists of sealing an approximately airtight chamber to a section of the interior or exterior of the air barrier system and using a fan to create a pressure differential across the air barrier specimen. If a smoke tracer source is moved over the surface of the test specimen on the higher pressure side, air leakage will draw smoke toward an air leakage site, visually indicating the location. Conversely, if a smoke tracer is moved over the surface of the test specimen on the low pressure side, air jets at air leakage sites will cause smoke to move away from the air leakage site.

4.2.7 *Chamber Depressurization in Conjunction With Leak Detection Liquid*—The practice consists of applying a leak detection liquid to the test specimen surface, sealing a transparent chamber around the specimen and depressurizing the chamber with a fan. The location of an air leakage site is indicated by bubbling of the detection liquid at the air leakage site.

4.2.8 *Other Practices*—Practices such as the use of a smoke bomb are not described here since they are very specialized and require extreme caution due to additional difficulties such as triggering smoke alarms and causing lingering odors.

5. Significance and Use

5.1 Air infiltration into the conditioned space of a building accounts for a significant portion of the thermal space condition load. Air infiltration can affect occupant comfort by producing drafts, cause indoor air quality problems by carrying outdoor pollutants into occupied building space and, in hot humid climates, can deposit moisture in the building envelope resulting in deterioration of building envelope components. In cold climates, exfiltration of conditioned air out of a building can deposit moisture in the building envelope causing deterioration of building envelope components. Differential pressure across the building envelope and the presence of air leakage sites cause air infiltration and exfiltration **(1)**.[4]

[4] The **boldface** numbers in parentheses refer to the list of references at the end of these practices.

5.2 In some buildings, restricting air movement between interior zones of a building may be desired to separate dissimilar interior environments or prevent the movement of pollutants. Although not dealt with specifically in this standard, the detection practices presented can also be useful in detecting air leaks between interior zones of the building.

5.3 Air leakage sites are often difficult to locate because air flows may be small under the prevailing weather conditions. Wind conditions can aid in air leakage detection by forcing air to enter a building; however, where air is exiting, the building envelope construction may make observations difficult. For these reasons, forced pressurization or depressurization is strongly recommended for those practices which require controlled flow direction.

5.4 The techniques for air leakage site detection covered in these practices allow for a wide range of flexibility in the choice of techniques that are best suited for detecting various types of air leakage sites in specific situations.

5.5 The infrared scanning technique for air leakage site detection has the advantage of rapid surveying capability. Entire building exterior surfaces or inside wall surfaces can be covered with a single scan or a simple scanning action, provided there are no obscuring thermal effects from construction features or incident solar radiation. The details of a specific air leakage site may then be probed more closely by focusing on the local area. Local leak detection is well addressed with the smoke tracer, anemometer, sound detection, the bubble detection and the tracer gas techniques, however these techniques are time consuming for large surfaces. The pressurized or depressurized test chamber and smoke tracer or a depressurized test chamber and leak detection liquid practices can be used in situations where depressurizing or pressurizing the entire envelope is impractical, such as is the case during construction. Both of the practices enable the detection of very small leaks. To perform these practices requires that the air barrier system be accessible.

5.6 Complexity of building air leakage sites may diminish the ability for detection. For example, using the sound detection approach, sound may be absorbed in the tortuous path through the insulation. Air moving through such building leakage paths may lose some of its temperature differential and thus make thermographic detection difficult. The absence of jet-like air flow at an air leakage site may make detection using the anemometer practice difficult.

5.7 Stack effect in multistory commercial buildings can cause gravity dampers to stand open. Computer-controlled dampers should be placed in normal and night modes to aid in determining the conditions existing in the building. Sensitive pressure measurement equipment can be used for evaluating pressure levels between floors and the exterior. Monitoring systems in high-tech buildings can supply qualitative data on pressure differences.

6. Hazards

6.1 Glass should not break at the pressure differences normally applied to the test structure. However, for added safety, adequate precautions such as the use of eye protection should be taken to protect the personnel. Occupant protection must also be considered.

6.2 Since the test is conducted in the field, safety equipment required for general field work also applies, such as safety shoes, hard hats, etc.

6.3 Because air-moving equipment may be involved in these tests, provide a proper guard or cage to house the fan or blower and to prevent accidental access to any moving parts of the equipment.

6.4 Noise may be generated by the moving air from pressurization systems. Therefore, make hearing protection available to personnel who must be close to the noise source.

6.5 Use of smoke tracers often produces pungent and caustic fumes. Although extremely localized, precautions should be taken so that smoke inhalation is minimized and respiratory protection is provided as required. See Note 1.

NOTE 1—Hands should be washed before eating if large quantities of pungent or caustic fumes have been generated.

6.6 Moving air from the pressurization devices can produce cold drafts affecting plants, birds, wall-mounted pictures, papers on desks, etc. These sensitive items should be moved out of the air path. Prolonged depressurization testing may result in lower temperatures in critical areas of the building and may adversely affect building components, for example frozen pipes.

6.7 Depressurization in buildings with fireplaces can cause movement of ashes into occupied spaces. Close dampers or cover fireplaces, or both, prior to depressurization.

6.8 Caution must be exercised as to the choice of tracer gases used and the level of concentration provided. Health guidelines, fire and explosion limits must not be exceeded. See Test Method E 741.

7. Procedure

7.1 Each practice enables the locating of air leakage sites and, if sealing methods are employed, enables the sites to be resurveyed to evaluate qualitatively the degree of success of the sealing procedure. Some air leakage sites involve preferred directional flow, requiring the correct choice of pressurization or depressurization to ensure detection. The following are more detailed descriptions of each of the practices previously presented.

7.2 *Depressurization (or Pressurization)/Infrared Practice*—This practice is based upon the principle that outside air, when drawn through the building envelope by building depressurization, will induce a temperature change in the inside surfaces surrounding the air leakage site. Infrared scanning methods can be used to detect the sites by sensing differences in the adjacent interior surface temperatures **(2,3,4)**. Training in the use of this equipment is essential.

7.2.1 *Background*—It is clear from using pressurization and depressurization techniques, such as described in Test Method E 779, that airflow through leakage sites is markedly increased with higher inside-outside pressure differences. During almost any day of the year, temperature differences of 5 °C or more between the inside and outside environments are present for at least part of the day. Under these conditions, air drawn through an air leakage site will alter the local surface temperatures around the site. Infrared equipment with sufficient sensitivity and resolution (see ISO Standard 6781 and ANSI-ASHRAE

Standard 101) can easily identify the altered surface temperature, thereby locating air leakage sites. The character of the thermal pattern on air-cooled (or heated) surfaces assists in separating such areas from other thermal differences due to conduction variations in the building envelope. Exterior observations at night normally require higher differential temperatures because of obscuring effects from wind and residual solar radiation. See ISO Standard 6781.

7.2.2 *Depressurization (or Pressurization) Systems*—These systems may consist of blower doors, window fans, fans associated with the mechanical system of the building, etc. that may be operated to induce pressure differences across the building envelope. The ability of such systems to provide pressure differentials of as high as 50 Pa will enhance airflow through the air leakage sites and aid in the rapid cooling (or heating) of the building surfaces. Pressure differentials of 20 Pa or less are commonly used in air leakage site detection.

7.2.3 *Infrared Equipment*—Detection of the surface temperature changes which result from the heating and cooling effects of air leakage requires sensitive infrared scanning equipment. Typical specification are found in ISO Standard 6781.

7.2.4 *Details*—Using building depressurization equipment, or employing blower doors or similar equipment, the building is depressurized and the resultant air leakage is allowed to alter local surface temperatures near the air leakage sites for a period of at least 10 min. Normally, a pressure differential of 10 to 50 Pa is adequate in most cases to provide flow in one direction free from weather effects such as wind pressure. Systematic scanning of the building interior with infrared equipment begins at this point, emphasizing the interior of the building envelope but not ignoring other interior surfaces such as partition walls. Leakage from the attic, for example, will show up on the interior surfaces as streaking from the upper portions of those walls that are affected. Masking of these effects can take place where solar radiation influences the local surface temperatures. Application of this method in commercial buildings where ceiling panels must be removed to obtain access to the underside of the floors and the roof can be complicated by interactions with the return air plenums and possible heating, ventilating and air conditioning (HVAC) system imbalance. The practice can also be carried out by pressurizing the building and scanning the exterior of the building envelope. Local weather influences such as wind and or solar radiation can make outside scanning difficult and influence the results of inside scans as well. Because of the nature of the air leakage site, inside and outside scans may reveal different aspects of the air leakage paths.

7.2.5 *Limitations*—The effectiveness of the practice can be compromised if the analysis does not correctly discriminate air leakage sites from thermal bridges. Thermal bridges occur at locations where there are significant increases in the thermal conduction across the building envelope, and are therefore not associated with air leakage sites. Different building envelope materials also have different thermal emissivities which may influence the interpretation of the infrared scan results. Thermal mass of building materials will affect the required times for surface temperatures to change and thus slow down the process in the case of masonry buildings and other heavy construction. Familiarity with the building envelope construction and details is required for effective interpretation of the infrared scan results.

7.3 *Smoke Tracer Practice*—This practice is based on the principle that air moving through an air leakage site will draw or deflect smoke seeded air in close proximity to the site, thereby allowing the site to be detected visually. Minimum training is required to use this practice.

7.3.1 *Background*—Under normal operating conditions, pressure differentials across the building envelope due to differences in air density and wind will induce airflow through air leakage sites. Building pressurization or depressurization techniques can be used to provide enhanced unidirectional air flows through the sites which provides a greater opportunity for smoke seeded air to be affected by airflow through the sites.

7.3.2 *Details*—With flow established in one direction through the air leakage sites, via pressurization or depressurization of the building interior, the controlled smoke source is moved close to the suspected air leakage site and the smoke direction carefully noted. Using the smoke trace on the higher pressure side of the envelope is generally the preferred technique since the smoke is drawn into the leakage site.

7.3.3 *Limitations*—When the smoke tracer is used inside the building, potential obscuring effects include airflow from the heating, ventilation and air-conditioning system. When the smoke tracer is used on the building exterior, wind may make observation difficult. Knowledge of potential air leakage sites is necessary to limit the investigation area to be covered by this means. Normally the controlled smoke source must be close to the leakage site (within approximately 10 cm) for best results, therefore only areas which can be physically reached can be surveyed using this practice. Since the smoke is often an acid vapor it must be used sparingly to reduce the possibility of annoyance to building occupants and damage to materials which may results from overuse. This is a local technique and therefore extensive use of smoke is not required.

7.4 *Anemometer Practice*—This practice is based on the principle that air close to the leakage site will be moving at a higher velocity than the surrounding air. If the building is depressurized, jet-like airflow will be encouraged at the air leakage sites. A large velocity gradient at the air leakage site is created which facilitates rapid detection of the site by using a anemometer to detect areas with high air velocities.

7.4.1 *Background*—Air velocities near wall surfaces tend to approach zero except where building air distribution systems cause local flow disturbances. Under normal operating conditions, pressure differentials across the building envelope due to differences in air density and wind will induce airflow through air leakage sites which result in variations in local air velocities. The use of building pressurization (or depressurization) establishes unidirectional airflow and increases air velocity at air leakage sites and thereby aid in detection.

7.4.2 *Anemometers*—Many different types of anemometers are available which can be used. Examples include small pin-wheel units, heated single or multiple thermistors, and high frequency response constant-temperature hot-wire anemometers. Anemometers which indicate airflow direction are generally more suitable. The simplest means of detecting air movement is using the hands to feel for differences in air velocity. This provides a simple but effective means of finding air leakage sites.

7.4.3 *Details*—This practice relies on local air movement near an air leakage site. The building is pressurized (or depressurized) and the anemometer is moved close to the building envelope and areas registering peak velocities are noted. The areas registering peak air velocities close to the interior surface of the building envelope represent potential air leakage sites.

7.4.4 *Limitations*—Since only areas which can be physically reached can be surveyed, a knowledge of the location of potential air leakage sites is necessary to limit the investigation area to be covered by this means. If the anemometer does not indicate airflow direction, use of an additional information source such as a wool tuft on the sensor or some other means may be required to clarify the readings.

7.5 *Acoustic Practice*—This practice is based upon the principle that sound passes readily through openings in building structures in the same way that air does. The method is simple, low cost, and can be used with minimum training **(5)**.

7.5.1 *Background*—Small openings through building structures serve as paths for both air leakage and sound. A quieter interior environment is a noticeable result of building envelope crack sealing procedures. The difference in sound intensity level between the two sides of the wall as a function of frequency is related to the size of the barrier, the amount of the acoustical absorption on either side of the wall, the angle of incidence of the sound at the wall, the acoustic properties within the wall, and other less important parameters such as humidity. Probing is done close to the sound-output side of the building envelope seeking local increases in sound level.

7.5.2 *Sound Sources*—Virtually any sound source of sufficient loudness can be used for this practice. The preferences are a steady and broad-band (white noise containing many frequencies) and a saw tooth warble tone that sweeps in frequency from 500 to 8000 Hz about three times per second. The broad-band sound can be produced by something as simple as a vacuum cleaner. Both sounds can be readily generated using a cassette tape and portable tape recorder. The warble tone is preferable because it is readily discernible. However, if the sound source needs to be placed outside the building, white noise is preferable because it is less annoying to occupants of adjacent buildings.

7.5.3 *Sound-Detecting Equipment*—On the listening side of the building envelope, it is necessary to provide a means for detecting the sound near the surface and over a very small area, preferably less than 1 cm diameter. The following equipment can be used: mechanic's stethoscope; plastic airline headset; Type I and Type II sound level meters; and low-cost sound meters consisting of a battery powered microphone and headphones. A microphone end piece with a limited opening of 4 mm diameter aids the latter in probing for small cracks and will be the means that is further described.

7.5.4 *Details*—With the sound source located on one side of the building envelope, the microphone is moved over the opposite side. Areas of local increase in sound intensity are recorded. These areas represent potential air leakage sites.

7.5.5 *Limitations*—Lightweight barriers will only slightly reduce sound levels making it difficult to discriminate leaks from normal sound transmission. Insulation in the wall will greatly reduce sound transmission, especially if the sound travels through an indirect air path as opposed to straight through the wall, making it difficult to find the air leakage site. Sound reflections at corners will cause a sound level increase of 3 dB where two walls meet and 6 dB where three walls meet. These anomalous indications should not be confused with an air leakage site. Noisy environments make the use of this method difficult.

7.6 *Tracer Gas Practice*—This practice is based on the principle that a detector for a specific substance, in this case a tracer gas as described in Test Method E 741, may be used to locate where air containing the tracer gas is leaking through the building envelope.

7.6.1 *Background*—There are various tracer gases, as described in Test Method E 741, and various detection methods suited to each. Some tracer gas detection systems are easily portable and can be operated in a continuous sampling mode, making them particularly suitable for use. Building depressurization and pressurization improve the effectiveness of this practice by providing airflow in one direction across the building envelope.

7.6.2 *Tracer Gas Injection (Seeding)*—To differentiate the air on one side of the building envelope from the air on the other side, a tracer gas is injected (seeded) and mixed with the air on one side using either a single or continuous injection. The resulting tracer gas concentration must be high enough that the detector can sense the seeded air after it passes through the air leakage site but must be limited to a concentration which will not saturate the detector, causing delays while the detector recovers.

7.6.3 *Details*—With the flow established in one direction through the air leakage sites by means of pressurization or depressurization of the building interior, the interior or exterior air is seeded with tracer gas to a suitable concentration level. For interior seeding this requires a specific quantity of tracer gas based upon interior volume of the building. A portable detector is moved over the opposite surface of the building envelope while it is operating in a continuous sampling mode. An area of increased tracer gas concentration indicates a possible air leakage site. In the case where the tracer gas analyzer cannot sample continuously or is not easily portable, it is possible to obtain a number of individual samples using syringes or sample bags. Each sample is labeled with the exact location and time of the sample. The individual samples are subsequently analyzed and used to identify possible leak locations.

7.6.4 *Limitations*—Unlike the smoke practice (7.3), the tracer gas practice can provide an overall indication if there is any significant leakage through the building envelope based on an evaluation of the tracer gas level. A detailed survey over the building envelope surfaces must be made if all air leakage site details are to be obtained.

7.7 *Smoke Tracer in Conjunction with a Depressurized (or Pressurized) Chamber Practice*—This practice is based upon the principle that air moving through air leakage sites in the building envelope will draw smoke seeded air that is in close proximity to the site through the same opening, thereby allowing the air leakage site to be detected by visual means.

7.7.1 *Background*—This practice is similar to that described in 7.3 except that the pressure differential across the building envelope is provided by depressurizing (or pressurizing) a test chamber rather than the entire building. Depressurization (or pressurization) of a local area enables the use of this practice when it is impractical to depressurize (or pressurize) the whole building. Using this practice it is possible to achieve pressure differentials of 300 Pa or greater, although a pressure differential in the range of 75 to 150 Pa is typical for detection of air leakage sites.

7.7.2 *Test Chamber*—The test chamber consists of a well sealed chamber which is designed to resist the pressure differentials used in the test. The test chamber is sealed to the air barrier system component and contains a connection point for attaching the fan inlet or outlet. The test chamber may also contain an adjustable bleed valve for controlling the pressure inside the chamber and a pressure tap to facilitate determining the pressure differential across the specimen with a manometer.

7.7.3 *Air Exhaust (or Supply) System*—A fan or blower that is capable of providing sufficient airflow to achieve the desired pressure differential across the test area is used. A speed control on the fan or an adjustable bleed valve in the test chamber can be used to control the pressure in the chamber.

7.7.4 *Details*—The test chamber is installed so that it encloses the entire test specimen, and the perimeter of the chamber is sealed to the air barrier system. The fan is used to pressurize (or depressurize) the test chamber and the smoke tracer source is moved over the surface of the test specimen. The direction of movement of the smoke trace is carefully noted. When the tracer source is used on the high pressure side of the test specimen, smoke will be drawn into air leakage sites. Conversely, if the tracer source is used on the low pressure side of the test area, smoke will be forced away from air leakage sites.

7.7.5 *Limitations*—A knowledge of potential air leakage sites is necessary to limit the number of tests. The air barrier system in the wall must be accessible in order to employ this practice.

7.8 *Leak Detector Liquid in Conjunction with Depressurized Chambers Practice*—This practice relies on the principle that a pressure differential across a liquid film at an air leakage site will form bubbles in the film. The film is located on the low pressure side of the specimen within a transparent test chamber to allow visual observation of the test specimen during the test.

7.8.1 *Background*—This practice is suitable for locating air leakage sites at specific details when depressurizing or pressurizing the entire building envelope is impractical, and enables the testing of penetrations and joints in rigid air barrier materials such as metal liners or membranes supported by rigid substrates. The practice subjects a test specimen and the surrounding area to a desired pressure differential which is limited by the structural capacity of the specimen.

7.8.2 *Test Chamber*—The test chamber consists of a well-sealed, transparent chamber which is capable of resisting the pressure differentials of the test. The chamber must be sufficient in size to enclose the test specimen. A pressure tap may be installed to allow the measurement of the pressure differential across the specimen during the test with a manometer.

7.8.3 *Leak Detector Solution*—A leak detector liquid which can be easily applied over the test specimen surface may be used. The viscosity should be sufficient so that the liquid remains in an even coat on the test specimen during the test. Bubbles should not form in the liquid during application.

7.8.4 *Air Exhaust System*—The air exhaust system consists of a fan which is able to provide sufficient airflow to achieve the desired pressure differential across the test specimen. A means of increasing the airflow at a rate of approximately 25 Pa/s or less enables the bubbles to form gradually without breaking at large air leakage sites.

7.8.5 *Details*—The leak detector liquid is applied evenly over the surface of the test specimen and the test chamber is fitted over the specimen and sealed to the surrounding air barrier system. Care must be taken so that bubbles are not formed in the liquid by the application technique. The fan is used to extract air from the test chamber until the desired pressure differential across the specimen is reached. Bubbles or visible distention of the leak detector liquid indicates the existence of air leakage sites through the air barrier system. An estimate of the relative size of the leak can be made based on the size and speed with which the bubbles form.

7.8.6 *Limitations*—A knowledge of potential air leakage sites is necessary to limit the search area using this practice. This practice is only suitable when the air barrier system is accessible and has sufficient rigidity that it is not pulled into the test chamber during the test. Care must be taken during the test that air leaks at the seal between the test chamber and the air barrier system are not confused with air leakage sites through the test specimen.

8. Precision and Bias

8.1 These practices are intended to qualitatively locate air leakage sites rather than provide a quantitative airflow rate for the sites. Properly used, all but the smallest leakage sites should be detected by any of these practices.

9. Keywords

9.1 acoustic method; air leakage; air leakage detection; air barrier system; anemometer method; bubble method; building envelopes; infrared method; smoke trace method; tracer gas method

REFERENCES

(**1**) *Measured Air Leakage of Buildings, ASTM STP 904*, ASTM, 1986.

(**2**) Pettersson, B., and Axen, B., "Thermography: Testing of Thermal Insulation and Airtightness of Buildings," *Swedish Council for Building Research Report D5*, 1980.

(**3**) Harrje, D. T., Dutt, G. S., and Beyea, J., "Locating and Eliminating Obscure But Major Energy Losses in Residential Housing," *ASHRAE Transactions*, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Vol 85, Part 2, 1979.

(**4**) Harrje, D. T., Dutt, G. S., and Gadsby, K. J., "Isolating the Building Thermal Envelope," *Thermal Infrared Sensing Applied to Energy Conservation in Buildings—Thermosensense III*, Society of Photo-Optical Instrumentation Engineers, 1981.

(**5**) Keast, D. N., "Acoustic Location of Infiltration Openings in Buildings," *Report No. 3942*, Bolt Beranek and Newman Inc., Cambridge, MA, 1978.