141st Field Artillery Battalion Readiness Center

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Technical Specifications

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Broadmoor Design Group, Dean Duplantier, Architect,
A Professional Architectural Corporation /
Blitch Knevel Architects, Inc. - A Joint Venture

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DISCLAIMER

These technical specifications are conceptual in nature and are not suitable for construction. It is the intent of these documents to clearly delineate the baseline minimum scale, scope and quality of the project. It is the responsibility of the design-builder that his proposal provides for a complete and functional facility responding to relative Army National Guard criteria, recognized industry standards and applicable building codes regardless of the content of these conceptual specifications.

Further, it will be the responsibility of the successful design-builder and his architect-of-record to prepare complete construction documents responding to the fullest intent of the conceptual drawings and specifications.

LIST OF PREPARER'S –

Architectural

The following specifications sections have been prepared by Broadmoor Design Group, Dean Duplantier, Architect, A Professional Architectural Corporation / Blitch Knevel Architects, Inc. – A Joint Venture

Division 2 - Site Construction
02221 Building Demolition
02361 Termite Control
02780 Unit Pavers

Division 3 – Concrete
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04810 Unit Masonry Assemblies
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Division 10 - Specialties

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Division 11 - Equipment
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Division 12 - Furnishings
12485 Foot Grilles
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Division 14 - Conveying Systems
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Civil

The following specifications sections have been prepared by Krebs, LaSalle, LeMieux Consultants, Inc.

Division 2 - Site Construction
02500 Pavement Base and Subbase
02513 Asphaltic Cement Concrete Pavement
02516 Portland Cement Concrete Pavement for Streets
02528 Concrete Walks and Curbs & Gutters
02713 Water Distribution System
02725 Culverts, Storm Drains & Structures
02800 Sanitary Sewage Collection System

Structural

The following specifications sections have been prepared by Morphy Makofsky, Inc.

Division 2 - Site Construction
02300 Earthwork
02455 Driven Piles

Division 3 - Concrete
03300 Cast-In-Place Concrete

Division 5 - Metals

05120	Structural Steel
05210	Steel Joists
05310	Steel Deck
05425	Prefabricated Steel Roof Trusses

Mechanical

The following specifications sections have been prepared by Lucien T. Vivien, Jr. & Associates, Inc.

Division 15 - Mechanical

15050	Basic Mechanical Materials & Methods
15250	Piping and Equipment Insulation
15350	Commissioning
15400	Plumbing
15800	Heating, Ventilation and Air Conditioning
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Division 17 – Sytems

17000	Systems Integration – Facilities Management Systems

Electrical

The following specifications sections have been prepared by IMC Consulting Engineers, Inc.

Division 16 - Electrical

16010	Electrical General Provisions
16050	Basic Electrical Materials and Methods
16051	Electrical Related Work
16055	Overcurrent Protective Device Coordination
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16950	Lightning Protection

SECTION 02221 - BUILDING DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Demolition and removal of buildings and site improvements.
   2. Abandoning in place and removing below-grade construction.
   3. Disconnecting, capping or sealing, and abandoning in-place an removing site utilities.
   4. Salvaging items for reuse by Owner.

1.2 DEFINITIONS

A. Demolish: Completely remove and legally dispose of off-site.

B. Recycle: Recovery of demolition waste for subsequent processing in preparation for reuse.

C. Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner. Include fasteners or brackets needed for reattachment elsewhere.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
   1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.4 SUBMITTALS

A. Qualification Data: For refrigerant recovery technician.

B. Proposed Protection Measures: Submit informational report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
   1. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain.

C. Schedule of Building Demolition Activities: Indicate the following:
   1. Detailed sequence of demolition work, with starting and ending dates for each activity.
   2. Temporary interruption of utility services.
   3. Shutoff and capping or re-routing of utility services.

D. Building Demolition Plans: Drawings indicating the following:
   1. Locations of temporary protection.

E. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.

F. Predemolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by building demolition operations. Comply with Division 01 Section "Photographic Documentation." Submit before the Work begins.

G. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

H. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.5 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Standards: Comply with ANSI A10.6 and NFPA 241.

D. Predemolition Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS

A. Buildings to be demolished will be vacated and their use discontinued before start of the Work.

B. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.
   1. Provide not less than 72 hours' notice of activities that will affect operations of adjacent occupied buildings.
   2. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.
      a. Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.

C. Owner assumes no responsibility for buildings and structures to be demolished.
   1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. On-site storage or sale of removed items or materials is not permitted.

1.7 COORDINATION

A. Arrange demolition schedule so as not to interfere with LAARNG's on-site operations and operations of adjacent occupied buildings.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soils: Comply with requirements in Division 2 Section "Earthwork."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting demolition operations.

B. Review Project Record Documents of existing construction provided by LAARNG. LAARNG does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Inventory and record the condition of items to be removed and salvaged.

D. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during building demolition operations.
1. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.

E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

3.2 PREPARATION

A. Refrigerant: Remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction before starting demolition.

B. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.
1. Arrange to shut off indicated utilities with utility companies.

2. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
3. Cut off pipe or conduit a minimum of 24 inches (610 mm) below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.

C. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of demolition.

D. Salvaged Items: Comply with the following:
1. Clean salvaged items of dirt and demolition debris.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to LAARNG.
4. Transport items to storage area designated by LAARNG.
5. Protect items from damage during transport and storage.

3.3 PROTECTION

A. Existing Facilities: Protect adjacent building facilities and site improvements during demolition operations. Maintain exits from existing buildings.

B. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.
1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by LAARNG and authorities having jurisdiction.
2. Provide temporary services during interruptions to existing utilities, as acceptable to LAARNG and authorities having jurisdiction.
   a. Provide at least 72 hours' notice to occupants of affected buildings if shutdown of service is required during changeover.

C. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction, and as indicated. Comply with requirements in Division 01 Section "Temporary Facilities and Controls."
1. Protect adjacent buildings and facilities from damage due to demolition activities.
2. Protect existing site improvements, appurtenances, and landscaping to remain.
3. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
4. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
5. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.

D. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

3.4 DEMOLITION, GENERAL

A. General: Demolish indicated existing buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
   1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
   2. Maintain fire watch during and after flame cutting operations.
   3. Maintain adequate ventilation when using cutting torches.
   4. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

B. Engineering Surveys: During demolition, perform surveys to detect hazards that may result from building demolition activities.

C. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from LAARNG and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
   2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

D. Explosives: Use of explosives is not permitted.

3.5 DEMOLITION BY MECHANICAL MEANS

A. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.

B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
   1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.

C. Salvage: Items to be salvaged are indicated on Drawings.

D. Below-Grade Construction: Demolish foundation and other below-grade construction.
   1. Remove below-grade construction, including foundations, and footings, completely.

E. Existing Utilities: Demolish and remove existing utilities and below-grade utility structures.

3.6 SITE RESTORATION

A. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.

1. Where new construction is not indicated, completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials according to backfill requirements in Division 2 Section "Earthwork."

B. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

3.7 REPAIRS

A. Promptly repair damage to adjacent buildings caused by demolition operations.

3.8 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site. See Division 01 Section "Construction and Demolition Waste Management" for recycling and disposal of demolition waste.
   1. Do not allow demolished materials to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Do not burn demolished materials.

3.9 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.

END OF SECTION 02221

SECTION 02231 – TREE PROTECTION / SITE CLEARING

PART 1 - GENERAL

1.1 SITEWORK

A. Tree Protection Zone: Area surrounding individual trees 8-inch caliper or larger or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

B. Erect and maintain temporary chain link fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
   1. Do not store construction materials, debris, or excavated material within fenced area.
   2. Do not permit vehicles, equipment, or pedestrian traffic within fenced area.
   3. Maintain fenced area free of weeds and trash.

C. Do not excavate within tree protection zones, unless otherwise indicated.

D. Where excavation for new construction is required within tree protection zones, use approved air spade.
   1. Cover exposed roots with burlap and water regularly.
   2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
   3. Backfill with soil as soon as possible.

E. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.
   1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damaged trees and shrubs.
   2. Replace trees that cannot be repaired or restored to full-growth status, as determined by Architect.

F. Remove obstructions, trees, shrubs, grass and other vegetation to permit installation of new construction.
   1. Do not remove trees, shrubs, and other vegetation indicated to remain.
   2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
   3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches (450 mm) below exposed subgrade.
   4. Use only air spade for excavation within tree protection zone.
   5. Dispose of all removed tree branches off-site.

G. Fill depressions caused by clearing and excavation operations with an approved topsoil material.

PART 2 - PRODUCTS (not applicable)

PART 3 - EXECUTION

3.1 REGRADING

A. Grade Lowering: Where new finish grade is indicated below existing grade around trees, slope grade beyond tree protection zones. Maintain existing grades within tree protection zones.

B. Grade Raising: Where new finish grade is indicated above existing grade around trees, slope grade away from trees as recommended by arborist, unless otherwise indicated.

C. Minor Fill: Where existing grade is 6 inches or less below elevation of finish grade, fill with decomposed pine bark. Place bark in a single uncompacted layer and hand grade to required finish elevations.

3.2 TREE PRUNING

A. Prune trees to remain that are affected by temporary and permanent construction.

B. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.

C. Pruning Standards: Prune trees according to ANSI A300 Part I and as follows:
1. Specialty Pruning: Type II Pruning.

D. Cut branches with sharp pruning instruments; do not break or chop.

E. Dispose of all removed tree branches off-site.

3.3 TREE REPAIR AND REPLACEMENT

A. Promptly repair trees damaged by construction operations within 24 hours. Treat damaged trunks, limbs, and roots according to arborist's written instructions.

B. Remove and replace trees indicated to remain that die or are damaged during construction operations that an arborist determines are incapable of restoring to normal growth pattern.
1. Provide new trees of same size and species as those being replaced; plant and maintain.
2. Damaged trees more than 6 inches in caliper size, measured 12 inches above grade, are required to be replaced. Provide new trees of 6-inch caliper size and of a species selected by Architect.

C. Aerate surface soil, compacted during construction, 10 feet beyond drip line and no closer than 36 inches to tree trunk. Drill 2-inch diameter holes a minimum of 12 inches deep at 24 inches o.c. Backfill holes with an equal mix of augered soil and sand.

3.4 DISPOSAL OF WASTE MATERIALS

A. Burning is not permitted.

B. Disposal: Remove excess excavated material and displaced trees from Owner's property.

3.5 UTILITY EXECUTION "PIPED UTILITIES"

A. Install piping and conduit by utilizing directional drilling under parking lots, under streets, existing trees and shrubs, and any other obstructions that cannot be disturbed as indicated on Drawings.

END OF SECTION 02231

SECTION 02300 - EARTHWORK

PART 1 – GENERAL

1.1 SUMMARY

A. Scope: The work included in this section of the specifications includes all labor, materials, equipment, and services necessary for preparing of subgrades for building foundations, slabs, as shown on the drawings.

B. Excavating and Backfilling for Mechanical/Electrical Work: Refer to Divisions 15 and 16 sections for excavation and backfill required in conjunction with underground mechanical and electrical utilities and buried mechanical and electrical appurtenances.

C. Excavation consists of removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed.

D. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be at Contractor's expense.

1. Backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Architect.

1.2 QUALITY ASSURANCE

A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

B. Testing and Inspection Service: The Contractor shall employ and pay for a qualified independent geotechnical testing laboratory to perform soil testing and inspection service during earthwork operations.

1.3 PROJECT CONDITIONS

A. Site Information: Data in subsurface investigation reports was used for the basis of the design and are available to the Contractor for information only. Conditions are not intended as representations or warranties of accuracy or continuity between soil borings. The Owner will not be responsible for interpretations or conclusions drawn from this data by Contractor.

1. Additional test borings and other exploratory operations may be performed by Contractor, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.

B. Existing Utilities: Locate existing underground utilities in areas of excavation work. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.

1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective service and facilities in operation. Repair damaged

utilities to satisfaction of utility owner.

2. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.

C. Use of Explosives: Use of explosives is not permitted.

D. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.
   1. Operate warning lights as recommended by authorities having jurisdiction.
   2. Protect utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Backfill and Fill Materials: Mississippi River pumped sand (sugar sand) free from organic matter.

PART 3 - EXECUTION

3.1 SITE PREPARATION

A. Site preparation shall include removal of all existing surficial features such as buildings, pavements, utilities, etc., limited tree removal, stripping of existing surficial soils, some limited cutting and filling in some areas to establish final grades.

B. All existing structures shall be removed including all underground foundation elements. Existing asphalt and concrete pavement slabs as indicated on the drawings shall also be removed. Trees, including their entire root systems shall be removed.

3.2 EXCAVATION

A. Excavation is unclassified and includes excavation to subgrade elevations indicated, regardless of character of materials and obstructions encountered.

3.3 STABILITY OF EXCAVATIONS

A. General: Comply with local codes, ordinances, and requirements of agencies having jurisdiction.

B. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

C. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.

D. Provide permanent steel sheet piling or pressure-creosoted timber sheet piling wherever subsequent removal of sheet piling might permit lateral movement of soil under adjacent structures. Cut off tops a minimum of 2'-6" below final grade and leave permanently in place.

3.4 DEWATERING

A. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or runoff areas.

Do not trench excavations as temporary drainage ditches.

3.5 EXCAVATION FOR STRUCTURES

A. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection.
1. Excavations for footings and foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Structures: Conform to elevations and dimensions indicated within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection. Do not disturb bottom of excavations, intended for bearing surface.

3.6 BACKFILL AND FILL

A. General: Place select soil material in layers to required subgrade elevations, using materials specified in Part 2 of this Section.
1. Do not backfill trenches until tests and inspections have been made and backfilling is authorized by Architect. Use care in backfilling to avoid damage or displacement of pipe systems.

B. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterprofing, and perimeter insulation.
2. Inspection, testing, approval, and recording locations of underground utilities have been performed and recorded.
3. Removal of concrete formwork.
4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.
5. Removal of trash and debris from excavation.
6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

3.7 PLACEMENT AND COMPACTION

A. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

B. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.

C. Control soil and fill compaction, providing minimum percentage of density specified. Correct improperly compacted areas or lifts as directed by Architect if soil density tests indicate inadequate compaction.

D. Percentage of Maximum Density Requirements:
   1. Fill materials shall be compacted from lifts not exceeding 8 in. in loose thickness to not less than 95 percent of standard Proctor (ASTM D 698) maximum dry density at moisture contents within 3 percentage points of the optimum water content. Fill and backfill materials placed in confined areas such as utility trenches and compacted using hand operated tampers will require the same compactive effort but the loose lifts shall not exceed 5 in. in thickness. Stability must be evident during compaction of each lift before any subsequent lifts of fill materials are added.
   2. Fill soils adjacent to within about 3 ft of retaining or subgrade walls shall be hand compacted as required to prevent imposition of excessive lateral pressures on the walls by heavy compaction equipment. These backfill soils shall be placed in loose lifts having a 5-in maximum thickness and compacted to not less than 95 percent of standard Proctor maximum dry density (ASTM D 698). The remainder of the backfill shall be compacted as indicated above.

3.8 GRADING

A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes.

C. Grading Surface of Fill Under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation.

D. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density.

3.9 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction: Allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed as required by

Architect.

1. Perform field density tests in accordance with ASTM D 1556 (sand cone method).
2. Confirm suitability of select fill material by Atterberg Limit tests at the rate of at least one test per 500 cubic yards.

B. Building Slab Subgrade: Perform at least one field density test of subgrade for every 5,000 sq. ft. of building slab.

1. In each compacted fill layer, perform field density test, as indicated above.
2. If in opinion of Architect, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, perform additional compactio and testing until specified density is obtained.

3.10 MAINTENANCE

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.

C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.

3.11 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Removal from Owner's Property: Remove waste materials, including excavated material, trash, and debris, and dispose of it off Owner's property.

END OF SECTION 02300

SECTION 02361 - TERMITE CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Soil treatment with termiticide.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include the EPA-Registered Label.

B. Product certificates.

C. Soil Treatment Application Report: Include the following:
   1. Date and time of application.
   2. Moisture content of soil before application.
   3. Brand name and manufacturer of termiticide.
   4. Quantity of undiluted termiticide used.
   5. Dilutions, methods, volumes, and rates of application used.
   6. Areas of application.
   7. Water source for application.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located.

B. Regulatory Requirements: Formulate and apply termiticides according to the EPA-Registered Label.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
   1. Warranty Period: Five years from date of Substantial Completion.

1.5 MAINTENANCE SERVICE

A. Continuing Service: Beginning at Substantial Completion, provide 12 months' continuing service including monitoring, inspection, and re-treatment for occurrences of termite activity.

Provide a standard continuing service agreement. State services, obligations, conditions, and terms for agreement period; and terms for future renewal options.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT

A. Termiticide: Provide an EPA-registered termiticide complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

PART 3 - EXECUTION

3.1 PREPARATION

A. General: Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

3.2 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.
   1. Slabs-on-Grade: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
   2. Foundations: Adjacent soil including soil along the entire inside perimeter of foundation walls, along both sides of interior partition walls, around plumbing pipes and electric conduit penetrating the slab, and around interior column footers, piers, and chimney bases; also along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
   3. Crawlspaces: Soil under and adjacent to foundations as previously indicated. Treat adjacent areas including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
   4. Masonry: Treat voids.
   5. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.

B. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

C. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

D. Post warning signs in areas of application.

E. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 02361

SECTION 02455 - DRIVEN PILES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Furnish all labor, materials, tools, and equipment, and perform all operations necessary for piling work indicated or specified.

B. This Section includes the furnishing and driving of the following types of piling:
1. Wood-Concrete Composite Piles.

1.2 DAMAGE TO EXISTING PROPERTY

A. Investigate the existing adjacent buildings, sewers, and utilities. Take proper and necessary precautions to protect those things from damage due to the execution of the Piling work. Should damage occur due to the Contractor's negligence, responsibility and cost for repairing or replacing the work in its original condition shall be borne by the Contractor, without additional compensation.

1.3 SUBSURFACE INFORMATION

A. Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that the Contractor will be responsible for all interpretations or conclusions which he draws from the subsurface information. Data are made available in the office of the Architect for the convenience of Contractor.

B. Additional soil borings and other exploratory operations may be made by Contractor at no cost to Owner.

1.4 QUALITY ASSURANCE

A. The Contractor shall employ an independent testing laboratory to perform the following:
1. Untreated Timber Piles: Inspect at source of supply and hammer mark in the butt to indicate conformance with the requirements of these specifications.
2. Logging of pile driving: Log the driving of all piling and record the following:
   a. Date driven.
   b. Hammer description.
   c. Dimensions of piles.
   d. Location of pile.
   e. Number of blows per foot for full length of pile.
   f. Length of time required for each sequence of the work, such as drilling, driving, splicing, etc.
   Submit driving records daily, no later than morning after driving.
3. Concrete Fill for Piles:

a. Inspect shell of composite piles immediately prior to placing concrete.
b. Perform all inspections and testing specified in Section 03300.

4. Vibration Study: During the driving of all piles, the laboratory shall monitor and record the vibrations to adjacent and surrounding areas. The laboratory shall employ the services of a vibration specialist engineer who in conjunction with the laboratory shall render complete reports and interpretations of the data obtained, including the possible effects of the measured vibrations on adjacent and surrounding structures. The vibrations shall be measured by means of a portable Seisomograph which directly measures particle velocity (rate of ground movement) in three mutually perpendicular directions (longitudinal, transverse, and vertical). Probes shall be located at various locations as directed. In addition to daily reports, a complete report of the vibration study, including seismograms, shall be furnished after the conclusion of the driving of the all piles.
5. Pile Load Tests: The Testing Laboratory shall perform two load tests. Load tests shall meet the requirements of the 2003 International Building Code. Laboratory shall furnish an accurately calibrated hydraulic jack with a capacity of not less than 100 tons which shall be installed by the Contractor as directed by the Laboratory.
6. Loading Procedure for Wood-Concrete Composite Pile: Shall be as follows:
Begin Load Tests no sooner than fourteen (14) days after driving piles to be tested, and reaction piles.

Increment		Load (Tons)	
1		5	
2		10	Hold each increment
3		15	1 thru 5, 1-hour
4		20	free of movement
5		25	
6	Begin Rebound	20	
7		15	
8		10	Hold each decrement
9		5	6 thru 9, 15 minutes.
10		0	Hold 1-hour free of movement .
11	Begin Reload	5	
12		10	Hold each decrement
13		15	11 thru 15, 15 minutes.
14		20	
15		25	Hold each increment
16		30	16 thru 30, 1-hour
17		32	free of movement
18		34	
19		36	If pile begins to fail
20		38	before reaching 50 tons,
21		40	rebound in 4 equal
22		42	decrements from failure load.
23		44	
24		46	

25	48	
26	50	
27	52	
28	54	
29	56	
30	58	5 ton increments to failure. Hold each increment 1-hour free of movement. After failure, rebound in 4 equal decrements from failure load.

1.5 TEST PILE PROGRAM

A. General: Test pile program shall be performed before proceeding with the remaining piles. Notify Architect/Engineer 48 hours prior to driving exploratory piles.

1.6 EXPLORATORY PILES

A. The Contractor shall furnish and drive in locations shown on the drawings fifteen (15) exploratory piles. Except as specified following, these piles must meet all requirements for piling as set forth in these specifications and shall not be part of the permanent foundation. Exploratory piles shall consist of a 50' long untreated wood pile and a 20' long composite steel shell section. Timber piles shall have tip and butt diameters no more than 1/2" larger than the minimum specified. The shell for the concrete section of pile shall be long enough to extend a minimum of five (5) feet above existing grade. The location of the last 3 exploratory piles will be determined by the Architect after the first 12 are driven.

1.7 LOAD TESTS

A. The Contractor shall set up for load test two exploratory piles. The load shall be applied by means of an accurately calibrated hydraulic jack acting concentrically with the head of the pile. All materials required for testing, (including reaction piles, frame, cap plate, etc.) with the exception of the hydraulic jack, shall be furnished and installed by the Contractor. The hydraulic jack shall be furnished by the testing laboratory and installed by the Contractor. Load test shall be performed a minimum of 14 days after driving exploratory piles and reaction piles for the wood concrete piles. The use of a static load to resist the jacking will not be permitted. Reaction piles must be used. Reaction piles shall be no closer than six (6) feet to the test pile for the wood-concrete composite pile tests.

PART 2 - PRODUCTS

2.1 WOOD - CONCRETE COMPOSITE PILES

A. Untreated Timber Section: Shall be ASTM Designation D25 (latest revision) round timber piles, rough peeled, Southern Pine with a 7" minimum tip diameter and a minimum 12" diameter 3' from the butt as shown on the drawings. Untreated timber piles shall be 48 feet

long.

B. Shell for Concrete Section: Shall be steel of sufficient strength to prevent distortion during driving of the pile or adjacent piles. The shell shall be a minimum of 11 inches (I.D.) and sufficiently water tight to exclude water and foreign matter during the placing of concrete. The connector shall be manufactured or fabricated of structural grade steel and shall consist, in general, of a drive-shoe of twelve (12) gauge or thicker material which is firmly attached to the steel casing. The drive-shoe shall be capable of penetrating a minimum of four (4) inches into the wood section. All other requirements for the connector shall conform to the requirements of the New Orleans Building Code. The splice shall withstand a minimum moment capacity of 4 foot kips, with no applied axial load. The splice shall withstand a minimum tensile force of 10 tons.

C. Concrete: Concrete for cast-in-place upper section of composite piles shall be in accordance with Section 03300 of these specifications. Concrete shall have a compressive strength of 4,000 psi at 28 days, except for exploratory piles which shall have a compressive strength of 4,000 psi at 14 days.

D. Reinforcing Steel: Where required by the drawings, shall conform to Section 03300 of these specifications.

E. Contract Length: Piles shall be driven to a tip elevation (-) 60.0 feet.

PART 3 - EXECUTION

3.1 HANDLING

A. Piles shall be carefully handled to prevent damage to timber piles and composite pile casings.

3.2 EQUIPMENT

A. Driving equipment is subject to the Architect's approval. Architect will reject equipment if in his opinion, at any time, the equipment does not perform its intended task adequately.

3.3 PREDRILLING

For each pile, drill a hole by the wet-rotary process (using a 3-blade 6" diameter Demon SH-800 bit) to Elevation (-) 10.0 feet. Immediately thereafter drive the pile into the drilled hole. Use a minimum amount of water during the drilling operations. The Architect may require the Contractor to change the depth and size of predrill. Changes to the size and depth of predrill shall be made at no additional cost to the Owner.

3.4 HAMMERS

A. Use a Vulcan No. 1 hammer (15,000 ft. lbs. per blow) for the wood-concrete composite piles.

3.5 DRIVING PROCEDURE

A. Driving shall be done with fixed leads that shall hold the pile firmly in position and in alignment with the hammer. The top of each pile before driving shall be cut at right angles to the longitudinal axis of the pile. The top of the pile shall be protected with a standard steel hood or similar-type device which will prevent damage to the pile during driving.

B. Drive continuously (except for time required for splicing) until proper penetration as determined by the Architect is obtained.

C. When pile is spliced and lower section of pile is allowed to remain in ground without completing driving of upper section for a period of time which renders the driving of the completed pile impossible without damage to the pile, furnish and drive additional piles as directed by Architect without additional compensation to Contractor.

D. Make field splice a sufficient distance above the ground surface to insure viewing of splice for complete seating prior to splice being driven below ground surface.

E. The upper portion of wood-concrete composite piles shall be driven with a mandrel.

3.6 LOCATION

A. Piles shall be driven plumb and accurately into positions shown on Drawings: a maximum variation not exceeding 2" for each pile will be accepted as fulfillment of Contract, providing limiting and controlling conditions make it impossible to maintain more accurately the spacing indicated on plans. Should the variations from true center exceed the above, the piles in each cluster shall be plotted by the Contractor and the center of gravity of said cluster determined. If required, sufficient pile shall then be added at locations determined by the Architect. Contractor shall, at his own cost, drive such additional piling and/or alter pile caps as may be required to compensate for or to rectify the conditions brought about by failure to preserve proper spacing, whether this defect is discovered before or after cutting off.

3.7 DEFECTIVE PILES

A. Immediately remove and replace a pile that is damaged, deflected, broken, or which cannot be driven to proper elevation. Replace such pile with an acceptable substitute pile at the location determined by the Architect. In the event that such pile's removal should prove to be impossible, abandon the defective pile; replace with an additional pile(s) driven close to the worthless one as directed by the Architect.

3.8 PLACING CONCRETE FOR COMPOSITE PILES

A. Shell of wood-concrete composite pile shall be clean of all earth and debris and must be dry prior to placing concrete.

B. Concrete shall not be placed until the shell has been inspected by the testing laboratory representative immediately prior to filling.

3.9 CUTOFF

A. Piles shall be cut-off on a neat horizontal plane and the cut-off portions shall be removed from the jobsite.

3.10 MISSING PILES

A. Contractor shall be held responsible for any pile omitted; and missing piles at whatever stage of work discovered shall be provided without extra cost to the Owner.

END OF SECTION 02455

SECTION 02500 - PAVEMENT BASE & SUBBASE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included:
1. Furnish and place embankment on a prepared surface.
2. Furnish and place select base and subbase materials on a prepared surface.

1.2 DEFINITIONS

A. Base
1. Base is the surface or plane directly beneath the pavement.
2. Base material is that material which is placed between the pavement and the subbase or subgrade.

B. Subbase
1. Subbase is the surface or plane that lies directly below the base material and separates the base material from the subgrade material.

C. Subgrade
1. Subgrade is the surface or plane, which lies below the base or subbase materials and separates the embankment from the natural ground.
2. Subgrade soils are the existing insitu soils.

D. Embankment
1. Embankment is the selected soil used to build the pavement section and lies below the base or subbase.

1.3 REFERENCED SPECIFICATIONS

A. Unless otherwise specified herein all work and material shall conform with the requirements of the L.D.O.T.D. "Louisiana Standard Specifications for Roads and Bridges", 2000, Section 301 and related specified sections.

B. Other Standards
1. L.D.O.T.D. "Louisiana Standard Specifications for Roads and Bridges", 2000 edition as amended.
2. A.S.T.M. American Society of Testing Materials
3. A.C.I. American Concrete Institute
4. A.A.S.H.T.O. American Association of State Highway and Transportation Officials "Standard Specifications for Transportation, Materials and Methods of Sampling and Testing".

1.4 QUALITY ASSURANCE

A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

B. Testing and Inspection Service: The Owner shall employ and pay for a qualified

independent testing laboratory to perform sampling, testing, and inspection service during earthwork operations.

PART 2 - MATERIALS

2.1 REQUIRED SPECIFICATIONS

A. Embankment
1. Selected non-plastic embankment soil shall be noted on the plans as "Select N.P." and shall conform to L.D.O.T.D. Paragraph 203.09.
2. Sand: Where noted, sand shall be a natural deposit or pumped material with 95% by weight falling between the No. 16 and the No. 200 screen sieve. It shall have a maximum liquid limit of 25 and a maximum plasticity index of 6 and be free of trash, roots and weeds.
3. All other embankment material shall conform to the requirements of La.D.O.T.D. Section 301.01.

B. Base Material
1. Sand base course for PCC pavement shall comply with the requirements of Paragraph A2 above.
2. Crushed concrete for asphaltic pavement shall conform with the requirements of A.S.T. M. 2940.

C. Geofabrics where shown to be used shall conform to the following requirements.
1. Geotextile shall be Mirifi 600x, Amoco 4552, or Contek C300.
2. Geogrid shall be Tensar BX1100 or Tenax LB030TPJ.
3. Geofabrics will be installed in accordance with manufacturer's recommendations.
4. Where cut for installation of utilities geofabrics will be replaced in accordance with design requirements.

D. Subbase Material
1. The subbase course for asphaltic pavements shall be a minimum of eighteen (18) inches of A-3 material compacted to ninety-seven (97) percent standard proctor (A.S.T.M. D-698) density.

E. Subgrade Material
1. All subgrade material which will not satisfactorily compact, shall be removed and replaced with material that will compact satisfactorily. The subgrade shall be brought to line and grade and the top six (6) inches compacted to ninety-five (95) percent of maximum density based on A.S.T.M. D-698..

PART 3 - EXECUTION

A. All work shall be in conformance with the requirements of L.D.O.T.D. unless noted otherwise.
1. The density requirement for sand used as a base for PCC pavement shall be a minimum of 97% of maximum density as determined by A.S.T.M. D698.
2. The density requirement for crushed concrete base course for asphaltic pavement shall be 96% of maximum dry density based on A.S.T.M. D1557.

B. Subgrade

1. Proof roll subgrade prior to placement of subbase or base course. Subgrade shall be compacted to a minimum density of 95% of maximum dry density based on A.S.T.M. D698.

C. Testing
1. Testing shall include materials classification, moisture density curves, field density testing, and thickness measurements of compacted soil layers.

END OF SECTION 02500

SECTION 02513 - ASPHALTIC CEMENT CONCRETE PAVEMENT

PART 1 - General

1.1 DESCRIPTION

A. Work included:
1. Designing, Mixing, Hauling, spreading and compacting the asphaltic cement concrete.
2. LaDOTD Section 501, "Asphaltic Concrete Mixtures"
3. LaDOTD Section 503, "Asphaltic Concrete Equipment and Processes"
4. LaDOTD Section 504, "Asphaltic Tack Coat"
5. LaDOTD Section 505, "Asphaltic Prime Coat"
6. LaDOTD Section 506, "Asphaltic Curing Membrane"
7. LaDOTD Section 506, "Asphaltic Surface Treatment"
8. LaDOTD Section 509, "Cold Planing Asphaltic Pavement"

B. Work not included:
1. Base repair and drainage.
2. Curbs & gutters.

1.2 QUALITY ASSURANCE

A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

B. Testing and Inspection Service: The Owner shall employ and pay for a qualified independent testing laboratory to perform testing and inspection.

PART 2 - MATERIALS

A. Unless otherwise noted on the plans Asphaltic cement concrete shall conform with all of the requirements of "Louisiana Standard Specifications for Roads and Bridges", 2000 Edition and the Supplemental Specifications approved by of L. D.O.T.D. for the various types shown on the plans.

PART 3 - EXECUTION

A. All work shall be in conformance with the requirements of L.D.O.T.D., unless otherwise noted.
B. Testing shall include plant and field inspection and testing including field cores for thickness and density.

END OF SECTION 02513

SECTION 02516 - PORTLAND CEMENT CONCRETE PAVEMENT FOR STREETS

PART 1 - GENERAL

A. Work Included:
   1. Construction of all streets and roadways shown on the plans in close conformity with these specifications and the lines, grades, slopes, sections, thickness, strength and locations.

PART 2 - MATERIALS

A. Cement shall conform to A.S.T.M. C150-75, Type I Specifications.

B. Coarse aggregate shall be clean, hard, durable rock or gravel. Coarse aggregate shall conform to A.S.T.M. C33-latest specifications. Gradation shall be according to size number 467 or number 57.

C. Fine aggregate shall be clean natural sand and shall conform to A.S.T.M. C33-77 specifications.

D. Water used in mixing concrete shall be potable water fit for human consumption.

E. Admixtures
   1. Air-entraining admixtures shall conform to A.S.T.M. C260-74 specifications.
   2. Water-reducing admixtures shall conform to A.S.T.M. C494-77 specifications.
   3. Water reducing retarding admixtures shall conform to A.S.T.M. C494, Type C.
   4. Superplasticizer shall conform to A.S.T.M. C494-92 Type F water reducing, high range admixture.

F. Curing compound shall be a white-pigmented impervious membrane. Curing compound shall conform to A.S.T.M. C309-74, Type 2 specifications.

G. Tie bars shall be deformed concrete reinforcing steel conforming to A.S.T.M. A615-76, Grade 40 specifications. Tie bars shall be secured by two metal stakes.

H. Welded wire fabric shall conform to A.S.T.M. A185-73 specifications.

I. Joint Sealing Compounds
   1. For use only in sealing roadway pavement joints in 6" thick pavement, use hot poured rubberized asphaltic type in compliance with L.D.O.T.D. 1005.02a.
   2. Joint sealant for 8" and thicker pavement shall be a combination insert and neoprene sealant installed in strict conformance with manufacturers recommendations.

J. Metal parting strips used to form keyed joints shall be 16 gauge plain, painted or galvanized steel shaped as shown on the plans. Metal parting strips shall have punched holes for tie-bars and supporting pins and conform to the dimensions shown on the plans. Lap parting strips two-inch (2") minimum.

K. Expansion joint filler shall be clear heart redwood, clear all heart western red cedar, Idaho white pine, western white spruce, northern white pine, sugar pine, western hemlock or white fir.

All species other than redwood and cedar shall be treated with preservatives. Occasional medium surface checks will be permitted provided that the board is free of any defects that will impair its usefulness for the purpose intended. No board of a length less than six feet (6') can be used and the separate pieces shall be held securely to form a straight line.

1. The preservative treatment of wood other than redwood and cedar shall be ammoniacal copper arsenate or chromated copper arsenate conforming to A.W.P.A. P5 with a minimum retention of 0.4 p.c.f.
2. The dimensions shall be as specified with a tolerance of 1/16" thickness, 1/8" depth and plus or minus ¼" length.
3. The load required to compress the material in an oven dry condition to fifty percent (50%) of its original thickness shall not exceed eighteen hundred (1800) pounds per square inch.

L. Load Transfer Devices

Load transfer devices shall conform to the types and details shown on L.D.O.T.D. Standard Plan No.CP-01-3 sheets.

In addition to the various joints shown on CP-01 an additional joint can be used where shown on the plans. This joint Type D is a Dummy Joint and shall conform to the details of joint Type LJ without the tie bars or supports.

M. Forms: Straight side forms shall be made of metal having a thickness of not less than 7/32 inch and shall be furnished in sections not less than ten (10) feet in length. On curves with a radius greater than one hundred fifty (150) feet straight forms of shorter lengths will be permitted. The forms shall contain provisions for locking the ends of abutting form sections together tightly and for secure setting.

N. The specified twenty-eight (28) day compressive strength (f'c) shall be 4000 psi. Concrete shall be designed with a water-reducing admixture and the slump shall not exceed four (4) inches.

1. Mixing and proportioning concrete – Concrete mix design. Concrete shall e proportionate to produce a minimum compressive strength of four thousand (4000) P.S.I. at 28 days. The minimum cement content shall be five and one-half (5 1/2) bags (94) lbs./bag) of cement per cubic yard with a minimum water cement ration of six (6) gallons of water per bag. Slump of the concrete shall range from two (2) inches to four (4) inches when using a vibrating screen and from one (1) inch to two and one-half (2 ½) inches when using a slip form paver.
2. When high early strength is required, a high range water-reducing admixture (superplasticizer) shall be used. The concrete mix prior to the addition of the superplasticizer shall not exceed 3".

B. If the concrete temperature measured at the point of discharge can be reasonably expected to exceed eighty-five (85) degrees F, a water reducing, retarding admixture (A.S.T.M. C494 Type D) shall be used.

C. The actual determination of mix design proportions shall be made by the Testing Laboratory and submitted to the Architect and Civil Engineer no later than 72 hours prior to concrete placement. No concrete shall be placed until the mix design has been reviewed and approved.

D. Except as modified herein, ready-mixed concrete shall meet all of the requirements of A.S.T.M. C94-latest revision. All methods, means, and equipment used to produce and deliver the concrete shall also meet A.S.T.M. C94-latest revision specifications.

E. The Contractor shall provide and maintain a process control system that will provide reasonable assurance that all materials, products and completed construction submitted for acceptance conform to contract requirements. The Contractor's process control activities and tests shall be documented and shall be available for review by the Architect and Civil Engineer throughout the duration of the Contract. Copies of all charts and records documenting the Contractor's process control activities and tests shall become the property of the Engineer upon completion of the work. All conforming and non-conforming test results shall be promptly recorded on approved forms or charts. The Engineer shall be provided a copy of the test results as they are completed during the performance of the work. The Contractor shall take prompt action to correct any errors, equipment malfunctions, process changes which have resulted or could result in the submission of materials, products, and completed construction which does not conform to the requirements of these provisions.

PART 3 - EXECUTION

A. Formwork
1. Formwork shall be properly anchored and secured prior to ordering and placement of concrete. Any movement of the forms will be cause for terminating the paving operations.

B. Placing and Finishing Concrete
1. Conditioning of Subgrade or Base Course: The subgrade or base course shall be brought to proper cross section. High areas shall be trimmed to proper elevation. The finished grade shall be maintained in a smooth and compacted condition until the pavement is placed. No concrete shall be placed until the subgrade or base course has been approved.
2. The subgrade or base course shall be uniformly moist when concrete is placed. If it becomes too dry, the subgrade or base course shall be sprinkled, but the method of sprinkling shall not be such as to form mud or pools or water.
3. Placing Concrete: The concrete shall be deposited on the grade in such a manner as to require as little rehandling as possible. All equipment shall be so designed and operated as to assure placing and spreading of concrete without segregation. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels or other approved tools, excluding rakes.
4. Concrete shall be consolidated by use of a vibrating screed or internal vibrators approved by the Engineer.
5. Concrete shall not be placed on a frozen subgrade, when the air temperature is below freezing, or when the air temperature is expected to go below thirty-two (32) degrees F within twelve (12) hours.
6. The pavement shall be of the size and shape shown on the plans including integral curb, and shall consist of one course of concrete with joints, dowels, etc., as called for in the plans.
7. Final strike-off, consolidation and finishing shall conform to the requirements of L.D.O.T.D. 601.08 except metal tine texturing will not be required. The surface texture shall be a broom finish.
8. Tolerance for surface smoothness shall be as stated in Part 7B.
9. Split slab construction, if used, will require forms on each side of the slab. The side of the slab to be joined to a later placement will have a metal keyed joint and tie bars. Heavy equipment, including batch trucks, will not be allowed on the base next to the fresh concrete until it is a minimum of twenty-four (24) hours old.
10. Heavy equipment including batch trucks will not be allowed on the split slab for a minimum of fourteen (14) days after it has been placed, unless a superplasticizer is used with Engineer's approval and the proper number of cylinders is obtained and

tests show a minimum of 3500 psi. The Engineer can extend the time period that the slab will not be used until the twenty-eight (28) day test results are available.

11. Curbs, if formed and poured separately, will be secured to the slab with tie bars. The surface of the slab that will receive the curb will be rough finished. After the curb is placed and finished it shall be cured with white pigmented curing compound. Concrete used for curbs shall be the same as concrete used for the slab. Prior to placement of the curb, the area to receive the curb shall be brushed clean and moistened.
12. Concrete whose temperature is ninety-five (95) degrees F or greater at the time of placement and concrete not deposited within one and one-half (1½) hours after the initial introduction of the mix water shall be rejected and not used in the work.
13. Final Strike-Off, Consolidation and Finishing Sequence: The sequence of operations shall be the strike-off and consolidation floating and removal of laitance, straight edging and final surface finish.
14. After concrete has been placed and vibrated adjacent to joints as required, the finishing machine shall be brought forward, operating in a manner to avoid damage or misalignment of joints.
15. Machine Finishing: Vibrators for full width vibration of concrete paving slabs shall not be operated longer than fifteen (15) seconds in one location.
16. Hand Finishing: Unless otherwise specified, hand-finishing methods will not be permitted except under the following conditions:
    a. In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs.
    b. Pavement widths not exceeding sixteen (16) feet or areas of irregular dimensions where operation of the mechanical equipment is impractical may be finished by hand methods.
17. Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used.
18. Consolidation shall be attained by the use of a suitable mechanical vibrator or other approved equipment.
19. Floating: After the concrete has been struck off and consolidated, it shall be further smoothed, trued and consolidated by means of a float, using an acceptable method.
20. Straightedge Testing and Surface Correction: After floating has been completed and excess water removed, but while the concrete is still plastic, the surface of the concrete shall be tested for trueness with an accurate ten-foot straightedge swung from handles approximately three (3) feet longer than one-half (½) the width of the slab. The straightedge shall be furnished and used by the Contractor. Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated and refinished. High areas shall be cut down and refinished. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and the slab conforms to the required grade and cross section.
21. Final Finish and Texture: Unless otherwise specified, the surface texture shall be a broom finish. It shall be applied when the water sheen has practically disappeared. The booming operation shall be so executed that the corrugations produced in the surface shall be uniform in appearance and not more than one-sixteenth (1/16) inch in depth. Brooming shall be completed before the concrete is in such condition that the surface will be torn or unduly roughened by the operation. The surface thus finished shall be free from rough and porous areas, irregularities and depressions resulting from improper handling of the broom.
22. Edging at Forms and Joints: After the final finish but before the concrete has taken its initial set, the edges of pavement along each side and each side of transverse expansion joints, formed joints and transverse construction joints shall be worked with

an approved tool and rounded to the radius specified. A well-defined, continuous radius shall be produced and a smooth, dense mortar finish obtained.

C. Curing

1. Immediately after completion of the finishing operation and as soon as marring of concrete will not occur, the entire surface of newly placed concrete shall be covered and cured with a white pigmented impervious membrane.
2. The Contractor shall have available at the job site sufficient covering material to cover and properly protect the last hour's pour against the effects of rain. This covering material may be burlap mats, waterproof paper or combined burlap and white polyethylene sheeting. Failure to provide sufficient cover material or to adequately take care of curing requirements shall be cause for immediate suspension of concreting operations.
   Concrete whose surface has been marred by rain shall be paid for at 90% of contract price.
3. Curing compound shall be applied under pressure by mechanical sprayers at the rate recommended by the manufacturer, but in no case less than one (1) gallon per one hundred (100) square feet of surface area. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be stirred continuously by mechanical or other approved means. Hand spraying of odd widths or shapes and on surfaces exposed by the removal of forms will be permitted provided curing compound has been thoroughly agitated prior to placing in the hand sprayer. Curing compound shall be applied to the inside faces of joints to be sealed. In split slab construction, the curing compound shall be applied in such manner as to prevent spraying exposed reinforcing steel.
4. Upon removal of side forms, the sides of the slabs and curbs exposed shall be protected immediately in such manner as to provide a curing treatment equal to that provided for the surface.
5. Curbs not cast integrally with the slab shall be cured in the manner specified above immediately after completion of finishing.
6. The entire surface of concrete to be cured shall be covered by curing compound, leaving no openings of any size including pin holes.

D. Joint Sealing

1. All joints must be sealed within ten (10) days of concrete placement and prior to the passage of any wheeled traffic.
2. Prior to placing sealant remove all loose material assuring that jointing surfaces are clean, dry and structurally sound. Clean joints by removing all materials by wire brushing or as required. Blow clean with compressed air just prior to placing sealant.
3. Follow all requirements of sealant manufacturer.

E. Opening to Traffic

1. Pavement shall not be opened to traffic until twenty-one (21) days after placement without approval of the Engineer.
2. The Contractor shall have full responsibility for the pavement until it is accepted by the Owner. The Contractor must suitably barricade all access to the pavement to prevent use of it by the public or his employees.
3. No traffic shall be allowed on the pavement until all joints have been cleaned and sealed.
4. The pavement may be opened to light traffic when the concrete compressive strength exceeds three thousand (3,000) psi. The pavement may be opened to all traffic when the concrete compressive strength averages four thousand (4,000) psi.

F. Final Inspection

1. The Contractor shall notify the Architect, Engineer, and OWNER forty-eight (48) hours in advance of the time he wishes to have the final inspection. The Construction superintendent shall attend the inspection and have available sufficient labor to open and close manholes, etc.
2. Prior to the final inspection the pavement shall be cleaned and all joints refilled to the dimension shown on the plans, but in no instance will joint filler be allowed to overflow joints.

G. Surface Smoothness Requirements:
1. When tested with a ten (10) foot rolling straightedge by test method L.D.O.T.D. TR618-75 not more than ten (10%) percent of each two hundred (200) linear feet of pavement shall have surface deviations in excess of one-fourth inch (¼").
2. When a greater percentage of a two hundred (200) linear foot segment shows deviation exceeding one-fourth inch (¼") or when roadway areas have deviations in excess of three-eighths inch (3/8"), the deficient areas must be ground down to within the one-fourth inch (¼") tolerance.
3. When the surface deviation exceeds five-eighths inch (5/8") in ten (10) feet the pavement shall be removed and replaced by the Contractor.

H. Thickness Requirements
1. After the pavement has met strength and surface smoothness requirements, it will be measured for thickness and evaluated for acceptance.
2. Pavement thickness will be determined from cores obtained by the testing laboratory in accordance with A.A.S.H.T.O. Designation T148-49 or A.S.T.M. Designation C174-49.
3. One core shall be obtained from each twenty-five hundred (2500) square feet of pavement.
4. The thickness of all of the pavement within the section shall be the thickness or length of the core in that section as measured by the laboratory in strict conformance with the requirements of A.A.S.H.T.O. or A.S.T.M.
6. If the Contractor believes that the thickness of all of the pavement within a section is not truly representative of the one core obtained then, at his expense, he can have the testing laboratory obtain additional cores. The location of the additional core(s) obtained will subdivide the section of the pavement into subsections divided in a like manner. Only one core will be obtained from each section of pavement between transverse joints.
7. Individual sections of pavement found to be deficient in thickness from the thickness specified or shown on the plans will be penalized. The penalty shall consist of a deduction form the contract cost in conformance with the table set for the in paragraph 9 below.
8. Individual sections of pavement found to be deficient in thickness by more than one-half inch (½") shall be evaluated by the Engineer who will make a recommendation to the Architect and Owner to either accept the deficient section of pavement and assess the penalty provided therefore or to require its removal and replacement with pavement of the thickness and strength specified on the plans. The decision will be made by the Owner.

9. Table of Acceptance and Penalty

Thickness as Determined by Cores	Penalty per Square Yard in Dollars
Full Specified Thickness or Greater	0
0.00 to 0.20 Inches Below Specified Thickness	0
0.21 to 0.30 Inches Below Specified Thickness	$4.00
0.31 to 0.40 Inches Below Specified Thickness	$5.00
0.41 to 0.50 Inches Below Specified Thickness	$7.00
0.51 to 0.60 Inches Below Specified Thickness	$12.00 or replace
0.61 to 0.75 Inches Below Specified Thickness	$15.00 or replace

I. Strength Requirements

1. The specified strength (f'c) of the concrete shall be that strength noted on the plans or if not noted shall be four thousand (4,000) psi compressive strength at twenty-eight (28) days. For the pavement to be acceptable, the average of all sets of three consecutive twenty-eight (28) day compressive strength tests shall equal or exceed the specified strength (f'c) with no individual strength test result more than five hundred (500) psi below the specified strength. Each strength test shall be the average of two standard test cylinders molded from the same sample of concrete and tested at the same age.
2. Any section of pavement, where the average of any set of three consecutive tests is below the specified strength (f'c) and any areas of pavement where the average of one set of cylinders show the concrete to be more than five hundred (500) psi below the specified strength, shall be evaluated by the Engineer, and, if in his judgement the deficient areas warrant removal, they shall be removed and replaced with concrete having the strength specified. The section to be removed, and replaced with concrete meeting the strength requirements, shall be that area which lies on both sides of the location that the deficient strength tests were obtained and extending both ways either to the end of the placement, the end of the days placement, or halfway to the location of the next adjacent pair of cylinders tested and meeting the minimum strength requirement.

J. Testing Requirements

1. Testing shall include plant and field inspection and testing, including molded concrete cylinders for testing, curing of cylinders, and testing of cylinders at 7 and 28 days of age. Also included are field cores for thickness verification.

END OF SECTION 02516

SECTION 02528 - CONCRETE WALKS AND CURBS & GUTTERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included:
1. This work consists of furnishing and constructing concrete curbs and gutters in accordance with these specifications and in conformance with lines, grades, dimensions and typical sections shown on the plans.

1.2 REFERENCED SPECIFICATIONS

A. Those parts of the referenced specifications, which as applicable hereto shall be considered as if written herein in full.
1. LaDOTD: "Louisiana Standard Specifications for Roads & Bridges", 2000 Edition, and the Supplemental Specifications approved by LaDOTD.
2. A.S.T.M.
3. A.C.I.
4. A.A.S.H.T.O.

B. Concrete shall conform to requirements of SECTION 02516 – "PORTLAND CEMENT CONCRETE PAVEMENT".

C. Except as included herein or noted on the plan, all work shall conform to the requirements of the referenced specifications listed above.

1.3 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for the proper performance of the work of this section.
1. During all of the time that this work is in progress, the Contractor must have present at the site of the work, a foreman or superintendent who is not operating equipment.

B. Use only equipment, which is specifically manufactured for and properly sized for the work to be performed.

C. Testing and Inspection Service: The Owner shall employ and pay for a qualified independent testing laboratory to perform sampling, testing, and inspection services.

PART 2 - MATERIALS

2.1 Concrete for curbs and gutters shall display a minimum 28-day compressive strength of 4,000 PSI.

2.2 Concrete for sidewalks shall display a minimum 28-day compressive strength of 3,000 PSI.

2.3 All materials and work unless otherwise noted on the plans will comply with all of the requirements of L.D.O.T.D. Section 707 Curbs & Gutters and specified related sections.

PART 3 - EXECUTION

3.1 QUALITY ASSURANCE All work, unless otherwise noted on the plans, shall comply with all requirements of LaDOTD Manual Section 707 Curbs & Gutters and specified related sections.

A. Provide a ¾ inch wide expansion joint with three, ¾ inch smooth steel dowel bars every thirty (30) ft. The dowel bars shall be 36 inches in length. Provide a preformed expansion material throughout the joint.

END OF SECTION 02528

SECTION 02713 - WATER DISTRIBUTION SYSTEM

PART 1 - GENERAL

A. Provisions and requirements of the Sewerage and Water Board of New Orleans Standard Specifications and Standard Drawings shall be followed in the construction of the water distribution system and all water system components.

PART 2 - MATERIALS

A. All materials used in the construction of the water distribution system shall conform to the requirements of the Sewerage and Water Board of New Orleans.

PART 3 - EXECUTION

A. All water line installation shall be in accordance with the requirements of the Sewerage and Water Board of New Orleans.

END OF SECTION 02713

SECTION 02725 - CULVERTS, STORM DRAINS & STRUCTURES

PART 1 - GENERAL

1.1 Description

A. This work consists of furnishing and installing pipe, manholes, junction boxes and catch basins. It includes the excavation of ditches both temporary and permanent.

B. When not in conflict with these specifications the requirements of La.D.O.T.D., "Louisiana Standard Specifications for Road and Bridges", 2000 Edition shall govern.

1.2 Quality Assurance

A. Use adequate number of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

B. Use equipment adequate in type, size, capacity and numbers to accomplish the work in a timely manner.

C. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

Testing and Inspection Service: The Owner shall employ and pay for a qualified independent geotechnical testing laboratory to perform soil testing and inspection.

PART 2 - MATERIALS

2.1 Materials shall conform to the following requirements

	LaDOTD
Usable Soil	203.06(a)
Select Soil	203.06(a)
Plastic Soil Blanket	203.10
Mortar	702.02
Portland Cement Concrete	901
Granular Material	1003.07
Bedding Material	1003.08
Concrete Sewer Pipe	1006.02
Reinforced Concrete Pipe	1006.03
Reinforced Concrete Pipe Arch	1006.04
Gasket Materials	1006.06
Plastic Culvert Pipe	1006.07
Sewer Pipe	1006.07
Split Plastic Coupling Bands	1006.07(b)(6)
Plastic Yard Drain Pipe	1006.09
Coupling Bands	1007.10
Geotextile Fabric	1019
Cast-in-Place Concrete (Class M)	901
Portland Cement	1001.01
Mortar Sand	1003.02(b)
Sewer Brick	1004.01
Asphaltic Varnish	1008.03
Metal Work Paint	1008.05
Reinforcing Steel	1009.01

Precast Reinforced Concrete Drainage Units	1016
Manhole Frames, Grates	1018.04

2.2 Quality Assurance

A. Manufacturing plants will be periodically inspected for compliance with specified manufacturing methods, and material samples will be obtained for laboratory testing for acceptance of manufacturing lots. Materials approved at the manufacturing plant will be subject to visual inspections at the job site or point of delivery.

B. The Contractor may furnish structures of either cast-in-place concrete precast concrete units, or brick where shown on the plans. For precast structures which are not covered by the plans, design and installation procedures must be submitted for approval.

C. Mortar shall consist of one part portland cement, two parts mortar sand, and water as required for proper consistency. Mortar shall be used within 30 minutes after mixing.

2.3 Material Type Abbreviations

A. Reinforced Concrete Pipe:
- RCP Reinforced Concrete Pipe
- RCPA Reinforced Concrete Pipe Arch

B. Corrugated Metal Pipe:
- CAP Corrugated Aluminum Pipe
- CAPA Corrugated Aluminum Pipe Arch
- PCCAP Polymer Coated Corrugated Aluminum Pipe
- PCCAPA Polymer Coated Corrugated Aluminum Pipe Arch
- BCCSP Bituminous Coated Corrugated Steel Pipe
- BCCSPA Bituminous Coated Corrugated Steel Pipe Arch
- PCCSP Polymer Coated Corrugated Steel Pipe
- PCCSPA Polymer Coated Corrugated Steel Pipe Arch

C. Plastic Culvert Pipe:
- PCP Plastic Culvert Pipe
- PVC Polyvinyl Chloride Plastic Pipe
- RPVCCP Ribbed Polyvinyl Chloride Culvert Pipe
- PVCCP Polyvinyl Chloride Culvert Pipe (Smooth Wall)

2.5 Yard Drain Pipe: When the Item for Yard Drain Pipe is included in the contract, the Contractor has the option of furnishing concrete sewer pipe, plastic yard drain pipe or plastic culvert pipe unless otherwise specified.

2.6 Material Requirements

A. All round concrete drainage pipe shall conform in all respects to A.S.T.M. C76, Class III, Wall B, and shall be Bell & Spigot joint with rubber "o" rings.

B. Concrete arch pipe shall conform in all respects to the latest provision of A.S.T.M. C-506, Class III and shall be tongue and groove.

C. Minimum gauge thickness for corrugated steel pipe (see L.D.O.T.D. Table 1) unless otherwise noted on the plans.

PART 3 - EXECUTION

3.1 Convenience to the Public

A. All materials excavated shall be placed so as to interfere as little as possible with public travel. At such street crossings, driveways and other points as may be directed

by the Architect, the trenches shall be bridged in a proper and secure manner so as to prevent any serious interruption of travel upon the roadway or sidewalk and also to afford necessary access to particular public or private premises.

B. Maintain traffic and utility services in area during construction.

3.2 Care of Structures and Utilities

A. The Contractor shall be responsible for all poles, posts, supports, pipes or any other surface and subsurface structures or objects existing along the line of his work within or without the limits of the work, he shall shore or otherwise support them when necessary and shall repair and make good any damage caused thereto by his work. All culverts, bench marks, etc., destroyed or disturbed in the execution of the Contract shall be properly replaced by the Contractor.

B. Care must be taken not to injure any gas or water pipe or sewer connection. The Contractor at his own expense will pay to repair or adjust all water services and any Public or Private utility line damaged by the Contractor which is not in direct conflict with the drainage pipe or structures.

3.3 Laying Conduit

A. Conduit laying shall begin at the downstream end of the line. The conduit shall be in contact with the foundation throughout its length. Bell or groove ends of conduit and outside circumferential laps of reverted metal conduit shall be placed facing upstream. Riveted seam metal conduit shall be placed with longitudinal laps at sides. Conduits in each continuous line shall have the same wall thickness. Metal conduits provided with lifting lugs shall be handled only by these lugs. After conduit has been laid and before backfill is placed, the Engineer will inspect the conduit for alignment, grade, integrity of joints, and coating damage.

B. Joining Conduit:

1. Joint Usage:
   (a) Type 1 (T1) joints shall be used for side drains under drives and similar installations.
   (b) Type 2 (T2) joints shall be used for cross drains under roadways, including turnouts.
   (c) Type 3 (T3) joints shall be used for closed storm drain systems, flumes and siphons.
2. Concrete Conduits: Concrete conduit may be either bell and spigot, or tongue and groove. The method and joining conduit sections shall be such that ends are fully entered and inner surfaces are flush and even. An approved mechanical pipe puller shall be used for joining conduits over 36 inches in diameter. For pipe less than 36 inches in diameter, any approved method for joining conduit may be used which does not damage the pipe. Joints shall conform to Subsection 1006.05, and shall be sealed with gasket material installed in accordance with the manufacturer's recommendations. Types 2 and 3 joints shall be wrapped with geotextile fabric for a minimum of 12 inches on each side of joint for conduit 36 inches or smaller and 18" on each side of the joint for conduit greater than 36 inches in diameter. Ends of the fabric shall be lapped at least 10 inches. The edges and ends of fabric shall be suitably secured for the entire circumstances of the pipe.
3. Metal Conduit: Metal conduit shall be firmly joined by coupling bands. Bands shall be centered over the joint. For Type 1 joints, approved gasket material shall be placed in one corrugation recess on each side of the joint at the

coupling band and on each band connection in such manner to prevent leakage.

When Type 2 or 3 joints are specified, joining of metal conduit sections shall conform to the following provisions:

(a) General: Band joints shall be sealed with gasket material. Gasket material shall be placed in accordance with the plan details. The joint shall be wrapped with geotextile fabric for a minimum of 12 inches on each side of the connecting band for conduit diameters 36 inches or less and a minimum of 18 inches on each side of the connecting band for conduit diameters greater than 36 inches. Ends of fabric shall be lapped at least 10 inches. The edges and ends of fabric shall be suitably secured for the entire circumference of the pipe.

(b) Circular Section: Connecting bands shall be of an approved design and shall be installed in accordance with plan details.

(c) Arch Section: Connecting bands shall be a minimum of 12 inches wide for pipe arch less than 36 inches round equivalent diameter, and a minimum of 21 inches wide for 36 inches round equivalent diameter pipe arch and greater. Bands shall be connected at the ends by approved angle or strap connections. Connecting bands used for 36 inches round equivalent diameter pipe arch and above shall be 2-piece bands.

4. Plastic Culvert Pipe: Joints for plastic culvert pipe shall be either bell and spigot or split coupling bands. Types 2 and 3 joints shall be wrapped with geotextile fabric for a minimum of 12 inches on each side of the joint for pipes 36 inches or less in diameter and for a minimum of 18 inches on each side of the joint for pipes greater than 36 inches in diameter. The ends of the fabric shall be lapped at least 10 inches. The edges and ends of the fabric shall be suitably secured for the entire circumference of the pipe.

(a) Bell and Spigot Type Joint System: The method of joining conduit sections shall be such that ends are fully entered and inner surfaces are reasonably flush and even.

An approved mechanical pipe puller shall be used for joining conduits over 36 inches in diameter. For pipe less than 36 inches in diameter, any approved method for joining conduit may be used which does not damage the pipe.

Joints shall be approved and shall be sealed with a gasket system utilizing gasket material conforming to Subsection 1006.06(a)

C. Backfilling:

1. General: Conduits found to be damaged or out of alignment or grade shall be removed and reinstalled, or replaced, at no direct pay.

2. Side Drain and Conduits: Backfill for side drain conduits for drives, field roads and similar installations shall conform to the following.

(a) Nonpaved Areas: Conduit backfill material, except for plastic culvert pipe, shall be usable soil placed by approved methods and satisfactorily compacted. Plastic culvert pipe shall be backfilled with granular material.

(b) Paved Areas: Conduit backfill material, placement and compaction shall be as specified in Heading (c).

3. Conduits other than Side Drains: Backfill material for conduits, except for plastic culvert pipe, other than side drains for drives, field roads and similar installations shall be selected soil or granular materials. Plastic culvert pipe shall be backfilled with granular material at no direct pay.
When corrugated metal pipe is used, the backfill material shall be tested and shall have a resistivity greater than 1500 ohm-cm and a pH greater than 5 when tested in accordance with DOTD TR 429 and DOTD TR 430 respectively.
If the top of conduit is even with or below the top of the trench, backfill material shall be brought up evenly on both sides of conduit for its fill length to an elevation of 1 foot above the top of conduit (or to subgrade if less than 1 foot) or to natural ground elevation, whichever is greater.
When the top of the conduit is above the top of the trench, backfill material shall be brought up evenly on both sides of conduit for its full length to 1 foot above the top of conduit (or to subgrade if less than 1 foot). Material in the trench and above the top of the trench for a distance on each side of the conduit equal to the horizontal outside diameter and to 1 foot above the top of conduit (or to subgrade if less than 1 foot) shall be backfill material.
The embankment shall be constructed to a minimum of 2 feet over the conduit before heavy construction equipment is allowed to cross the installation. Where practical, installations with less than 2 feet of cover over the top of the conduit shall be constructed after heavy hauling is completed over the conduit location. After completion of hauling operations, the Contractor shall remove excess cover material. Conduit damaged by hauling and backfilling operations shall be removed and reinstalled, or replaced, at no direct pay.
   (a) Backfill Methods:
      (1) General: Compaction by flooding will not be allowed. When plastic culvert pipe is used, the backfill shall be granular materials.
      (2) Selected Soils: Backfill shall be placed at or near optimum moisture content determined in accordance with DOTD TR 418 in layers not exceeding 6 inches compacted thickness. Backfill material shall be thoroughly compacted under the haunches. Each layer shall be compacted by approved methods to a least 95 percent of maximum density prior to placement of a subsequent layer.
      (3) Granular Material: Backfill shall be placed at or near optimum moisture content determined in accordance with DOTD TR 418. Backfill material shall be thoroughly compacted under haunches and then compacted in layers not exceeding 12 inches compacted thickness. Each layer shall be compacted by approved methods to a least 95 percent of minimum density proper to placement of a subsequent layer. Exposed slopes at the conduit ends shall be covered by at least 12 inches compacted thickness of plastic soil blanket.
   (b) Density Requirements: Maximum density will be determined in accordance with DOTD TR 418 and in-place density determined in accordance with DOTD TR 401.

3.4 Inspection of Conduits: After completion of embankment and prior to roadway surfacing, the Engineer shall inspect conduits for proper alignment and integrity of joints. Any misaligned conduit or defective joints shall be corrected by the Contractor at no direct pay.

A. Plastic Pipe: Installed plastic pipe shall be tested to ensure that vertical deflections do not exceed 5.0 percent. Maximum allowable deflections shall be governed by the mandrel requirements stated herein. Deflection tests shall be performed no sooner than 30 calendar days after installation and compaction of backfill. The pipe shall be cleaned and inspected for offsets and obstructions prior to testing. For pipe 36 inches and less in diameter, a mandrel shall be pulled through the pipe by hand to ensure that maximum allowable deflections have not been exceeded. The mandrel shall be approved by the Engineer prior to use. Use of an unapproved mandrel or a mandrel altered or modified after approval will invalidate the test. If the mandrel fails to pass, the pipe is overdeflected. Unless otherwise permitted, overdeflected pipe shall be uncovered and, if not damaged, reinstalled. Damaged pipe shall not be reinstalled, but shall be removed and replaced with new pipe. Any pipe subjected to any method or process other than removal, which attempts, even successfully, to reduce or cure any overdeflection, shall be removed and replaced with new pipe. The mandrel shall be rigid, nonadjustable, odd-numbered legged (minimum 9 legs) mandrel having a length not less than its nominal diameter, The minimum diameter at any point shall be 5.0 percent less than the nominal diameter of the pipe being tested. The mandrel shall be fabricated of steel, fitted with pulling rings at each end, stamped or engraved on some segment other than a runner with the nominal pipe size and mandrel outside diameter, and furnished in a suitable carrying case. For pipe larger than 36 inches in diameter, deflection shall be determined by a method approved by the Engineer. If a mandrel is selected, the minimum diameter, length, and other requirements shall conform to the above requirements.

Mandrel testing shall be conducted by the Contractor in the presence of the Engineer.

B. Metal Pipe: If the inside diameter of metal pipe or rise dimension of metal pipe arch deflects more than 5.0 percent from original dimensions, they shall be removed and reinstalled, unless they do not rebound or are damaged. Pipe or pipe arch which are damaged or do not rebound shall be removed and replaced at no direct pay. Measurement of deflecting will be made by the Engineer away from rerolled ends.

C. Cleaning Conduit: Prior to final acceptance, conduits installed by the Contractor shall be cleansed of all debris and soil to the invert of the conduit. Existing conduits which are extended shall be cleaned of debris and soil to the flow line elevation of the outfall ditch at no direct pay.

3.5 Stubbing and Plugging Conduits: When it is required that conduits be plugged, such plugs shall be constructed of Class R concrete conforming to Section 901. Thickness of plug and method of construction shall be as directed.

When new conduits are to be stubbed into new or existing conduits or other structures, the connection shall be made with approved mortar conforming to 702.02.

3.6 Constructing Manholes, Conflict Boxes, Catch Basins, Etc.:

A. All essential details of construction of structures are shown in the plans. These drawings must be followed. Bricks must be laid in full, close, shove joints of mortar, according to best work standards. Manholes and catch basins shall be plastered on

the inside with a minimum thickness of one-fourth (1/4") inch of mortar. Inverts and benches in manholes shall be surfaced with a one-half (½") inch thick layer of cement mortar.

B. Concrete construction shall conform to Section 805. Joints shall be full mortar joints not more than ½ inch wide. When specified, outside faces of structures shall be plastered with ½ inch thick cement-sand mortar. Exposed surfaces of concrete and masonry shall be cured in accordance with subsection 805.10 for at least 48 hours.

C. Precast concrete units shall be cast with the specified number and size of pipe openings to incorporate the unit into the drainage system; however, if additional pipe is required during construction for which no openings have been provided, the Contractor may make such openings provided any damaged units are replaced or satisfactorily repaired. Precast units shall be set to established grade within ±½ inch. Joints for sectional precast units shall be sealed with flexible plastic gasket material conforming to Subsection 1006.06(b) installed as to form a watertight seal. The joints of precast units shall be wrapped with geotextile fabric a minimum of 18 inches on each side of the joint. Ends of the fabric shall be lapped at least 10 inches. The edges and ends of the cloth shall be suitably secured.

D. Metal frames shall be set in a full mortar bed. Conduit sections shall be flush on the inside of structure wall and project outside sufficiently for proper connection with the next conduit section. Masonry shall fit neatly and tightly around conduit.

E. When grade adjustments of existing structures are specified, frames, covers and gratings shall be reset at required elevation. Metal parts shall be thoroughly cleaned and laced in good repair. In lieu of adjusting structures, the Contractor may adjust structures by means of approved metal adjustment rings.

F. New Structures shall be cleaned of silt, debris or other foreign matter, and nongalvinized metal parts of new or adjusted structures shall be coated with asphaltic varnish or metalwork paint.

G. The structure shall be backfilled in accordance with Subsection 701.08(c)(1). Excavated material not satisfactory for backfill and surplus material shall be disposed of in accordance with Subsection 202.02.

3.7 Backfilling

A. General: Conduits found to be damaged or out of alignment or grade shall be removed and reinstalled, or replaced.

B. Side Drain and Conduits: Backfill for all drain conduits for shall be granular material.

C. When corrugated metal pipe is used, the backfill material shall be tested and shall have a resistivity greater than 1500 ohm-cm and a pH greater than 5 when tested in accordance with DOTD TR 429 and DOTD TR 430 respectively. If the top of conduit is even with or below the top of the trench, backfill material shall be brought up evenly on both sides of conduit for its fill length to an elevation of 1 foot above the top of conduit (or to subgrade if less than 1 foot) or to natural ground elevation, whichever is greater. When the top of the conduit is above the top of the trench, backfill material shall be brought up evenly on both sides of conduit for its full length to 1 foot above the top of conduit (or to subgrade if less than 1 foot). Material in the trench and above the top of the trench for a distance on each side of the conduit equal to the horizontal outside diameter and to 1 foot above the top of conduit (or to subgrade if less than 1 foot) shall be backfill material. The embankment shall be constructed to a minimum

of 2 feet over the conduit before heavy construction equipment is allowed to cross the installation. Where practical, installations with less than 2 feet of cover over the top of the conduit shall be constructed after heavy hauling is completed over the conduit location. After completion of hauling operations, the Contractor shall remove excess cover material. Conduit damaged by hauling and backfilling operations shall be removed and reinstalled, or replaced.

1. Backfill Methods:
   a. General: Compaction by flooding will not be allowed. When plastic culvert pipe is used, the backfill shall be granular materials.
   b. Selected Soils: Backfill shall be placed at or near optimum moisture content determined in accordance with DOTD TR 418 in layers not exceeding 6 inches compacted thickness. Backfill material shall be thoroughly compacted under the haunches. Each layer shall be compacted by approved methods to a least 95 percent of maximum density prior to placement of a subsequent layer.
   c. Granular Material: Backfill shall be placed at or near optimum moisture content determined in accordance with DOTD TR 418. Backfill material shall be thoroughly compacted under haunches and then compacted in layers not exceeding 12 inches compacted thickness. Each layer shall be compacted by approved methods to a least 95 percent of minimum density proper to placement of a subsequent layer. Exposed slopes at the conduit ends shall be covered by at least 12 inches compacted thickness of plastic soil blanket.
2. Density Requirements: Maximum density will be determined in accordance with DOTD TR 418 and in-place density determined in accordance with DOTD TR 401.

3.8 Prior to a request for final inspection and acceptance, all drainage work must be complete. All pipe lines and structures must be clean at the time of the final inspection. The Contractor shall supply labor to open and close manholes and catch basins.

3.9 The Contractor shall arrange for the work to be inspected jointly and concurrently by the Architect, Civil Engineer with representatives of the governmental body having authority over the acceptance of the work.

3.10 Repair of Roadways, Sidewalks, Etc.

A. Asphalt or concrete roadway which has been cut or broken in the course of work, shall be replaced with concrete by the drainage Contractor in conformance with the details shown on the plans.

B. Should the street or sidewalk pavements, curbs, gutters, culverts, or other public works outside the limits specified above, be damaged, cracked, settle, or disturbed or injured in any manner by the work of the Contractor, such damage or injury must be repaired and made good and such pavements, gutters, etc., restored to their former condition.

END OF SECTION 02725

SECTION 02780 - UNIT PAVERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Brick pavers set in mortar setting beds.
   2. Flagstone pavers set in mortar setting beds.

1.2 SUBMITTALS

A. Product Data: For materials other than water and aggregates.

B. Samples for unit pavers and joint materials. .

1.3 QUALITY ASSURANCE

A. Mockups: Build mockups for each form and pattern of unit paver.
   1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or build on frozen subgrade or setting beds.

B. Cold-Weather Requirements for Mortar and Grout: Heat materials to provide mortar and grout temperatures between 40 and 120 deg F (4 and 49 deg C). Protect unit paver work against freezing for 24 hours after installation.

PART 2 - PRODUCTS

2.1 BRICK PAVERS

A. Brick Pavers: Type manufacturered by the soft-mud wood molding process rather than the extrusion process. The face brick shall have black ferrous or other burnt mineral spots irregularly appearing through the body of the brick. The paver brick shall have a smooth saned finish, and the general field face brick shall be a range of colors consisting of a deep rose pink (approximately 2/3) and a soft rose reds (approximately 1/3). There is to be a close range of shades, giving an overall deep rose pink appearance when viewed from a normal distance (soft red range.)
   1. Basis-of-Design Product: The design for brick pavers is based on St. Joe Brick Works in Slidell, Louisiana – St. Joe Brick "Rose Blend". Subject to compliance with requirements, provide the named product or a prior approved comparable product.

2. Thickness: 2-1/4 inches (57 mm) .
3. Face Size: 3-5/8 by 7-5/8 inches (92 by 194 mm) .

2.2 FLAGSTONE PAVERS

A. Flagstone Pavers: Tennesse Buff Sandstone, ASTM C 616
1. Thickness: 1 inche (25 mm) minimum.
2. Face Size: 16 by 16 inches (400 by 400 mm)..

2.3 ACCESSORIES

A. Compressible Foam Filler: Preformed strips complying with ASTM D 1056, Grade 2A1.

2.4 MORTAR SETTING-BED MATERIALS

A. Portland Cement: ASTM C 150, Type I or II.

B. Hydrated Lime: ASTM C 207, Type S.

C. Sand: ASTM C 144.

D. Water: Potable.

2.5 GROUT MATERIALS

A. Polymer-Modified Grout: ANSI A118.7, sanded grout; in color indicated.
1. Product Type: Either dry mix, containing ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients, or two-component mix, containing liquid-latex and prepackaged dry-grout mix.

B. Grout Colors: As selected by Architect from manufacturer's full range.

C. Water: Potable.

2.6 MORTAR AND GROUT MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions. Discard mortars and grout if they have reached their initial set before being used.

B. Mortar-Bed Bond Coat: Mix neat cement or cement and sand with latex additive to a creamy consistency.

C. Portland Cement-Lime Setting-Bed Mortar: Type M complying with ASTM C 270, Proportion Specification.

D. Latex-Modified, Portland Cement Slurry Bond Coat: Mix Portland cement, sand, and latex additive to comply with written instructions of latex-additive manufacturer.

E. Polymer-Modified Grout Mix: Proportion and mix grout ingredients according to grout manufacturer's written instructions.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

B. Cut unit pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.

C. Joint Pattern:
1. Brick Pavers: Basket weave brick band (both sides of walk); 16 inches (400 mm), nominal. band width.
2. Flagstone: Set on 45 degree to edge of walk.

D. Tolerances: Do not exceed 1/16-inch (1.6-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) from level, or indicated slope, for finished surface of paving.

E. Expansion and Control Joints: Provide joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers. Locate joints at all joint locations in concrete subbase.

3.2 MORTAR SETTING-BED APPLICATIONS

A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing setting bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch (1.6-mm) thickness for bond coat.

C. Apply mortar bed over bond coat immediately after applying bond coat. Spread and screed to subgrade elevations required for accurate setting of pavers to finished grades indicated.

D. Mix and place only that amount of mortar that can be covered with pavers before initial set. Cut back and discard setting-bed material that has reached initial set before placing pavers.

E. Wet brick pavers before laying if the initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

F. Place pavers before initial set of cement occurs. Immediately before placing pavers, apply uniform 1/16-inch- (1.5-mm-) thick, slurry bond coat to bed or to back of each paver.

G. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation

before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

H. Spaced Joint Widths: Provide 3/8-inch (10-mm) nominal joint width with variations not exceeding plus or minus 1/16 inch (1.5 mm) .

I. Grout joints as soon as possible after initial set of setting bed.
   1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
   2. Tool exposed joints slightly concave when thumbprint hard.

J. Cure grout by maintaining in a damp condition for seven days, unless otherwise recommended by grout or liquid-latex manufacturer.

K. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

END OF SECTION 02780

SECTION 02800 - SANITARY SEWAGE COLLECTION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
1. This section covers the construction of the sewer system from the point of collection to the point of disposal.
2. Included in this section are sewer house connections, sewer mains, fittings, manholes, and conflict boxes. Also included are AS-BUILT plan(s).
3. The Contractor shall furnish all materials, equipment, transportation, tools and labor necessary and complete the sewage collection system in substantial conformance with the lines, grades, and locations shown on the plans.

B. Work not included:
1. This section does not include the construction of sewage treatment facilities.
2. This section does not include the construction of sewage lift stations and force mains.

1.2 REFERENCED SPECIFICATIONS

A. Those parts of the referenced specifications, which are applicable hereto, shall be considered as if written herein in full.
1. A.S.T.M.: American Society of Testing Materials.
2. A.W.W.A: American Water Works Association.

B. Testing
1. Testing shall include materials classification, moisture density curves, field density testing, and thickness measurements of compacted soil layers.

PART 2 - MATERIALS

A. Foundation & Backfill
1. Embedment Material shall be crushed stone or crushed concrete conforming to the requirements of A.S.T.M. D2321, Class I or II as noted.
2. Granular Backfill shall be a natural deposit or pumped material with ninety-five (95%) percent by weight falling between the No. 16 and No. 200 screen sieve. It shall have a maximum liquid limit (L.L.) of 25 and a maximum plasticity index (P.I.) of 6 and be free of trash, roots and weeds.
3. Foundation material shall conform to the requirements of A.S.T.M. D2321 Class I or II.
4. Foundation lumber shall be No. 2 Common Southern Pine.

B. Gravity Pipe
1. Polyvinyl Chloride (PVC) sewer pipe shall be designed and manufactured to carry sewage by gravity flow and shall meet the requirements of A.S.T.M. D3034 with a maximum SDR of 35 and a minimum F/Y stiffness of 45 PSI tested in conformance with A.S.T.M. D2412. Joints for PVC pipe shall consist of an integral bell with a factory installed locked in gasket. Fittings shall be those manufactured by or approved for use by the manufacturer of the pipe. All fittings shall have the same or greater strength than the pipe.
2. Asbestos cement pipe and fittings shall not be used.
3. Cast iron pipe shall be thickness Class 23 conforming to A.N.S.I. Spec. A21-6 or A21-8. Cast iron fittings shall be Class D up to 12" in diameter. Joints shall be flexible watertight rubber gasket joint conforming to A.S.T.M. C443.

4. Pipe shall be green in color.

C. Structures
1. Clay brick shall conform to A.S.T.M. C32.
2. Mortar shall be composed of one part Portland cement, two parts masonry sand and enough water to make a paste.
3. Castings for manholes shall conform to A.S.T.M. A48, Class 20 with the word SEWER cast into the cover. Castings shall be made within THE UNITED STATES, shall be free from cracks, blow holes, mold pull, risers, fins and shall not exceed plus or minus 1/16" per linear foot of major dimension. Castings shall be equal to VULCAN FOUNDRY VM9, machine seated weighing 360 lbs.
4. Precast manholes shall conform to the requirements of ASTM C478.
5. Manhole steps shall conform to ASTM A48.
6. Concrete used in structures shall have a minimum of 5½ sacks of cement per cubic yard, a maximum slump of 4", and a specified strength of 3500 PSI @ 28 days.
7. Reinforcing steel shall conform to ASTM A15 and A395.
8. No construction when temperature is 32 degrees F. or lower or when the temperature is predicted to go below 32 degrees F. within 24 hours, or when bricks contain frost.

D. Other Materials:
1. Materials not included herein when noted or allowed to be used shall conform to the General Specifications of the Sewerage and Water Board of New Orleans.

PART 3 - EXECUTION

A. Excavation
1. Excavations shall be open cuts with vertical sides. Excavated material will be placed so as not to interfere with public movement or to endanger the trench.
2. No greater length of trench shall be opened in advance of the installed pipe or structure, nor left unfilled to the rear for more than 100'.
3. If unauthorized excavation is made below the grade required by the plans, the Contractor at his expense shall backfill to grade with foundation material.
4. Excavation includes removal of stumps, roots and logs encountered within the trench, and to a depth of 12" below the bottom of the trench.
5. Trench boxes shall not be allowed without written permission of the Sewerage and Water Board of New Orleans.

B. Sheeting & Bracing
1. Protection of the excavation against caving or settling of the banks shall be the sole responsibility of the Contractor.
2. The sheeting and bracing shown on the plans is for the purpose of controlling the loading on the pipe only. The Contractor by his operations, the proximity of his equipment to the trench and the weight of this equipment, the location of backfill and construction material relative to the trench, etc. will increase or decrease the possibility of trench wall collapse and is solely responsible for installing the sheeting and bracing necessary to prevent this collapse.
3. All sheeting and bracing left in the trench shall be cut off a minimum of 3 feet below existing ground surface.

C. Backfilling
1. Backfilling of sewer trenches shall begin as soon as the joints have been made properly and the location of WYES and TEES properly recorded.

2. Embedment material shall be placed in the trench on top of the foundation on both sides and over the pipe in accordance with the plan section and compacted to a minimum of 95% of ASTM D698.
3. Granular material or select excavated material, as noted on the plans, shall be placed over the embedment material in layers not to exceed 12" and each layer tamped prior to the placement of the next layer.
4. The requirement for embedment and backfilling vary with the relative location of the sewer to the pavement. See plan details and notes.

D. Structures
1. Lay bricks in full close shove joints of mortar. A reasonable number of half bricks or larger will be allowed along with chips limited in use to filling the spaces between the bricks.
2. Perforated bricks may be used in laying walls of the manholes less than seven feet in height from invert to top of casting and solid bricks shall be used on all others.
3. Brick manholes shall be plastered on the outside and inside with a coat of mortar 1/4" thick.
4. Precast manholes shall conform to current ASTM C478.
   a) Precast risers shall be the eccentric cone type.
   b) Sewer openings shall be encased in one section of the manhole.
   c) Manhole steps and cover shall conform to the plan requirements.
5. Manholes constructed of materials other than brick or concrete only upon written approval of Engineer.
7. Manhole foundation slabs shall be constructed on dry bottom. Precast only with written approval of Engineer.
   a) Concrete f'c = 3500 PSI @ 28 days.
   b) Base for manhole foundation slab shall be 6" of compacted crushed stone or crushed concrete.

E. House Connections
I. A house connection shall be laid to each building shown on the plan.
2. When not shown otherwise house connections will be laid to a depth at the property line of three feet below the top of the proposed adjacent curb.

F. Laying Gravity Pipe
1. Prior to laying pipe, verify the location and elevation of tie-ins.
2. Lay pipe to line and grades with bell upgrade.
3. Each pipe length shall be clean and laid to form a close joint.

G. Work In Built Up Area
1. All material excavated and all construction material shall be placed so as to interfere as little as possible with public travel.
2. Bridge trenches at street crossings, driveways and sidewalks keeping open alternate streets crossing the work.
3. Give free access to fire engines, fire hydrants, water valves, fire alarm boxes, mailboxes and as far as possible driveways.
4. Protect all poles, posts, gallery supports, signs, etc.

H. Care & Restoration of Streets, Driveways, Etc.
1. All streets, driveways, sidewalks, etc. damaged shall be repaired.
   a) If not shown otherwise on the plans, concrete for repairs shall contain 6½ sacks of cement per cubic yard, a water reducing admixture and have a maximum slump of 4".

b) If not shown otherwise on the plans repairs of concrete shall be to the nearest joint, or, if approved to a saw cut joint.

c) Repairs shall be of the thickness of the concrete being repaired but not less than 4" for sidewalks, 5" for driveways and 8" for streets, unless otherwise shown.

2. Excavations through yards and grassy areas shall be topped with a 6" thick mixture of clay granular material and fertilized.

I. Gravity Pipe

1. All sewer lines shall be "LAMPED" between manholes. Contractor shall provide personnel and equipment and assist Engineer. Equipment furnished shall be mirrors, battery operated lights, canister type gas masks.
2. The full cross section shall be visible when lamped between manholes. The sewer shall be true to line and grade, clean, have no cracked or broken pipes or defective joints.
3. The location of the house connections shall be properly marked.
4. Infiltration test:
   a) The Contractor shall furnish the measuring devices and provide the assistance to conduct the infiltration test. The test will be conducted in the presence of a representative of the testing laboratory and the testing laboratory shall certify the test.
   b) The allowable leakage under the exterior ground water pressure shall not exceed 125 GPD per inch diameter per mile of pipe in 24 hours unless noted otherwise. In conducting the test, the sewer system can be tested in its entirety or broken down into connecting mains. In determining the length of section tested, manholes, junction boxes, etc. will be added in as pipe length and not considered separately.

J. Structures

1. Manholes and conflict boxes shall be properly built and shall show no cracks, displacement, or other defects and be constructed to grade and properly backfilled.

K. Other Considerations

1. Streets damaged by the work shall be satisfactorily repaired.
2. "AS BUILT" plan completed by the Contractor.
3. Site clean.

END OF SECTION 02800

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Scope: The work to be done under this section of the specifications includes all labor, materials, equipment, and services necessary for cast-in-place concrete including formwork, reinforcing, mix design, placement procedures, finishes, as indicated on drawings and herein specified.

1.2 CAST-IN-PLACE CONCRETE: Includes the following:

A. All concrete shown on the drawings.

B. Equipment pads and bases.
1. Include all concrete pads and supports for mechanical and electrical equipment where indicated. Unless otherwise shown, these pads shall include concrete of the size required to support the equipment purchased and 500 lbs. of reinforcing steel per cubic yard of concrete.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM)

1.	C31	Making and Curing Concrete Test Specimens in the Field
2.	C39	Test for Compressive Strength of Cylindrical Concrete Specimens
3.	C143	Test for Slump of Portland Cement Concrete
4.	C150	Portland Cement
5.	C260	Air-Entraining Admixtures for Concrete
6.	C494	Chemical Admixtures for Concrete
7.	C33	Concrete Aggregates
8.	C618	Fly Ash for Use in Concrete
9.	C94	Ready-Mixed Concrete
10.	D2103	Polyethylene Film and Sheeting
11.	E1155	Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers

B. American Concrete Institute (ACI)

1.	ACI 214-89	Recommended Practice for Evaluation of Compression Test Results for Field Concrete
2.	ACI 301-89	Specifications for Structural Concrete for Buildings
3.	ACI 304-89	Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete
4.	ACI 308-92	Standard Practice for Curing Concrete
5.	ACI 318-95	Building Code Requirements for Reinforced Concrete
6.	SP-66 ACI	Detailing Manual
7.	AC1 117	Tolerances for Concrete Construction and Materials
8.	AC1 302.1R	Guide for Concrete Floor and Slab Construction

1.4 SUBMITTALS

A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections.

B. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others if requested by Architect.

C. Shop drawings for reinforcement detailing fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, bent bar diagrams, and arrangement of concrete reinforcement. Include special reinforcing required for openings through concrete structures. Reproductions made from contract documents will not be allowed. Submit two prints and one reproducible.

D. Samples of materials as requested by Architect, including names, sources, and descriptions.

E. Laboratory test reports for concrete materials and mix design test.

F. Material certificates in lieu of material laboratory test reports when permitted by Architect. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:
1. American Concrete Institute (ACI) 301-89, "Specifications for Structural Concrete for Buildings."
2. ACI 318, "Building Code Requirements for Reinforced Concrete," current edition.
3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice,"current edition.

B. Concrete Testing Service: The Contractor shall employ a testing agency to perform material evaluation tests and to design concrete mixes.

C. Materials and installed work may require testing and retesting at any time during progress of Work. Retesting of rejected materials for installed Work shall be done at Contractor's expense.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.

B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Creating Void Areas: Fiberboard carton forms completely wax impregnated throughout with water resistant paraffin and polyethylene and designed to carry a uniformly distributed top load up to 1000 p.s.f.

D. Form Release Agent: Provide commercial formulation form release agent with a maximum of 350 mg/l volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

E. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to the plane of the exposed concrete surface.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615, Grade 60 deformed.

B. Steel Wire: ASTM A 82, plain, cold-drawn steel.

C. Welded Wire Fabric: ASTM A 185, welded steel wire fabric.

D. Deformed-Steel Welded Wire Fabric: ASTM A 497.

E. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar-type supports complying with CRSI specifications.
   1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material ill not support chair legs.
   2. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1).

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type II.
   1. Use one brand of cement throughout Project unless otherwise acceptable to Architect.

B. Fly Ash: ASTM C 618, Type C or F.

C. Normal-Weight Aggregates: ASTM C 33 and as specified. Provide aggregates from a single source for exposed concrete.
   1. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.
   2. Local aggregates not complying with ASTM C 33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to Architect.

D. Lightweight Aggregates: ASTM C 330.

E. Water: Potable.

F. Admixtures, General: Provide concrete admixtures that contain not more than 0.1 percent chloride ions.

G. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

H. Water-Reducing Admixture: ASTM C 494, Type A.

I. High-Range Water-Reducing Admixture: ASTM C 494, Type approved by Architect.

J. Water-Reducing, Accelerating Admixture: ASTM C 494, Type C or E.

K. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.

2.4 RELATED MATERIALS

A. Vapor Retarder: Provide vapor retarder that is resistant to deterioration when tested according to ASTM E 154, as follows:
1. Clear polyethylene sheet not less than 6 mils thick conforming to ASTM D2103.

B. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

C. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
1. Waterproof paper.
2. Polyethylene film.
3. Polyethylene-coated burlap.

D. Liquid Membrane-Forming Curing Compound: Liquid-type membrane-forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.55 kg/sq. meter when applied at 200 sq. ft./gal.
1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 mg per liter.

E. Water-Based Acrylic Membrane Curing Compound: ASTM C 309, Type I, Class B.

F. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.

G. Underlayment Compound: Free-flowing, self-leveling, pumpable, cement-based compound for applications from 1 inch thick to feathered edges.

H. Bonding Agent: Polyvinyl acetate or acrylic base.

I. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material type, grade, and class to suit Project requirements.

J. Waterstops: Dumbbell or centerbulb polyvinyl chloride type conforming to CRD-C572. Size and configuration shall be as indicated on the Drawings.

K. Curing, Sealing and Hardening Compound: Water based chemically-reactive penetrating sealer and hardener, seals by densifying concrete so that water molecules cannot pass through but air and water vapor can. Products offered by manufacturers to comply with the requirements include the following:
1. Ashford Formula Curecrete Distribution, Inc.

L. Dry Shake Surface Hardner: Product composed of a pre-mixed, ready-to-use mineral aggregate surface hardener that is proportioned, mixed and packaged at the factory. Products offered by manufacturers to comply with the requirements include the following:
1. MASTERCRON F_F ; Master Builders, Inc.

2.5 PROPORTIONING AND DESIGNING MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.

B. Submit written reports to Architect of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been submitted to Architect.

C. Design mixes to provide normal weight concrete or light weight concrete with the 28-day compressive strength as indicated on drawings.

D. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
1. Not more than 4 inches.

E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Architect. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in Work.

2.6 ADMIXTURES

A. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.

B. Use accelerating admixture in concrete slabs placed at ambient temperatures below 40 deg F (10 deg C) and falling.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements of ASTM C 94, and as specified.
1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes. Ice can be added to concrete so that delivery time can remain at 1-1/2 hours.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms and reinforcing steel.

3.2 FORMS

A. General: Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits:
   1. Provide Class A tolerances for concrete surfaces exposed to view.
   2. Provide Class C tolerances for other concrete surfaces.

B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like for easy removal.

D. Provide temporary openings for clean-outs and inspections where interior area of formwork is inaccessible before and during concrete placement. Securely brace temporary openings and set tightly to forms to prevent losing concrete mortar. Locate temporary openings in forms at inconspicuous locations.

E. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

F. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

G. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

3.3 VAPOR RETARDER/BARRIER INSTALLATION

A. General: Under all slabs on grade, place vapor retarder/barrier sheeting in position with longest dimension parallel with direction of pour.

B. Lap joints 6 inches and seal with manufacturer's recommended mastic or pressure-sensitive tape.

3.4 PLACING REINFORCEMENT

A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as specified.
   1. Avoiding cutting or puncturing vapor retarder/barrier during reinforcement placement and

concreting operations. Repair damages before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Architect.

D. Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 JOINTS

A. Construction Joints: Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Architect.

B. Provide keyways as indicated on drawings or at least 1-1/2 inches deep in construction joints in walls and slabs and between walls and footings. Bulkheads designed and accepted for this purpose may be used for slabs.

C. Provide dumbbell or centerbulb type waterstops at all construction joints in areas indicated on the drawings.

D. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise. Do not continue reinforcement through sides of strip placements.

E. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.

F. Isolation Joints in Slabs-on-Grade: Construct isolation joints in slabs-on-grade at points of contact between slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Joint fillers and sealants are specified in Division 7 Section "Joint Sealants."

3.6 INSTALLING EMBEDDED ITEMS

A. General: Set and build into formwork anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.

B. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.7 PREPARING FORM SURFACES

A. General: Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before placing reinforcement.
   1. Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.
   2. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.

3.8 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.
   1. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.

C. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
   1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.
   2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.

D. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.
   1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.
   2. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
   3. Maintain reinforcing in proper position on chairs during concrete placement.

E. Cold-Weather Placement: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

F. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.
   1. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Architect.

3.9 FINISHING FORMED SURFACES

A. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.

B. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.

C. Grout Cleaned Finish: Provide where indicated on Drawings in accordance with ACI 301-89, paragraph 10.3.2.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces.

3.10 MONOLITHIC SLAB FINISHES

A. Scratch Finish: Apply scratch finish to monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile, portland cement terrazzo, and other bonded applied cementitious finish flooring material, and where indicated.

B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and where indicated.
   1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

C. Trowel Finish: Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.
   1. After floating, begin first trowel-finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance.

D. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply a trowel finish as specified, then immediately follow by slightly scarifying the surface with a fine broom.

E. Nonslip Broom Finish: Apply a nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
   1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-

bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

F. Finishing Tolerances – All slabs other than those designated as Random Traffic Slabs shall be finished with Class A tolerances in accordance with ACI 301, paragraph 11.9. For Random Traffic Slab tolerances refer to paragraph 3.16 of this section.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as specified to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

3.12 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive old or hot temperatures. In hot, dry, and windy weather protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
   1. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.

B. Curing Methods: Cure concrete by curing compound, by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified.
   1. Provide moisture curing by the following methods:
      a. Keep concrete surface continuously wet by covering with water.
      b. Use continuous water-fog spray.
      c. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4-inch lap over adjacent absorptive covers.
   2. Provide moisture-retaining cover curing as follows:
      a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
   3. Apply curing compound on exposed interior slabs and on exterior slabs, walks, and curbs as follows:
      a. Apply curing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours

after initial application. Maintain continuity of coating and repair damage during curing period.

b. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.

C. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

D. Curing Unformed Surfaces: Cure unformed surfaces, including slabs, floor topping, and other flat surfaces, by applying the appropriate curing method.

1. Final cure concrete surfaces to receive finish flooring with a moisture-retaining cover, unless otherwise directed.

3.13 REMOVING FORMS

A. General: Formwork not supporting weight of concrete, such as sides of beams,walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 12 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.

C. Comply with ACI 301-89, Chapter 4, Article 4.6 - Reshoring.

3.14 REUSING FORMS

A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be accceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use patched forms for exposed concrete surfaces except as acceptable to Architect.

3.15 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Architect.

B. Mix dry-pack mortar, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.

1. Cut out honeycombs, rock pockets, voids, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be

patched with bonding agent. Place patching mortar before bonding agent has dried.

2. For surfaces exposed to view, blend white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.

1. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.

1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
3. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Architect.
4. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

3.16 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. General: The Contractor shall employ a testing agency to perform tests and to submit test reports.

B. Sampling and testing for quality control during concrete placement shall include the following, as directed by Architect.

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
2. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
3. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and one test for each set of

compressive-strength specimens.

5. Compression Test Specimen: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
6. Compressive-Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yd. plus additional sets for each 50 cu. yd. more than the first 25 cu. yd. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

C. Random Traffic Floor:
1. Designation: The ground floor slab for the facility is designated the Random Traffic Floor. Any floor slab comprising part of the Random Traffic Floor shall be designated a Random Traffic Slab.
2. Local Flatness/Levelness Tolerance: All Random Traffic Slabs shall conform to the following ACI F-Number requirements:
Specified Overall Value: F_F 35/F_L25
Minimum Local Value: F_F24/F_L17
3. General Conformity to Design Grade: The entire Random Traffic Floor shall fall within +or - 1/2" of the as-built floor elevations shown on the plans.
4. Expectations and Modifications: All floor tolerance measurements shall be referenced to the as-built design grades shown on the plans, even when (as with sloped-to-drain and predeflection cambers) such grades are not horizontal.
5. Floor Tolerance Measurements: Floor flatness and levelness tests on the Random Traffic Floor shall be conducted in accordance with the provisions set forth in ASTM E1155-87 using a Dipstick © Floor Profiler manufactured by Face Construction Technologies, Norfolk, VA or approved equal. Floor tolerance measurements shall be made by the Owner within 16 hours after completion of the final troweling operation - and in all cases before forms and/or shores have been removed - using a suitable flatness measuring device. Results of all floor tolerance tests - including a formal notice of acceptance or rejection of the work - shall be provided to the Contractor within 24 hours after data collection (not excluding weekends or holidays.)
6. Remedy for out-of-tolerance work: All Random Traffic Floor sections measuring at or above both of the specified Minimum Local F-Numbers shall be accepted for tolerance compliance as constructed. All Random Traffic Floor sections measuring below either (or both) of the specified Minimum Local F-Numbers shall be removed and replaced. For the purposes of this paragraph, a floor section shall be any rectangular area bound by column and/ or half-column lines, as determined by the A/E.
7. Defective Concrete Finishing: Concrete finishing which is not true to line and plane, which is not thoroughly troweled and properly surfaced as required, which fails to achieve the specified tolerance requirements or has a rough top surface, except where required, or which does not connect properly to adjoining work, or does not slope to drains, or is not properly cured, will be deemed defective. Remove and replace with proper work and material conforming to the requirements, when so directed by the A/E.
8. Floors judged by the A/E to be unfit to receive floor covering material shall be brought to required finish by the Contractor at no additional cost to the Owner. An underlayment material must be used.

D. Test results will be reported in writing to Owner, Architect, Structural Engineer, Ready-Mix Producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

F. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

END OF SECTION 03300

SECTION 03360 - CONCRETE FINISHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Division 3 Section 03300 "Cast-In-Place Concrete", apply to this Section.

C. Division 3 Section 03395 "Sealing Concrete Floors", apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
1. Application of mineral-aggregate, colored, ready-to-use dry-shake surface hardener that utilizes specially treated, sized, and graded mineral aggregate.

1.3 REFERENCES

A. ACI 211.1-91 Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.

B. ACI 301-89 Specification for Structural Concrete for Buildings

C. ACI 302.1R-89 Guide for Concrete Floor and Slab Construction

D. ACI 304.1R-89 Guide for Measuring, Mixing, Transporting and Placing Concrete

E. ACI 305R-91 Hot Weather Concreting

F. ACI 306R-88 Cold Weather Concreting

G. ASTM C 309-89 Specification for Liquid Membrane-Forming Compounds for Curing Concrete

H. ASTM E-1155 Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical bulletins and MSDS on each product.

B. Submit list of project references as documented in this Specification under Quality Assurance Article. Include contact name and phone number of person charged with oversight of each project.

C. Quality Control Submittals:
   1. Provide protection plan of surrounding areas and non-cementitious surfaces.

D. Color Charts.

1.5 QUALITY ASSURANCE

A. Job Mock-Up: Place a minimum 100 ft^2 (10 m^2) floor mock-up using materials and procedures proposed for use in the project. Revise materials and procedures as required to obtain acceptable finish surface.
   1. Maintain the same controls and procedures used in the acceptable mock-up throughout the project.

B. Field Support: During job mock-up and initial period of installation, the manufacturer of the surface hardener shall provide, at no cost, a trained, full-time employee to aid in securing proper use of the product.
   1. Notify surface hardener manufacturer at least three days prior to initial use of the product.

C. Installer Qualifications: Engage an experienced installer who has specialized in the application of floor finishes similar to that required for this project, who has demonstrated the capability of producing acceptable quality floor flatness and hand trowel finishes.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete: Provide concrete materials complying with requirements of Section 03300 "Cast-In-Place Concrete".

B. Surface Hardener: Ready-to-use cementitious, dry-shake floor hardener that utilizes specially treated, sized, and graded mineral aggregate designed to improve wear and impact resistance to concrete floors when evenly distributed and finished over freshly leveled and floated concrete
   1. Acceptable Product: Mastercron ® by Degussa Building Systems.
   2. Color: Color to be selected by Design Professional from Manufacturers standard color chart.
   3. Application Rate: 1.0 to 2.0 lbs/ft^2 (4.9 to 9.8 kg/m^2).

C. Monomolecular Film: A monomolecular film can be used only under severe drying conditions, due to high concrete and or ambient temperatures, low humidity, high winds, etc. including work in heated interiors during cold weather, to aid in the maintaining of concrete moisture, and only per surface hardener manufacturer's recommendation. The misuse of this product can compromise color and performance of the surface hardener.
   1. Acceptable Product: "CONFILM®" by Degussa Building Systems.

D. Curing Compound: A water-based polymer and wax-emulsion curing compound.
   1. Acceptable Product: "MASTERKURE® 200W" by Degussa Building Systems as per surface hardener manufacturer's recommendation.

E. Joint Filler:

1. Acceptable Product: "MASTERFILL® 300i" by Degussa Building Systems as per surface hardener manufacturer's recommendation.

F. Compatibility of Products: Provide products manufactured by a single manufacturer to maintain compatibility of products.

PART 3 - EXECUTION

3.1 CONCRETE PLACEMENT

A. Section 03300, Cast-In-Place Concrete, specifies basic concrete materials and placement requirements.

B. For wear resistant concrete floors, provide concrete with the following additional requirements:
1. Maximum slump of 5" (12.7 cm) for slabs on grade and 3.5" (8.9 cm) for suspended slabs.
2. Do not apply over concrete containing more than 3% air content when tested by ASTM C173 or ASTM C231 procedures.
3. Do not use calcium chloride or set-accelerating admixtures containing calcium chloride.
4. Do not use admixtures that increase bleeding.
5. Consult ACI 211 Table 6.3.6 for base concrete mix designs and additives for dry shake slabs.
6. Follow ACI 302 recommendations for placement of flat floors.

3.2 APPLICATION OF SURFACE HARDENER

A. Apply material in two operations if more than 1.0 lb./ft^2 (4.5 kg/m^2) total amount of shake is required. Place and integrate half of the total amount in the first application and the remaining half on the second application.

B. Following the use of the highway straightedge, apply up to 1.0 lb./ft^2 (4.5 kg/m^2) of surface hardener per application. Distribute evenly by use of a mechanical spreader to be assured of maintaining indicated flatness values.

C. Use finishing machines with detachable float shoes. Compact surface by a third mechanical floating if time and setting characteristics of the concrete will allow. Do not add water to the surface.

D. As surface further stiffens, indicated by loss of sheen, hand or mechanically trowel with blades set relatively flat.

3.3 CURING AND PROTECTION

A. Cure finished floors using film-forming curing compound as specified above and as recommended by surface hardener manufacturer. Uniformly apply curing compound over the entire surface at a coverage that will provide moisture retention in excess of the requirements of ASTM C 309. Maintain ambient temperature of 50°F (10°C) or above during the curing period.

B. After drying, protect hardened surface by covering with scuff-proof, non-staining building paper or polyethylene.

C. Keep floors covered and free of traffic and loads for a minimum of 10 days after completion. Maintain ambient temperature at 50°F (10°C) or above during the curing period.

3.4 REMOVAL OF CURING COMPOUND

A. Upon completion of concrete curing period and no longer than 28 days after concrete pour, remove curing compound in accordance with manufacturer's recommendations.

3.5 JOINT FILLING

A. After a minimum of 90 days, apply a semi-rigid epoxy joint filler in all control and saw cut construction joints. Place joint filler in a method complying with manufacturer's label instructions.

END OF SECTION 03360

SECTION 03395 - SEALING CONCRETE FLOORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Application of sealer for concrete floors.

1.2 RELATED SECTIONS

A. Division 3 Section 03300 "Cast-In-Place Concrete".

B. Division 3 Section 03360 "Concrete Finishes".

1.3 SUBMITTALS

A. Material requirements for concrete to which sealer is to be applied, including cement type, water-cement ratio, type of trowel finish, limitations on admixtures, pigments, bonding agents, and bond breakers, etc.

B. Product Data: Manufacturer's data sheets, including product specifications, test data, preparation instructions and recommendations, storage and handling requirements and recommendations, and installation methods.

C. Maintenance instructions, including precautions for avoiding staining after application.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Applicator experienced with installation of product and certified by manufacturer, or applicator experienced with similar products and providing manufacturer's field technician on site to advise on application procedures; and providing adequate number of skilled workers trained and familiar with application requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver product in factory numbered and sealed drums, with numbers recorded for Owner's records.

B. Store products in manufacturer's unopened drums until ready for installation.

1.6 PROJECT CONDITIONS

A. No satisfactory procedures are available to remove petroleum or rust stains from concrete. Prevention is therefore essential. Take precautions to prevent staining of concrete prior to application of sealer and for minimum of three months after application:
   1. Prohibit parking of vehicles on concrete slab.

2. If vehicles must be temporarily parked on slab, place drop cloths under vehicles during entire time parked.
3. If construction equipment must be used for application, diaper all components that might drip oil, hydraulic fluid, or other liquids.
4. Prohibit pipe cutting using pipe cutting machinery on concrete slab.
5. Prohibit temporary placement and storage of steel members on concrete slab.

B. Do not install products under environmental conditions outside manufacturer's absolute limits.

C. Do not use frozen material; thaw and agitate prior to use.

1.7 WARRANTY

A. Provide manufacturer's warranty that a structurally sound concrete surface prepared and treated according to the manufacturer's directions will remain permanently dustproof, hardened and water repellent. If after the specified sealing period the treated surface does not remain dustproof, hardened and water repellent, provide, at manufacturer's expense, sufficient material to reseal defective areas.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 MATERIALS

A. Concrete Sealer: Water-based chemically-reactive penetrating sealer and hardener, that seals by densifying concrete so that water molecules cannot pass through but air and water vapor can, while allowing concrete to achieve full compressive strength, minimizing surface crazing, and eliminating dusting.
1. Manufacturer / Product: Curecrete Distribution, Inc./Ashford Formula
2. Colorless, transparent, odorless, non-toxic, non-flammable.
3. Containing no solvents or volatile organic compounds.
4. USDA approved for food handling facilities.
5. Allowing traffic on floors within 2 to 3 hours, with chemical process complete within 3 months.
6. No change to surface appearance except a sheen developed due to traffic and cleaning.

B. Water: Clean, potable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared and are suitable for application of product.
   1. Verify that curing compound has been complete removed from concrete slabs prior to application of sealer.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation in accordance with manufacturer's recommendations.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in strict accordance with manufacturer's instructions.

B. Provide manufacturer's technical representative on-site to familiarize installers with proper procedures and to verify procedures are followed properly.

C. Prevent damage to and soiling of adjacent work.

D. Apply sealer to freshly cured concrete after a minimum of 30 days but no later than 45 days.
   1. Spray on at a rate of 200 square feet per gallon (4.8 sq. m/L).
   2. Keep surfaces wet with sealer for minimum soak-in period of 30 minutes, without allowing drying out or becoming slippery. In hot weather slipperiness may appear before the 30-minute time period has elapsed. If that occurs, apply more cure-seal-hardener as required to keep entire surface in a non-slippery state for the first 15 minutes. For the remaining 15 minutes, mist the surface as needed with water to keep the material in a non-slippery state.
   3. After this period, when treated surface becomes slippery lightly mist with water until slipperiness disappears.
   4. Wait for surface to become slippery again and then flush entire surface with water removing all residue of sealer.
   5. Squeegee surface completely dry, flushing any remaining slippery areas until no residue remains.
   6. Wet vacuum or scrubbing machines may be used to remove residue, provided manufacturer's instructions are followed.

3.4 PROTECTION

A. Protect installed floors until chemical reaction process is complete; at least three months.
   1. Comply with precautions listed under PROJECT CONDITIONS.
   2. Clean floor regularly in accordance with manufacturer's recommendations because water will accelerate the sealing and scrubbing will impart a shine.

3. Clean up spills immediately and spot-treat stains with good degreaser or oil emulsifier.

B. Precautions and cleaning are the responsibility of the General Contractor until Substantial Completion.

END OF SECTION 03395

SECTION 04810 - UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes unit masonry assemblies consisting of the following:
   1. Concrete masonry units (CMUs).
   2. Decorative concrete masonry units.
   3. Face brick.

B. See Division 05 Section "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.

C. See Division 07 Section "Sheet Metal Flashing and Trim" for furnishing manufactured reglets installed in masonry joints for metal flashing.

1.2 PERFORMANCE REQUIREMENTS

A. General: Design and install unit masonry assemblies to comply with applicable standards of 2003 International Building Code including the withstanding of loads from wind, gravity, movement of building structure and thermally induced movement, as well as to resist deterioration under conditions of normal use including exposure to weather, without failure. Design masonry anchors and anchoring systems to provide a complete system capable with withstanding all types of loads imposed.
   1. The unit masonry requirements shown on the drawings are intended to establish basic dimensions of units, including profiles, coursing and bonding. The visual concept shall be maintained as shown on the drawings.
   2. The requirements for the unit masonry support and anchorage indicated on the drawings are intended to establish the basic intent of the support and anchorage system. The Design Build Contractor shall be responsible for the design of the support and anchorage system and shall make whatever modifications and additions to the details as may be required to fulfill the performance requirements.

B. Blast Resistance: Provide unit masonry assemblies at exterior walls capable of resisting airblast loading of intensities required by UFC documents pertaining to Antiterrorism Standards for Buildings.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.

C. Samples for each type and color of exposed masonry units and colored mortars.

D. Material Certificates: For each type of product indicated. Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards.
   1. For masonry units include material test reports substantiating compliance with requirements.

E. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1.4 QUALITY ASSURANCE

A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Payment for these services will be made by Contractor.
   1. Clay Masonry Unit Test: For each type of unit required, per ASTM C 67.
   2. Concrete Masonry Unit Test: For each type of unit required, per ASTM C 140.
   3. Mortar Test (Property Specification): For each mix required, per ASTM C 780.
   4. Grout Test (Compressive Strength): For each mix required, per ASTM C 1019.

B. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

C. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects.
   1. Build sample panels for each type of exposed unit masonry construction in sizes approximately 48 inches (1200 mm) long by 48 inches (1200 mm) high.

1.5 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602, Article 1.8C..

B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602, Article 1.8D.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS (CMUs)

A. Shapes: Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

B. Integral Water Repellent: Provide units made with liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength at all locations below second floor level and at all wet locations, such as locker/shower rooms, above second floor level.

C. Concrete Masonry Units: ASTM C 90.
   1. Unit Compressive Strength: As required to meet design load requirements.
   2. Weight Classification: As required to meet design load requirements.
   3. Pattern and Texture for Decorative Units, refer to finish schedule for locations:
      a. Standard pattern, ground finish.
      b. Provide units with chamfer edge at outside corners of walls constructed with decorative units.
   4. Colors and Special Aggregates: As selected from manufacturer's full range of products and color.

2.2 CONCRETE AND MASONRY LINTELS

A. General: Provide either concrete or masonry lintels, at Contractor's option, complying with requirements below.

B. Concrete Lintels: Precast or cast-in-place units matching concrete masonry units and with reinforcing bars required to support loads imposed.

C. Masonry Lintels: Made from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout.

2.3 BRICK

A. General: Provide shapes indicated and as follows:
   1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
   2. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Face Brick:
   1. Manufacturer: St. Joe Brick Works in Slidell, Louisiana is an approved manufacturer. Prior approved equals will be considered.
   2. Type: Manufactured by the soft-mud wood molding process rather than the extrusion process.
   3. Finish: Smooth sanded finish.
   4. Range of color: Consisting of a deep rose pink (approximately 2/3) and soft rose reds (approximately 1/3) with a close range of shades giving an overall deep rose pink appearance with view from a normal distance.
      a. The face brick shall have black ferrous or other burnt mineral spots irregularly appearing through the body of the brick.
      b. Color: "New Orleans Red" blend
   5. Size (Actual Dimensions): 3-5/8 inches (92 mm) wide by 2-1/4 inches (57 mm) high by 7-5/8 inches (194 mm) long.

2.4 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction.

B. Hydrated Lime: ASTM C 207, Type S.

C. Masonry Cement: ASTM C 91.

D. Mortar Pigments: Iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.

E. Colored Cement Product: Packaged blend made from portland cement and lime or masonry cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.
1. Formulate blend as required to produce color selected from manufacturer's standard colors.

F. Aggregate for Mortar: ASTM C 144.
1. For joints less than 1/4 inch (6.5 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.

G. Aggregate for Grout: ASTM C 404.

H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

I. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.

J. Water: Potable.

2.5 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).
1. Provide at all locations above second floor level.

B. Expoxy-Coated Steel Reinforcing Bars: ASTM A 775
1. Provide at all locations below second floor level.

C. Masonry Joint Reinforcement:
1. Stainless Steel Wire: ASTM A580, Type 304
   a. Provide at all locations below second floor level.
2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating after fabrication.
   a. Provide at all "wet" locations , such as shower/locker rooms, above second floor level.
3. Mill Galvanized, Carbon-Steel Wire: ASTM A82; with ASTM A 641 before fabrication.
   a. Provide at all non-wet locations above second floor level.
4. Wire Size: As required to meet design load requirements.
5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
6. Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.
7. Multiwythe Masonry: Provide type required for various locations.

a. Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches (100 mm) in width, plus 1 side rod at each wythe of masonry 4 inches (100 mm) or less in width.
b. Tab type, with 1 side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face.
c. Adjustable (two-piece) type, with one side rod at each face shell of backing wythe and with ties that extend into facing wythe. Ties engage eyes or slots in reinforcement and extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face.

8. Veneers Anchored with Seismic Masonry-Veneer Anchors: Provide as required for seismic loading conditions.

2.6 TIES AND ANCHORS

A. Materials:
1. Stainless Steel Wire: ASTM A580, Type 304
   a. Provide at all locations below second floor level.
2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
   a. Provide at all "wet" locations , such as shower/locker rooms, above second floor level.
3. Mill Galvanized, Carbon-Steel Wire: ASTM A82; with ASTM A 641 before fabrication.
   a. Provide at all non-wet locations above second floor level.
4. Stainless Steel Sheet: ASTM A167, Type 304.
   a. Provide at all locations below second floor level.
5. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
   a. Provide at all locations above second floor level.

B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches (50 mm) parallel to face of veneer.

C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches (100 mm) wide.

D. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

E. Adjustable Masonry-Veneer Anchors
1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
   a. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch (1.3 mm).
2. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.
   a. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, and slotted holes for inserting wire tie.

3. Seismic Masonry-Veneer Anchors: Units consisting of a metal anchor section and a connector section designed to engage a continuous wire embedded in the veneer mortar joint.
   a. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, and slotted holes for inserting connector section.
   b. Connector Section: Rib-stiffened, sheet metal bent plate; sheet metal clip; or wire tie and rigid extruded vinyl clip designed to engage continuous wire. Size connector to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face.

2.7 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with Division 07 Section "Sheet Metal Flashing and Trim."
   1. Metal Drip Edges: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
   2. Metal Flashing Terminations: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 3/8 inch (10 mm) to form a stop for retaining sealant backer rod.

B. Flexible Flashing: For flashing not exposed to the exterior, use one of the following, unless otherwise indicated:
   1. Copper-Laminated Flashing: 7-oz./sq. ft. (2-kg/sq. m) copper sheet bonded with asphalt between 2 layers of glass-fiber cloth.
   2. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.030 inch (0.8 mm).
   3. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637, 0.040 inch (1.0 mm) thick.

C. Solder and Sealants for Sheet Metal Flashings: As specified in Division 07 Section "Sheet Metal Flashing and Trim."

D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; formulated from neoprene, urethane, or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Use one of the following, unless otherwise indicated:

1. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches (9 by 38 by 89 mm) long.
2. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe, in color selected from manufacturer's standard.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
1. Provide one of the following configurations:
   a. Strips, full-depth of cavity and 10 inches (250 mm) wide, with dovetail shaped notches 7 inches (175 mm) deep.
   b. Strips, not less than 1-1/2 inches (38 mm) thick and 10 inches (250 mm) wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
   c. Sheets or strips full depth of cavity and installed to full height of cavity.

2.9 MASONRY CLEANERS

A. Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains from new masonry without damaging masonry. Use product approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
1. Cleaning of Face Brick: Do not use muriatic acid or other acidic cleaner on any face brick surface. Refer to brick manufacturer's guidelines for cleaning of brick.

2.10 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, unless otherwise indicated.
1. Do not use calcium chloride in mortar or grout.
2. Limit cementitious materials in mortar for exterior and reinforced masonry to portland cement and lime.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Mortar for Unit Masonry: Comply with ASTM C 270 , Property Specification.
1. For masonry below grade or in contact with earth, use Type M or S as recommended for type of brick specified..
2. For reinforced masonry, use Type S or N to meet performance requirements.
3. For mortar parge coats, use Type S or N.
4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
5. Color for Face Brick: Natural gray.
6. Color for Decorative Concrete Masonry Units: As selected from manufacturer's full range of colors for colored mortar.

C. Grout for Unit Masonry: Comply with ASTM C 476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 2103.10 of the 2003 International Building Code. And Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Use full-size units without cutting if possible. If cutting is required, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

D. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.

E. Masonry Protection: Cover top of all unfinished masonry work with waterproofing material to keep masonry work dry. Secure covering from displacement due to wind.

3.2 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

D. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.

E. Fill cores in hollow concrete masonry units with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

3.3 MORTAR BEDDING AND JOINTING

A. Lay hollow concrete masonry units as follows:
1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.

3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

3.4 COMPOSITE MASONRY

A. Bond wythes of composite masonry together using one of the following methods:
1. Individual Metal Ties: Provide ties installed in horizontal joints, spaced as required to comply with structural requirements imposed by wind or seismic forces. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (915 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.
2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
   a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes or tab-type reinforcement.
   b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement.

B. Corners: Provide interlocking masonry unit bond in each wythe and course at corners, unless otherwise indicated.

C. Intersecting and Abutting Walls: Expect where vertical expansion or control joints are required at juncture, bond walls together as follows:
1. Provide individual metal ties not more than 8 inches (203 mm) o.c.
2. Provide continuity with masonry joint reinforcement by using prefabricated T-shaped units.
3. Provide rigid metal anchors not more than 24 inches (610 mm) o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

3.5 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:
1. Individual Metal Ties: Provide ties installed in horizontal joints spaced as required to comply with structural requirements imposed by wind or seismic forces Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (915 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.
2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.

a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes or tab-type reinforcement.
b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement.
c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement to allow for differential movement regardless of whether bed joints align.

3. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

C. Coat cavity face of backup wythe to comply with Division 07 Section "Bituminous Dampproofing."

D. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches (300 mm) o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit insulation between wall ties and other confining obstructions, with edges butted tightly. Press units firmly against inside wythe of masonry.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).

B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.7 ANCHORING MASONRY TO STRUCTURAL MEMBERS

A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
1. Provide an open space not less than 1 inch (25 mm) in width between masonry and structural member, unless otherwise indicated.
2. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
3. Space anchors as required to comply with structural requirements imposed by wind or seismic forces.

3.8 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers to wall framing and concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:
1. Fasten screw-attached anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners.

a. Provide seismic anchors as required to comply with structural requirements imposed by seismic forces.

2. Embed tie sections in masonry joints. Provide not less than 2 inches (50 mm) of air space between back of masonry veneer and face of sheathing.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as required to comply with structural requirements imposed by wind or seismic forces. . Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 36 inches (914 mm), around perimeter.

3.9 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities.

B. Install flashing as follows, unless otherwise indicated:
1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing as recommended by flashing manufacturer.
2. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
3. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal flashing termination.

C. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
1. Use specified weep/vent products to form weep holes.
2. Space weep holes 24 inches (600 mm) o.c., unless otherwise indicated.

D. Place cavity drainage material in cavities to comply with configuration requirements for type of cavity drainage material used to maintain cavities clear of mortar.

E. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.
1. Close cavities off vertically and horizontally with blocking. Install through-wall flashing and weep holes above horizontal blocking.

3.10 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
   1. Provide reinforcement to comply with performance requirements described in "Part 1 – General" of this section of the specifications.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).
   3. Fully grout all concrete masonry units throughout project.

3.11 FIELD QUALITY CONTROL

A. Inspectors: Owner will engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
   1. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.

B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:
   1. Payment for these services will be made by Owner.

C. Testing Frequency: One set of tests for each 5000 sq. ft. (465 sq. m) of wall area or portion thereof.

D. Clay Masonry Unit Test: For each type of unit provided, per ASTM C 67.

E. Concrete Masonry Unit Test: For each type of unit provided, per ASTM C 140.

F. Mortar Test (Property Specification): For each mix provided, per ASTM C 780. Test mortar for mortar air content and compressive strength.

G. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019.

H. Construction Testing and Inspection Services: Provide testing and inspection services in accordance with Section 1704.5.3 *Engineered Masonry in Essential Facilities* of the 2003 International Building Code.

3.12 PARGING

A. Parge exterior faces of below-grade masonry walls, in 2 uniform coats to a total thickness of 3/4 inch (19 mm) with a steel-trowel finish. Form a wash at top of parging and a cove at bottom. Damp-cure parging for at least 24 hours and protect parging until cured.

3.13 CLEANING OF CONCRETE MASONRY UNITS

A. In-Progress Cleaning: Clean concrete masonry units as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed concrete masonry units as follows:
   1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
   2. Protect adjacent surfaces from contact with cleaner.
   3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
   4. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.14 CLEANING OF FACE BRICK

A. Do not clean brick after laying. Care should be used to keep the work as clean as possible during the laying.

B. Scrubbing, or cleaning, with a wire or other stiff brush shall not be allowed.

C. Refer to brick manufacturer's cleaning guidelines.

D. Do not use high pressure cleaners.

E. Do not use muriatic acid.

END OF SECTION 04810

SECTION 04851 - DIMENSIONED STONE CLADDING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of dimension stone:
   1. Stone façade panels
   2. Stone preassembled units
   3. Stone copings, sills, soffits, lintels and miscellaneous features
   4. Steel support and retention connections for stonework, including necessary shims.
   5. Secondary structural steel framing for stonework where not shown or not sized on structural drawings.

1.2 PERFORMANCE REQUIREMENTS

A. General: Design, fabricate and install stonework to withstand loads from wind, gravity, movement of building structure, and thermally induced movement, as well as to resist deterioration under conditions of normal use including exposure to weather, without failure. Design stone anchors and anchoring systems according to ASTM C 1242.
   1. The cladding requirements shown by the general stone details are intended to establish basic dimensions of units or modules, plus profiles and sight lines for the stonework. Within these limitations, the Contractor shall be responsible for the design of the stonework, and make whatever modifications and additions to the details as may be required to fulfill the performance requirements. The visual concept shall be maintained as shown, including profiles and alignment components.
   2. The requirements for the stone support and anchorage as shown by the details are intended to establish the basic intent of the stone anchorage system. The Contractor shall be responsible for the design of the support and anchorage system and shall make whatever modifications and additions to the details as may be required to fulfill the performance requirements. Final shapes and locations shall be as designed by a registered professional engineer.

B. Engineering Calculations: The cladding support and retention system shall be designed by a registered professional engineer experienced in cladding design. The system shall include all items required to connect the stone cladding to the structure (or secondary framing) as shown and detailed on the structural and architectural drawings. The cladding engineer shall be registered in the State of Louisiana and shall prepare engineering calculations for the justification of all principal stonework, units, fasteners, and anchorage components for compliance with the criteria established hereunder. After review, revisions and final approval, the cladding engineer shall certify a record copy of the calculations with professional engineer's stamp or seal.
   1. Based on the design loads, material properties and safety factors (all as defined in this Section), the calculations shall include, as a minimum, the following information:
      a. Stone loads, stresses and safety factors.
      b. Support and anchorage loads, stresses, safety factors, esign loads, and allowable loads.
      c. Stone thicknesses.
      d. Support and anchorage sizes.

e. Drawings of all support and anchorage items in sufficient detail for fabrication and for the detailing and completion of the shop drawings as prepared by the stone fabricator. The cladding engineer shall review all stone shop drawings prepared by stone installer or fabricator.

C. Physical Properties of Stone: The Indiana Limestone physical properties shall meet or exceed the values listed in the Indiana Limestone Institute of America, Inc. *Handbook* (ILIA), latest edition.

D. Safety Factors for Stone: Safety factors for Indiana Limestone shall be not less than as listed in the *Technote on Safety Factors*, as published by ILIA.

E. Connections and Attachments for Stone:
1. Support and retention steel: All steel shapes, plates and straps shall be designed to carry the design loads with safety factors and allowable stresses in accordance with the American Institute of Steel Construction, Inc. (AISC) except that steel supports carrying gravity loads shall be stressed not more than 50% of the yield stress in bending.
2. Connections into the Stone: Expansion bolts, straps, hooks, anchors, and other devices shall be designed to carry the design loads with safety factors not less than listed in ILIA *Technote on Safety Factors.*
3. Attachments to the structure: Connections and attachments to the structure or secondary framing shall be designed to carry the design loads with safety factors or allowable stresses in accordance with the following:
   a. Welds: Structural Welding Code (AWS D1.1 and AISC)
   b. Expansion Bolts: Per ICBO evaluation report for the specific bolt to be used. If an ICBO report is not available, use not less than the following:
      1) Safety Factors: Into 4,000 psi concrete – 4 to 1; into grouted CMU – 6 to 1.
      2) The combined load factor for combined tension and shear shall satisfy the ILIA *Technote on Safety Factors.*
   c. Bolts: AISC.
   d. Concrete Embedded (Cast-In) Items: PCI or manufacturer's recommendations, whichever is more conservative. The safety factor shall be not less than 4 to 1 based on concrete failure.

F. Design Loads: All cladding and cladding attachments shall be designed to carry the following design loads with safety factors not less than specified in this section:
1. Wind Loads: Per 2003 International Building Code requirements
2. Seismic Loads: Per code where applicable.
3. Vertical Loads:
   a. Dead Loads: Actual computed weight of cladding.
   b. Live Loads: Per 2003 International Building Code requirements.

G. Provisions for Fabrication and Erection Tolerances: Design, detail and fabricate connections to provide allowance for fabrication tolerances, erection tolerances and structural deflections.

H. Control of Corrosion: Prevent galvanic and other forms of corrosion by insulating metals and other materials from direct contact with non-compatible materials, or by suitable coating.

1.3 SUBMITTALS

A. Product Data: For each stone, stonework accessory, and other manufactured products indicated.

B. Shop Drawings: Show fabrication and installation details for dimension stone cladding system, including dimensions and profiles of stone units.

1. Show locations and details of joints both within dimension stone cladding system and between dimension stone cladding system and other construction.
2. Show locations and details of anchors and backup structure.
3. The shop drawings shall include details as developed by cladding engineer as defined in the performance requirements section.
4. Include large scale details of decorative surfaces and inscriptions.

C. Stone Samples: In form of sets of three, not less than 12 inches (300 mm) square. Sample sets shall show range of variations in color and grain to be expected in completed work.

D. Preassembled Stone Units: Provide samples as specified under Part 2 of this section of the specifications.

E. Colored Pointing Mortar Samples: For each color required.

F. Sealant Samples: For each type and color of joint sealant required.

G. Material Test Reports: From a qualified independent testing agency, as follows:

1. Stone Test Reports: For stone variety proposed for use on Project, provide test data indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous three years.

H. Data for Limestone Cladding: For limestone cladding, submit the following data which has been signed and stamped by a qualified profession engineer registered in State of Louisiana who thereby certifies preparing or supervising the preparation of the data to comply with the performance requirements and recognized engineering principles and practices:
1. Engineering calculations as defined in the Performance Section
2. Connection details as defined in the Performance Section.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated.

B. Source Limitations for Stone: Obtain limestone, regardless of finish, from a single quarry with resources to provide materials of specified consistent quality. The fabricator and the quarry shall have sufficient capacity to quarry, cut, and deliver the stonework on schedule. Both fabricator and quarry must be members in good standing of Indiana Limestone Institute.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of uniform quality and from one manufacturer for each cementitious and admixture component and from one source or produce for each aggregate.

D. Source Limitations for Other Materials: Obtain each type of stone accessory, sealants and other materials from one manufacturer for each product.

E. Information on Drawings and in Specifications: The information contained on the Drawings and in these specifications establishes requirements for both aesthetic effects and performance of the limestone cladding. Aesthetic effects are indicated by dimensions, arrangement, alignment and profiles of components and assemblies as they relate to sight lines and relationships to one another and to adjoining work. Performance is indicated by criteria that is subject to verification by either preconstruction or field test, if applicable, or by in-service experience.
   1. Do not modify intended aesthetic effects. Where modifications are proposed, submit comprehensive explanatory data for review and approval.

F. Installer Qualifications: Engage an installer with not less than ten (10) years experience and who has successfully completed stonework similar in material, design and extent to that indicated for this project. Submit liss of completed projects; include project names, addresses, and names of architects and owners.

G. Preconstruction Stone Testing: Engage a qualified independent testing agency to perform preconstruction testing indicated below.

   1. Furnish test specimens randomly selected from, and representative of actual materials proposed for incorporation into the Work.
   2. Physical Property Tests: Test limestone for compliance with physical property requirements for Limestone Building Stone, Type II, as listed in ASTM C-568. The following test reports shall be submitted:
      a. ASTM C 99 Modulus of Rupture
      b. ASTM C 170 Compressive Strength
   3. Flexural Strength Tests: For each combination of limestone, thickness, orientation of cut, and finish, proposed for use on Project, tested according to ASTM C 880, in both wet and dry conditions.
   4. Anchorage Tests: For each combination of limestone, orientation of cut, finish, and anchor type proposed for use on Project, tested according to ASTM C 1354.

H. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

   1. Build mockups of typical exterior wall with dimension stone cladding, approximately 15 feet (4.5 m) long by 10 feet (3 m) high.

I. Qualifications for Welding Work: Qualify welding operators in accordance with AWS "Standard Qualification Procedure."
   1. Provide certification that each welder employed in the work is qualified for welding processes involved by having satisfactorily passed AWS qualification tests and, if applicable, by undergoing recertification. Retesting for recertification shall be contractor's responsibility.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver masonry materials to project in undamaged condition.

B. Store and handle stone and related materials to prevent their deterioration or damage:
   1. Do not use pinch or wrecking bars on stonework.
   2. Lift with wide-belt type slings where possible; do not use wire rope or ropes containing tar or other substances which might cause staining.

3. Store stone on non-staining wood skids or pallets, covered with non-staining, waterproof membrane. Place and stack skids and stone to distribute weight evenly and to prevent breakage or cracking of stones.
4. Store cementitious materials off the ground, under cover and in dry location.

1.6 PROJECT CONDITIONS

A. Protection of Stonework: Protect stonework during erection as follows:
1. Cover top of walls with non-staining waterproof sheeting at end of each day's work. Cover partially completed structures when work is not in progress. Extend cover a minimum of 24" down both sides and hold securely in place.
2. Prevent staining of stone from mortar, grout, sealants, and other sources. Immediately remove such materials from stone without damage to the stonework.

B. Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.

C. Protect sills, ledges and projections from droppings of mortar and sealants.

D. Environmental Limitations for Mortar: Do not use frozen materials or materials mixed or coated with ice or frost. Remove and replace dimension stone cladding damaged by frost or freezing conditions. Comply with cold- and hot-weather construction and protection requirements for masonry contained in ACI 530.1/ASCE 6/TMS 602.

E. Environmental Limitations for Sealants: Do not install sealants when ambient and substrate temperatures are outside limits permitted by sealant manufacturer or below 40 deg F (5 deg C) or when joint substrates are wet.

PART 2 - PRODUCTS

2.1 LIMESTONE

A. Limestone: Comply with ASTM C 568.

1. Classification: II Medium-Density .
2. Description: Oolitic limestone.

B. Variety and Sources: Indiana oolitic limestone quarried in Lawrence, Monroe, or Owen Counties, Indiana.

C. Indiana Oolitic Limestone Grade and Color: Select, buff according to grade and color classification established by ILI.

D. Finish: Smooth.

2.2 MORTAR MATERIALS

A. Portland Cement: ASTM C 150, Type I, except Type III may be used for cold-weather construction. Provide gray or white cement as required to produce mortar color indicated.

1. Low-Alkali Cement: Portland cement for use with limestone shall contain not more than 0.60 percent total alkali when tested according to ASTM C 114.

B. Hydrated Lime: ASTM C 207. Type S.

C. Aggregate: ASTM C 144; except for joints narrower than 1/4 inch (6 mm) , use aggregate graded with 100 percent passing No. 16 (1.18-mm) sieve.

D. Mortar Pigments: Natural and synthetic iron oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in mortar and containing no carbon black.

E. Water: Clean, non-alkaline and potable.

2.3 ANCHORS AND BACKUP STRUCTURE

A. Provide anchors and attachments of type and size required to support the stonework frabricated from the following metals for conditions indicated below.
1. Anchors Located Below the Second Floor Level: Stainless steel, ASTM A 666, Type 316.
2. Anchors Located Above the Second Floor Level: Stainless steel, ASTM A 666, Type 304 or Type 316.
3. Dowels And Pins Located Below the Second Floor Level: Stainless steel, ASTM A 276, Type 316.
4. Dowels And Pins Located Above the Second Floor Level: Stainless steel, ASTM A 276, Type 304 or Type 316.
5. Shelf Angles Located Below the Second Floor Level: Stainless steel ASTM A666, Type 316.
6. Shelf Angles Located Above the Second Floor Level: Hot-dip galvanized steel, ASTM A 36/A 36M for materials and ASTM A 123/A 123M for galvanizing.
7. Cast-in-Place Concrete Inserts: Galvanized malleable iron adjustable inserts
8. Anchor Bolts, Nuts, Washers Not in Direct Contact with Stone; Comply with ASTM A 307, Grade A, for material, and ASTM C 153, Class C, for galvanizing.
9. Steel Plates, Shapes and Bars Not in Direct Contact with Stone: Comply with ASTM A36 for materials and ASTM A 123 for galvanizing.
10. Expansion bolts Not in Direct Contact with Stone: Zinc plated or cadmium plated bolts with stainless steel expansion clips.
11. Postinstalled Anchor Bolts for Concrete and Masonry: Chemical anchors torque-controlled expansion anchors or undercut anchors made from stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group A1 or A4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors.
12. Dovetail Slots: Where required, furnish dovetail slots, with filler strips, of slot size requied to receive anchors provided, fabricated from 0.03336 (22-gage) galvanized steel sheet steel complying with ASTM A446, G90.
13. Threaded Fasteners:
    a. For stainless steel, use stainless-steel bolts, nuts, and washers; ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group A1 or A4).
    b. For galvanized steel shelf angles and backup structure, use carbon steel bolts, nuts, and washers; ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), for bolts; ASTM A 563 (ASTM A 563M), Grade A, for nuts; and ASTM F 436 (ASTM F 436M) for washers; all hot-dip or mechanically zinc coated.

14. Weld Plates for Installation in Concrete: Comply with Division 05 Section "Metal Fabrications."

B. Miscellaneous Steel Framing: For framing members in contact with stone fabricate from same material and finish specified for anchors for locations indicated above. For framing members not in contact with stone, comply with requirements indicated below:

1. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M, minimum thickness of 3/16 inch (5 mm).
2. Steel Tubing: ASTM A 500 (cold formed), or ASTM A 513, Type 5 (mandrel drawn), minimum thickness of 3/16 inch (5 mm).
3. Slotted Channel Framing: Cold-formed metal channels with continuous slot complying with MFMA-3, made from steel sheet complying with ASTM A 1008/A 1008M, structural steel, Grade 33 (Grade 230), not less than 0.105-inch (2.66-mm) nominal thickness, hot-dip galvanized after fabrication to comply with ASTM A 123/A 123M.

2.4 PREASSEMBLED STONE UNITS

A. Performance Requirements: Performance requirements defined elsewhere in this section apply to the preassembled units.

B. Adhesive: The adhesive shall be a two-component epoxy consisting of epoxy resin and hardener.

C. Adhesive Properties: The adhesive used shall meet the following minimum requirements after a 7-day cure at 75 degrees Fahrenheit. (Property: Value / Test Method)
1. Tensile Bond Strength: Cohesive failure in stone / ASTM C-321
2. Tensile Elongation: 2.5% / ASTM D-638
3. Tensile Strength: 3,500 psi / ASTM D-638
4. Compressive Double Shear: 400 psi / MMM G-650A
5. Compressive Strength: 6,000 psi / ASTM D-695
6. Shore "D" Hardness: 75 / ASTM D-1706
7. Water Absorption (24 hours): 0.50% / ASTM D-570

D. Samples: Two sample units of stone bonded together with adhesive shall be submitted showing stone and joint quality. Samples shall be 6" long, 3" wid, ¾" thick, bonded together on the large face, at right angles. No fabrication or assembly shall begin until approval of sample is obtained.
1. Industry practice permits 1/8" thick adhesive joints.

E. Drawings: The epoxy joint construction including mechanical anchoring and framing shall be shown on the shop drawings.

F. Shop Assembly Requirements:
1. Stone shall be dry and free from grease, oil, dirt, loose particles, and efflorescence. Clean compressed air should be employed to blow stone dust from the pores of the stone. Heat is recommend for the removal of moisture from the stone prior to applying epoxy. No moisture should be observed creeping into areas to be bonded following the removal of heat.
2. Units shall not be assembled when the stone temperature and the surrounding air temperatures are below 50 degrees F or above 95 degrees F. Assembly of units below 50 degrees F is permitted when the temperature of the stone units and adhesive is raised by heating to a temperature above 50 degrees F. After the units have been joined, heat

should continue to be applied to stone adjacent to the joint area to give the adhesive the curing temperature above 50 degrees F. Approved clips, frames, expansion bolts, and other mechanical connections shall be installed in strict accordance with the approved shop drawings.

3. Adhesives shall be mixed in parts by weight or parts by volume in strict accordance with manufacturer's instructions, with strict compliance to the manufacturer's recommendations on the "pot life" of the adhesive.
4. Upon joining the stone members together, suitable clamps or bracing shall be used to keep the stone in proper alignment until the adhesive sufficiently hardens. Process shall include any and all shims needed to insure proper alignment.
5. Assembled stone units shall not be moved until the adhesive has cured sufficiently to assure there will be no joint damage. Curing shall continue until the adhesive has reached the required hardness. When stones are pressed together, the adhesive shall flow out of the joint. On exposed joints, in a textured finish, it is recommended that the excessive adhesive be removed after the adhesive has taken on its initial hardening. The extra adhesive may be scraped away with a putty knife. Any excessive adhesive on smooth finish may be removed after complete hardening with the use of power sanders.
6. All dowels, anchors, expansion bolts, bearing plates, and other steel items in direct contact with the stone or contained with the stone shall be stainless steel of type specified above for different locations indicated.
7. Fabricate and assemble structural framing in shop to comply with AISC Specifications for the *Design, Fabrication, and Erection of Structural Steel for Buildings*, including "Commentary" and Supplements thereto as issued, and as indicated on final shop drawings.
8. Weld or bolt connections to comply with the following requirements:
   a. Install high strength threaded fasteners to comply with AISC *Specifications for Structural Joints using ASTM A-325 or A-490 bolts* approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundations (RCRBSJ).
   b. Weld connections to comply with AWS D1.1 *Structural Welding Code – Steel.*

G. Transportation and Storage: Extreme care shall be taken to insure that the assembled units are free of torsional stress during transportation, handling, and storage.

H. Erection: The stone fabricator shall make provisions for the employment of the necessary lifting methods of the assembled units, in cooperation with the erector. Such lifting devices as clamps, slings, etc., shall be furnished by the erector.

2.5 STONE ACCESSORIES

A. Setting Shims: Leas, stainless steel, or plastic shims, nonstaining to stone, sized to suit joint thickness and bed depths of stonework involved without intruding into required depths of joint sealants.

B. Concealed Sheet Metal Flashing: Fabricate from stainless steel in thicknesses indicated, but not less than 0.0156 inch (0.4 mm) thick. Comply with requirements specified in Division 07 Section "Sheet Metal Flashing and Trim."

C. Cementitious Dampproofing for Limestone: Provide cementitious formulations that are recommended by ILI and that are nonstaining to stone, compatible with joint sealants, and noncorrosive to anchors and attachments.

D. Weep and Vent Tubes: Medium-density polyethylene tubing, 1/4-inch (6-mm) OD and of length required to extend from exterior face of stone to cavity behind.

E. Sealants for Joints in Dimension Stone Cladding: Comply with applicable requirements in Division 07 Section "Joint Sealants" and provide sealants that do not stain stone.

F. Sealant for Filling Kerfs: Same sealant used for joints in dimension stone.

2.6 STONE FABRICATION

A. General: Fabricate stonework in sizes and shapes required to comply with the requirements as shown on approved shop drawings.

B. Comply with recommendations of the Indiana Limestone Institute of America, Inc. (ILI) as published in the *Indiana Limestone Handbook* (latest edition).

C. Cut and drill sinkages and holes in stones for anchors, fasteners, supports, and lifing devices as indicated or needed to set stonework securely in place; shape beds to fit supports.

D. Cut stones to produce pieces of thickness, size and shape indicated or required and within fabrication tolerances recommended by ILI.

E. Thickness of Exterior Stone Cladding: Provide stone thicknesses required to comply with performance requirements but not less than shown on architectural drawings. Use tables in *Indiana Limestone Handbook* as a guide to size requirements.

F. Control depth of stone and back check to maintain minimum clearance of 1 inch (25 mm) between backs of stone units and surfaces or projections of structural members, fireproofing (if any), backup walls, and other work behind stone.

G. Cut joints (bed and vertical) straight and at right angle to face, unless otherwise indicated.

H. Quirk-miter corners, unless otherwise indicated; shall provide for cramp anchorage in top and bottom bed joints of corner pieces.

I. Finish exposed faces and edges of stone to comply with requirements indicated for finish and to match approved samples and mockups.

J. Cut stone to produce uniform joints 3/8 inch (10 mm) wide and in locations indicated.

K. Contiguous Work: Provide chases, reveals, reglets, openings, and similar features as required to accommodate contiguous work.

L. Fabricate molded work, including washes and drips, to produce stone shapes with a uniform profile throughout entire unit length, with precisely formed arrises slightly eased to prevent snipping, and with matching profile at joints between units.

M. Carve and cut decorative surfaces and inscriptions to conform with approved shaded drawings or models. Use skilled stone carvers experienced in the successful performance of work similar to that indicated.

2.7 MORTAR MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions. Do not use admixtures including coloring pigments, air-entraining agents, accelerators, retarders, water repellent agents, anti-freeze compounds, or calcium chloride, unless otherwise indicated.

B. Mixing: Combine and thoroughly mix cementitious materials, water and aggregates in a mechanical batch mixer; comply with referenced ASTM standard for mixing time and water content, unless otherwise indicated.

C. Portland Cement-Lime Setting Mortar: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated below:
1. Set limestone with Type N mortar.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Require installer to examine surfaces to receive stonework and conditions under which stonework will be installed and to report in writing any conditions which are not in compliance with requirements. Do not proceed with installation until surfaces and conditions comply with requirements indicated in specifications or elsewhere for execution of other work which affects stonework.

3.2 PREPARATION

A. Advise installers of other work about specific requirements relating to placement of inserts, flashing reglets and similar items which will be used by stonework installer for anchoring, supporting and flashing of stonework. Furnish installers of other work with drawings or templates showing locations of these items. General contractor or concrete contractor will provide drawings to locate weld-plates and embeds for connection of stone skin or its system.

B. Clean stone surfaces which have become dirty or stained prior to setting to remove soil, stains and foreign materials. Clean stones by thoroughly scrubbing stones with fiber brushes flowed by a thorough drenching with clear water. Use only mild cleaning compounds that contain no acid, caustic or abrasives.

3.3 INSTALLING BACKUP STRUCTURE

A. Installing Miscellaneous Steel Framing: Comply with AISC's "Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design."

1. Maintain erection tolerances of backup structure within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. For prefabricated units to which stone has been installed before erection, maintain tolerances of stone faces and edges as specified in "Installation Tolerances" Article.

B. Attach framing for stone support system to structural frame of building at connection points indicated by welded or bolted field connections complying with following requirements:

1. Install high strength threaded fasteners to comply with AISC *Specifications for Structural Joints using ASTM A325 or A 490 bolts* approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation (RCRBSJ).
2. Weld Connections to comply with AWS D1.1 *Structural Welding Code Steel.*
3. Provide joints to exclude water or permit its escape to exterior of building. Provide weeps at locations where water could accumulate due to condensation or other cause.
4. For galvanized surfaces of assembled framing, comply with ASTM A 780 for cleaning field welds, bolted connections and abraded areas and application of galvanizing repair paint.
5. For shop-painted surfaces, clean field welds, bolted connections, and abraded areas, immediately after erection. Apply paint to exposed areas using same material as used for shop painting.

3.4 SETTING DIMENSION STONE CLADDING, GENERAL

A. Execute dimension stone cladding installation by skilled mechanics and employ skilled stone fitters to do necessary field cutting as stone is set. Use power saws with diamond blades to cut stone. For exposed edges, produce edges which are cut straight and true. Mallet and chisel cutting will be permitted provided craftsmen are skilled in their use.

B. Contiguous Work: Provide chases, reveals, reglets, openings and other spaces as indicated for accommodating contiguous work. Close up openings in stonework after other work is in place with stonework which matches that already set.

C. Set stone to comply with requirements indicated on Drawings and final Shop Drawings. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure dimension stone cladding in place. Shim and adjust anchors, supports, and accessories to set stone accurately in locations indicated with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.

D. Dampproofing for stain prevention: Coat limestone with dampproofing to extent indicated below:

1. Stone at Grade: Beds, joints, and back surfaces to at least 12 inches (300 mm) above finish-grade elevations.
2. Stone Extending below Grade: Beds, joints, back surfaces, and face surfaces below grade.
3. Dampproof all adjacent concrete surfaces on which limestone will rest, including concrete or cmu haunches and ledges, as well as support angles.
4. Cementitious coatings must be allowed to cure before treated stone is set. Due care must be exercised in handling all dampproofed stone to avoid chipping or off-setting.

E. Provide expansion, control, and pressure-relieving joints of widths and at locations indicated or required.

1. Sealing expansion and other joints is specified in Division 07 Section "Joint Sealants."
2. Keep expansion joints free of mortar and other rigid materials, including shims.

F. Install concealed flashing at continuous shelf angles, lintels, ledges, and similar obstructions to downward flow of water to divert water to building exterior.

G. Keep cavities open where unfilled space is indicated between back of stone units and backup wall; do not fill cavities with mortar or grout.

1. Place weep holes in joints where moisture may accumulate, including base of cavity walls, above shelf angles, and flashing. Locate weep holes at intervals not exceeding 24 inches (600 mm).
2. Place vents in cavity walls at tops of cavities, below shelf angles and flashing, and at intervals not exceeding 20 feet (6 m) vertically. Locate vents in joints at intervals not exceeding 60 inches (1500 mm) horizontally.

3.5 SETTING DIMENSION STONE CLADDING

A. Attach anchors securely to stone and to backup surfaces. Comply with recommendations in ASTM C 1242.

B. Fill anchor holes with non-staining mortar or sealant.
1. Where dowel holes occur at pressure-relieving joints, provide compressive material above and below dowels.

C. For stones supported on clip or continuous angles, set stones on non-corrosive and non-staining shim material in sufficient area to support the load. Mortar may be used in lieu of shims provided that setting pads are provided to maintain joint sizes if stone weight squeezes out mortar.
1. Place setting buttons of adequate size, in sufficient quantity, and of same thickness as indicated joint width, to prevent mortar from squeezing out and to maintain uniform joint widths. Hold buttons back from face of stone to provide space for backer rope and sealant.
2. The joint between bottom of relieving angles and top surface of stones below angles shall be free of mortar or shims to avoid load transfer.

D. Where mortar is used in setting stones on anchors or elsewhere, rake out mortar from joints to depths adequate to receive sealants and sealant backings.

E. Embed ends of lugged sills on shims or mortar; leave balance of joint open until final sealing.

F. Set the stonework with open vertical joints for installation of joint sealants. Use no shims or spacers in vertical joints.

3.6 JOINT-SEALANT INSTALLATION

A. Prepare joints and apply sealants of type and at locations indicated to comply with applicable requirements in Division 07 Section "Joint Sealants."

3.7 INSTALLATION TOLERANCES

A. Variation from Plumb: For vertical lines and surfaces of walls, do not exceed 1/4 inch in 10 feet (6 mm in 3 m) or 1/2 inch in 40 feet (12 mm in 12 m) or more. For external corners, corners and jambs within 20 feet (6 m) of an entrance, expansion joints, and other conspicuous lines, do not exceed 1/8 inch in 10 feet (3 mm in 3 m) or 3/8 inch in 40 feet (10 mm in 12 m) or more.

B. Variation from Level: For lintels, sills, parapets, horizontal bands, and other conspicuous lines, do not exceed 1/8 inch in 10 feet (3 mm in 3 m) or 3/8 inch (10 mm) maximum.

C. Variation of Linear Building Line: For positions shown in plan, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (12 mm in 12 m) or more.

D. Variation in Joint Width: Do not vary from average joint width more than plus or minus 1/8 inch (3 mm) or a quarter of nominal joint width, whichever is less.

E. Variation in Plane between Adjacent Stone Units (Lipping): Do not exceed 1/16-inch (1.5-mm) difference between planes of adjacent units.

3.8 ADJUSTING AND CLEANING

A. Repairing Damaged Stone: Repair of stone is an accepted practice and will be permitted. Some chipping is expected; repair of small chips is not required if it does not detract from the overall appearance of the work, or impair the effectiveness of the mortar or sealant. The criteria for acceptance of chips and repairs will be per standards and practices of the industry unless other criteria are mutually agreed upon.

B. Remove and replace stonework of the following description:
   1. Stones so damaged that repair is impossible, either structurally or aesthetically.
   2. Defective joints.
   3. Stones and joints not in conformance with approved samples and field-constructed mockups.
   4. Stonework not complying with other requirements indicated.

C. Replace in manner which results in stonework conforming to approved samples and field-constructed mockups, complying with other requirements and showing no evidence of replacement.

D. Clean stonework using clean water and stiff bristle fiber brushes. Do not use wire brushes, acid type cleaning agents, or other materials or methods which could damage stone. Mechanical or pressure cleaning methods may be used if approved. Protect limestone when adjacent brick is being cleaned.

3.9 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to fabricator and installer, which ensures stonework being without damage or deterioration at time of substantial completion.

END OF SECTION 04851

SECTION 05120 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Scope: This Section includes fabrication and erection of structural steel work, as shown on drawings including schedules, notes, and details showing size and location of members, typical connections, and types of steel required.

B. Structural steel is that work defined in American Institute of Steel Construction (AISC) "Code of Standard Practice" and as otherwise shown on drawings.

C. Miscellaneous Metal Fabrications are specified elsewhere in Division 5.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data or manufacturer's specifications and installation instructions for following products. Include laboratory test reports and other data to show compliance with specifications (including specified standards).
1. Structural steel (each type), including certified copies of mill reports covering chemical and physical properties.
2. High-strength bolts (each type), including nuts and washers.
3. Structural steel primer paint.
4. Shrinkage-resistant grout.

C. Shop drawings prepared under supervision of a Louisiana licensed Structural Engineer, including complete details and schedules for fabrication and assembly of structural steel members, procedures, and diagrams.
1. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols and show size, length, and type of each weld.
2. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed as work of other sections.
3. See Section Submittals for shop drawings requirements. Reproductions made from contract drawings will not be accepted. Submit one sepia and two blueline prints with each submittal. Review of shop drawings by the Architect/Engineer will be for general compliance with contract documents. No responsibility will be assumed for correctness of dimensions, quantities or details.
4. Miscellaneous Metal Fabrications are specified elsewhere in Division 5.
5. All shop drawings used in the field must bear the Architect/Engineer shop drawings review stamp with "Approved" indicated.

D. Mill Test Reports: Submit manufacturer's certified test reports to the testing laboratory and architect showing chemical analysis and results of tensile and bending tests. Tests shall meet the requirements of ASTM A6/A6M.

E. Test reports conducted on shop- and field-bolted and welded connections. Include data on type(s) of tests conducted and test results.

1.3 QUALITY ASSURANCE

A. Standard Specifications: Except as modified or supplemented by these specifications, materials, design, fabrication, and erection of Structural Steel shall be in accordance with the American Institute of Steel Construction's "Specifications for Structural Steel for Buildings, Allowable Stress Design and Plastic Design", June 1, 1989, and the A.I.S.C. "Code of Standard Practice for Steel Buildings and Bridges", September 1, 1986. A.I.S.C. "Manual of Steel Construction, Allowable Stress Design", Ninth Edition.

B. Codes and Standards: Comply with provisions of following, except as otherwise indicated:
1. American Institute of Steel Construction (AISC) "Code of Standard Practice for Steel Buildings and Bridges."
   a. Paragraph 4.2.1 of the above code is hereby modified by deletion of the following sentence:
   "This approval constitutes the Owner's acceptance of all responsibility for the design adequacy of any detail configuration of connections developed by the fabricator as a part of his preparation of these shop drawings."
2. AISC "Specifications for Structural Steel Buildings," including "Commentary."
3. "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts" approved by the Research Council on Structural Connections.
4. American Welding Society (AWS) D1.1 "Structural Welding Code - Steel."
5. ASTM A 6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use."

C. Qualifications for Welding Work: Qualify welding procedures and welding operators in accordancewith AWS "Qualification" requirements.
1. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests.
2. If re-certification of welders is required, retesting will be Contractor's responsibility.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site at such intervals to ensure uninterrupted progress of work.

B. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time to not to delay work.

C. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration. If bolts and nuts become dry or rusty, clean and relubricate before use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Metal Surfaces, General: For fabrication of work that will be exposed to view, use only materials that are smooth and free of surface blemishes including pitting, rust and scale seam marks, roller marks, rolled trade names, and roughness. Remove such blemishes by grinding, or by welding and grinding,

prior to cleaning, treating, and applying surface finishes.

B. Structural Steel Shapes, Plates, and Bars: ASTM A 572 Grade 50.

C. Cold-Formed Steel Tubing: ASTM A 500, Grade B, min. fy = 46 ksi.

D. Steel Pipe: ASTM A 53, Type E or S, Grade B; or ASTM A 501, min. fy = 35 ksi.

E. Anchor Bolts: ASTM A 307, non-headed type unless otherwise indicated.

F. Unfinished Threaded Fasteners: ASTM A 307, Grade A, regular low-carbon steel bolts and nuts.
   1. Provide hexagonal heads and nuts for all connections.

G. High-Strength Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers, as follows.
   1. Quenched and tempered medium-carbon steel bolts, nuts, and washers, complying with ASTM A 325.
   2. Where indicated as galvanized, provide units that are zinc coated, either mechanically deposited complying with ASTM B 695, Class 50, or hot-dip galvanized complying with ASTM A 153.

H. Electrodes for Welding: Comply with AWS Code.
   1. Welding electrodes for manual shielded metal-arc welding shall conform to AWS A5.1 or A5.5 E70XXX welding electrodes and flux used in submerged arc process shall conform to AWS A5.17 F7X-EXXX. Use low hydrogen electrodes for A572 steel.

I. Structural Steel Primer Paint: Rust-inhibitive conforming to Fed. Spec. TT-P-664 and be compatible with finish paint systems.

J. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean, uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 2.0 parts sand, by volume, with minimum water required for placement and hydration.

K. Nonmetallic Shrinkage-Resistant Grout: Premixed, nonmetallic, non-corrosive, non-staining product containing selected silica sands, Portland cement, shrinkage compensating agents, plasticizing and water-reducing agents, complying with CE-CRD-C621.

2.2 FABRICATION

A. Shop Fabrication and Assembly: Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings. Provide camber in structural members where indicated.
   1. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize field handling of materials.
   2. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.

B. Connections: Weld or bolt shop connections, as indicated.
   1. Bolt field connections, except where welded connections or other connections are indicated.

C. Welded Construction: Comply with AWS Code for procedures, appearance and quality of welds, and

methods used in correcting welding work.

D. Holes for Other Work: Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members, as shown on final shop drawings.
   1. Provide threaded nuts welded to framing and other specialty items as indicated to receive other work.
   2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.

2.3 SHOP PAINTING

A. General: Shop-paint structural steel, except those members or portions of members to be embedded in concrete or mortar. Paint embedded steel that is partially exposed on exposed portions and initial 2 inches of embedded areas only.
   1. Do not paint surfaces to be welded or high-strength bolted with friction-type connections.
   2. Do not paint surfaces scheduled to receive sprayed-on fireproofing.
   3. Apply 2 coats of paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

B. Painting: Immediately after surface preparation, apply structural steel primer paint in accordance with manufacturer's instructions and at a rate to provide dry film thickness of not less than 1.5 mils. Use painting methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.4 GALVANIZING

A. Items shown on the plans to be galvanized and bolts for same shall be hot dip zinc coated after fabrications. Galvanizing shall be done in accordance with A.S.T.M. Serial Designation A123 and A153. Any zinc coating that is damaged shall be touched up with Galvacon as manufactured by Southern Coatings in accordance with the manfacturer's recommendations.

2.5 SOURCE QUALITY CONTROL

A. General: Materials and fabrication procedures are subject to inspection and tests in mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.
   1. Promptly remove and replace materials or fabricated components that do not comply.

B. Design of Members and Connections: Details shown are typical; similar details apply to similar conditions, unless otherwise indicated. Verify dimensions at site whenever possible without causing delay in the work.
   1. Promptly notify Architect whenever design of members and connections for any portion of structure are not clearly indicated.

PART 3 - EXECUTION

3.1 ERECTION

A. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections

of sufficient strength to bear imposed loads. Remove temporary Members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of structures as erection proceeds.

B. Temporary Planking: Provide temporary planking and working platforms as necessary to effectively complete work.

C. Setting Bases and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.
   1. Set loose and attached base plates and bearing plates for structural members on wedges or other adjusting devices.
   2. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
   3. Pack grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.
   4. For proprietary grout materials, comply with manufacturer's instructions.

D. Field Assembly: Set structural frames accurately to lines and elevations indicated. Align and adjust various members forming part of complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
   1. Level and plumb individual members of structure within specified AISC tolerances.
   2. Splice members only where indicated and accepted on shop drawings.

E. Erection Bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces.
   1. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
   2. Do not enlarge unfair holes in members by burning or by using drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

F. Gas Cutting: Do not use gas cutting torches in field for correcting fabrication errors in primary structural framing. Cutting will be permitted only on secondary members that are not under stress, as acceptable to Architect. Finish gas-cut sections equal to a sheared appearance when permitted.

G. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.
   1. Apply by brush or spray to provide minimum dry film thickness of 1.5 mils.

3.2. QUALITY CONTROL

A. The Contractor shall engage an independent testing and inspection agency to inspect high-strength bolted welded connections and to perform tests and prepare test reports.
   1. Testing agency shall conduct and interpret tests, state in each report whether test specimens comply with requirements, and specifically state any deviations therefrom.
   2. Provide access for testing agency to places where structural steel work is being fabricated or produced so that required inspection and testing can be accomplished.
   3. Testing agency may inspect structural steel at plant before shipment.

B. Correct deficiencies in structural steel work that inspections and laboratory test reports have indicated

to be not in compliance with requirements. Perform additional tests, at Contractor's expense, as necessary to reconfirm any noncompliance of original work and to show compliance of corrected work.

C. Shop-Bolted Connections: Inspect or test in accordance with AISC specifications.
Verify that gaps of installed Direct Tension Indicators are less than gaps specified in ASTM F 959, Table 2.

D. Shop Welding: Inspect and test during fabrication of structural steel assemblies, as follows:
1. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.
2. Perform visual inspection of all welds.
3. Perform tests of welds as follows.

Ultrasonic Inspection: ASTM E 164.

E. Field-Bolted Connections: Inspect in accordance with AISC specifications.

F. Field Welding: Inspect and test during erection of structural steel as follows:
1. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.
2. Perform visual inspection of all welds.
3. Perform tests of welds as follows:
Ultrasonic Inspection: ASTM E 164.

END OF SECTION 05120

SECTION 05210 - STEEL JOISTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: All steel joist work as shown on the drawings.

1.2 QUALITY ASSURANCE

A. Standard Specifications: Except as modified or supplemented herein, materials, designs, fabrication, painting and erection of all steel joists and bridging for same shall be in accordance with the latest edition of the following publications of the Steel Joist Institute, as applicable:
   1. Standard Specifications for Open Web Steel Joists, K-Series.
   2. Standard Specifications for Long Span Steel LH-Series and Deep Long Span Steel Joists, DHL-Series.
   3. Standard Specifications for Joist Girders.
   4. Recommended Code of Standard Practice for Steel Joists and Girders.

B. Welders: All welders for field welds shall be approved by an independent Testing Laboratory in accordance with American Welding Society standards and qualified for the type of welding which they will perform.

1.3 SUBMITTALS

A. Manufacturer's Data: For information only, submit 2 copies of manufacturer's specifications and installation instructions for each type of joist, joist girder and its accessories. Include manufacturer's certification that joists comply with "Standard Specifications".

B. Shop Drawings: Submit detailed drawings showing layout and erection of joists, special connections, jointing and accessories. Include the mark, number, size and properties, panel point locations, type, locations and spacing of joists and bridging. See Section - Submittals for shop drawing requirements. Reproductions made from contract drawings will not be acceptable. Submit one sepia and two blue line prints.

C. Design Computations: Furnish design computations bearing the seal and signature of a Civil Engineer with State of Louisiana registration for all joists and bridging required to be designed for wind uplift.

PART 2 - PRODUCTS

2.1 MANUFACTURE

A. See Article "Standard Specifications" preceding. Manufacturer of steel joists must be a member of the Steel Joist Institute or must be approved by the Architect prior to receipt of bids. Where ends of K- Series joists bear less than 2-1/2" on beams, joist manufacturer shall design the joist ends to provide for the reduced bearing. Staggering of joists will not be permitted.

2.2 MATERIALS

A. GENERAL
1. Comply with "Standard Specifications".
2. In designing joists and bridging the uplift requirements, if any, required by the drawings must be met.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with "Standard Specifications".

3.2 FIELD CONNECTIONS

A. All field connections of steel to steel, including bridging, shall be welded.

B. The Contractor's independent Testing Laboratory shall visually inspect all connections in field to determine quality, size, and compliance with reviewed erection drawings. Where the quality of a weld is in question, the Architect will be advised. The Contractor may then be required to remove and reweld the connection or if the Contractor desires he may have the weld inspected further by radiography. The cost of this radiography inspection will be borne by the Contractor whether or not the weld is acceptable.

3.3 FIELD PAINTING

A. After erection, all field connections, welds, and abraded places shall be touched-up with same paints as shop coat. Refer to Section - Painting, for additional field coats of paint.

END OF SECTION 05210

SECTION 05310 - STEEL DECK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. All steel decking as shown on the drawings.

B. Standing Seam Metal Roofing, if required by the drawings, is specified in Division 7.

1.2 QUALITY ASSURANCE

A. Standard Specifications: Except as modified or supplemented herein, the decking shall be designed in accordance with the latest edition of AISI "Specifications for the Design of Cold-Formed Steel Structural Members and all applicable requirements contained in "Design Manual for Composite Decks, Form Decks and Roof Decks" of the Steel Deck Institute, Inc.

B. Testing – Contractor's independent testing laboratory shall witness all welded connections.

1.3 SUBMITTALS

A. Manufacturer's Data: For information only, submit 2 copies of manufacturer's specifications and installation instructions for each type of decking and accessories. Include manufacturer's certifications as may be required to show compliance with these specifications.

B. Shop Drawings: Submit detailed drawings showing layout and types of deck panels, anchorage details, and conditions requiring closure panels, supplementary framing, cut openings, special jointing or other accessories.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Deck, Dimensions and Properties: Dimensions and properties of the various types of deck are shown on the drawings. Deck configurations shall be similar to that of the decks called for on the drawings. Allowable stresses shall be equal to that of the deck specified on the drawings.

B. Deck Coating: Galvanized, ASTM A525, G90.

C. Miscellaneous Steel Shapes: ASTM A36.

D. Sheet Metal Accessories: ASTM A 526, commercial quality, galvanized.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Deck sheets shall be erected and welded to supports in accordance with the manufacturer's specifications and erection layouts and as required to resist the uplift loads, if any, noted on the drawings.

B. Side joints must be fastened together in accordance with manufacturer's specifications. Cutting openings through the deck less than 16 square feet in area, and all skew cutting shall be performed in the field. Deck shall be continuous over three (3) or more spans.

C. Except where other permanent type edge closures are shown on the drawings, provide sheet metal edge closures around the perimeter of all steel deck areas, including openings, where concrete is to be applied to the deck. Deck closures shall be of proper gage and configuration to retain the wet concrete.

3.2 TOUCH-UP

A. All damaged coating, including welds, shall be touched up with an approved coating before placing fill.

END OF SECTION 05310

SECTION 05425 - PREFABRICATED STEEL ROOF TRUSSES

PART 1 - GENERAL

1.1 SUMMARY

A. Scope: This work to be done under this section of the specifications includes all labor, materials, equipment, and services necessary for design, fabrication and erection of prefabricated steel roof trusses, as indicated on drawings and herein specified.

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. and types of steel required.

1. AMERICAN IRON AND STEEL INSTITUTE (AISI)
   AISI Cold-Formed Spec (1996) Specification & Commentary for the Design of Cold-Formed Steel Structural Members (Part V of the Cold-Formed Steel Design Manual)
2. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(2001) Zinc(Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2001) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 370	(1997a) Mechanical Testing of Steel Products
ASTM A 653/A 653M	(2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot- Dip Process
ASTM B 633	(1985)R 1998) Electrodeposited Coatings of Zinc on Iron and Steel
ASTM E 329	(2000b) Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

3. AMERICAN WELDING SOCIETY (AWS)
   AWS D1.3 (1998) Structural Welding Code - Sheet Steel
4. SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)
   SAE J 78 (1998) Steel Self Drilling Tapping Screws

1.3 SUBMITTALS

A. The following shall be submitted in accordance with SUBMITTAL PROCEDURES:

1. Shop Drawings (Sealed and signed by a Louisiana licensed Civil Engineer)
2. Truss Components:
   a. Cross sections, plans, and/or elevations showing component types and locations for each truss application; including shop coatings and material thicknesses for each truss component.
   b. Connection details showing fastener type, quantity, location, and other information to assure proper installation.
   c. Drawings depicting truss configuration, dimensions, components, locations, and construction sequence for the Contractor to install prefabricated/prefinished trusses.

3. Mill Certificates;
   a. Mill certificates or test reports from independent testing agency, qualified in accordance with ASTM E 329, showing that the steel sheet used in the manufacture of each cold-formed component complies with the minimum yield strengths and uncoated steel thickness specified. Test reports shall be based on the results of three coupon tests in accordance with ASTM A 370.
4. Welds;
   a. Certified copies of welder qualifications test record showing qualification in accordance with AWS D1. 3.

1.4 DELIVERY, HANDLING AND STORAGE

A. Materials shall be delivered and handled preventing bending or other damage, and avoiding contact with soil or other contaminating materials. Finish of the framing members shall be maintained at all times, using an approved high zinc dust content, galvanizing repair paint whenever necessary to prevent the formation of rust.

PART 2 PRODUCTS

2.1 STEEL MEMBERS, BRACING, BRIDGING, AND ACCESSORIES

A. Truss components shall comply with ASTM C 955 and the following:
   1. Material shall be corrosion-resistant steel complying with ASTM A 653/A 653M,Grade 33 or higher, having a minimum yield of 33,000 psi and a G 90 minimum zinc coating.
   2. Minimum uncoated steel thickness (design thickness times 0.95):
      a. Bracing and bridging: Thickness as shown on the drawings.
      b. Accessories: Standard thickness as shown on the drawings.

2.2 MARKINGS

A. Truss elements shall have product markings on the web of the section. The markings shall be repeated throughout the length of the member at a maximum spacing of 4 feet on center and shall be legible and easily read. The product marking shall include the following.
   1. Manufacturer's identification.
   2. Minimum delivered uncoated steel thickness.
   3. Protective coating designator.
   4. Minimum yield strength.

2.3 CONNECTIONS

A. Screws for steel-to-steel connections shall be self-drilling tapping in compliance with SAE J 78 of the type, size, and location as shown on the drawings. Electroplated screws shall have a Type II coating in accordance with ASTM B 633. Screws, bolts, and anchors shall be hot-dipped galvanized in accordance with ASTM A 123/A 123M or ASTM A 153/A 153M as appropriate.

PART 3 EXECUTION

3.1 Delivery, Handling and Storage

A. Materials shall be delivered and handled in a manner to avoid bending or other damage and to avoid contact with the soil or other contaminating materials.

B. Finish of the truss members shall be maintained at all times, using an approved high zinc dust content galvanizing repair paint whenever necessary to prevent the formation of rust.

3.2 CONNECTIONS

A. Welds
1. All welding shall be performed in accordance with AWS D1.3, as modified by AISI Cold-Formed Spec. All welders, welding operations, and welding procedures shall be qualified according to AWS D1.3. All welds shall be cleaned and coated with rust inhibitive galvanizing paint.

B. Screws
1. Screws shall be of the type, size, and location shown on the drawings. Screw penetration through joined materials shall not be less than three exposed threads. Minimum spacing and edge distances for screws shall be as specified in AISI Cold- Formed Spec. Screws covered by sheathing materials shall have low profile heads.

C. Anchors
1. Anchors shall be of the type, size, and location shown on the drawings.

3.3 INSTALLATION

A. General Requirements
1. Prefabricated trusses shall be square, with components attached to prevent racking during fabrication, transportation, and lifting. Design and construction of trussesshall include include provisions for lifting.
2. Cutting of steel trusses shall be by saw, shear, or plasma cutting equipment. Oxyacetylene torch cutting is not permitted.
3. Temporary bracing shall be provided and remain in place until work is permanently stabilized.
4. Trusses shall be securely anchored to the supporting structure as shown on the drawings.
5. Splicing of truss components, is not permitted.
6. Wire tying of truss members is not permitted.

B. Trusses
1. Trusses shall be spaced as shown on the drawings.
2. Trusses shall be bridged and braced as shown on the drawings before the installation of collateral materials.

3. Temporary bracing shall be provided and remain in place until work is permanently stablized.

END OF SECTION 05425

SECTION 05500 – METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Miscellaneous steel framing and supports.
   2. Shelf angles.
   3. Metal ladders.
   4. Metal bollards.
   5. Loose steel lintels.

B. See Division 05 Section "Metal Stairs" for metal-framed stairs.

C. See Division 05 Section "Pipe and Tube Railings" for metal pipe and tube railings.

D. See Division 05 Section "Ornamental Metal Railings" for ornamental metal railings.

1.2 SUBMITTALS

A. Product Data: For the following:
   1. Grout.

B. Shop Drawings: Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

C. Templates: For anchors and bolts.

PART 2 - PRODUCTS

2.1 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without blemishes.

B. Ferrous Metals:
   1. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
   2. Steel Tubing: ASTM A 500, cold-formed steel tubing.
   3. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

C. Nonferrous Metals:
   1. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy 6063-T6.
   2. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, alloy 6061-T6.
   3. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

2.2 FASTENERS

A. General: Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

B. Cast-in-Place Anchors in Concrete: Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.

2.3 MISCELLANEOUS MATERIALS

A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI #79.

B. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.

C. Galvanizing Repair Paint: SSPC-Paint 20, high-zinc-dust-content paint for regalvanizing welds in steel.

D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

E. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa), unless otherwise indicated.

2.4 FABRICATION

A. General: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.
   1. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.
   2. Weld corners and seams continuously. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. Finish exposed welds smooth and blended.
   3. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.
   4. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
   5. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 24 inches (600 mm) o.c.

B. Loose Steel Lintels: Fabricate loose steel lintels from steel angles and shapes for openings and recesses in masonry walls and partitions.
   1. The size of loose steel lintels shall be designed to comply with requirements of 2003 International Building Code, Section 2107 *Working Stress Design* or Section 2108 *Strength Design of Masonry.*
   2. Lintels in Exterior Walls: Galvanize.

3. Minimum length of end support shall be 4 inches (102 mm).

C. Shelf Angles: Fabricate shelf angles for attachment to framing. Fabricate with horizontally slotted holes to receive 3/4-inch (19-mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) o.c.
1. The size of shelf angles shall be designed to comply with requirements of 2003 International Building Code, Section 2107 *Working Stress Design* or Section 2108 *Strength Design of Masonry*.
2. Shelf Angles in Exterior Walls: Galvanize.

D. Metal Ladders: Comply with ANSI A14.3, unless otherwise indicated.
1. Elevator Pit Ladders: Comply with ASME A17.1.
2. Space siderails 16 inches (406 mm) apart, unless otherwise indicated.
3. Steel Ladder Construction: Flat bar siderails, with 3/4-inch- (19-mm-) diameter steel bar rungs fitted in centerline of siderails, plug-welded, and ground smooth on outer rail faces.

E. Metal Bollards: Fabricate from Schedule 80 steel pipe.
1. Fabricate sleeves for bollard anchorage from steel pipe with 1/4-inch- (6-mm-) thick steel plate welded to bottom of sleeve.

2.5 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Finish metal fabrications after assembly.

B. Steel and Iron Finishes:
1. Hot-dip galvanize items as indicated to comply with ASTM A 123/A 123M or ASTM A 153/A 153M as applicable.
2. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with requirements indicated below for environmental exposure conditions of installed metal fabrications:
   a. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
3. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, with edges and surfaces level, plumb, and true.
1. Fit exposed connections accurately together. Weld connections that are not to be left as exposed joints but cannot be shop welded. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication.

2. Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.
3. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

B. Bollards:
1. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. Fill annular space around bollard solidly with nonshrink, nonmetallic grout.
2. Fill bollards solidly with concrete, mounding top surface to shed water.

C. Touch up surfaces and finishes after erection.
1. Painted Surfaces: Clean field welds, bolted connections, and abraded areas and touch up paint with the same material as used for shop painting.
2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05500

SECTION 05511 – METAL STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Preassembled steel stairs with concrete-filled treads.
   2. Steel tube railings attached to metal stairs and to walls adjacent to metal stairs.

B. See Division 05 Section "Pipe and Tube Railings" for pipe and tube railings.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance of Stairs: Provide metal stairs capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   1. Uniform Load: 100 lbf/sq. ft. (4.79 kN/sq. m).
   2. Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
   3. Uniform and concentrated loads need not be assumed to act concurrently.
   4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
   5. Limit deflection of treads, platforms, and framing members to L/240 or 1/4 inch (6.4 mm), whichever is less.

B. Structural Performance of Railings: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   1. Handrails:
      a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
      b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   2. Top Rails of Guards:
      a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
      b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   3. Infill of Guards:
      a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
      b. Uniform load of 25 lbf/sq. ft. (1.2 kN/sq. m) applied horizontally.
      c. Infill load and other loads need not be assumed to act concurrently.

1.3 SUBMITTALS

A. Product Data: For metal stairs.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 COORDINATION

A. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

PART 2 - PRODUCTS

2.1 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5 (mandrel drawn).

D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

E. Wire Rod for Grating Crossbars: ASTM A 510 (ASTM A 510M).

F. Iron Castings: Either gray iron, ASTM A 48/A 48M, Class 30, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

G. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25 (Grade 170).

H. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, either commercial steel, Type B, or structural steel, Grade 30 (Grade 205).

2.2 MISCELLANEOUS MATERIALS

A. Fasteners: Provide zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 25 for exterior use, and Class Fe/Zn 5 where built into exterior walls.

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.

C. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa), unless otherwise indicated.

D. Welded Wire Fabric: ASTM A 185, 6 by 6 inches (152 by 152 mm)--W1.4 by W1.4, unless otherwise indicated.

2.3 FABRICATION

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
   1. Join components by welding, unless otherwise indicated. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. At exposed connections, finish exposed welds smooth and blended.
   2. Use connections that maintain structural value of joined pieces.
   3. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
   4. Form bent-metal corners to smallest radius possible without impairing work.
   5. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.

B. Stair Framing: Fabricate stringers of steel plates or channels Construct platforms of steel plate or channel headers and miscellaneous framing members.
   1. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
   2. Where stairs are enclosed by gypsum-board assemblies, provide hanger rods or struts to support landings from floor construction above or below.

C. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.0677 inch (1.7 mm).
   1. Provide stair assemblies with metal-pan subtreads filled with reinforced concrete.

D. Steel Tube Railings: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.
   1. Configuration: 1-5/8-inch- (41-mm-) diameter top and bottom rails, 1-1/2-inch- (38-mm-) square posts, and 1/2-inch- (13-mm-) square pickets spaced less than 4 inches (100 mm) clear.
   2. Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose.
   3. Form changes in direction of railings by bending or by inserting prefabricated fittings.
   4. Form curves by bending members in jigs to produce uniform curvature without buckling.
   5. Close exposed ends of railing members with prefabricated end fittings.
   6. Provide wall returns at ends of wall-mounted handrails.
   7. Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.
   8. Connect posts to stair framing by direct welding.

2.4 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Finish metal stairs after assembly.

B. Hot-dip galvanize stair components below second floor level. Comply with ASTM A 123/A 123M or ASTM A 153/A 153M as applicable.

C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with requirements indicated below for environmental exposure conditions of installed products:

1. Interior Stairs (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

D. Apply shop primer to uncoated surfaces of metal stair components. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

B. Install metal stairs by welding stair framing to steel structure, unless otherwise indicated.

C. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints. Do not weld, cut, or abrade surfaces of units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

D. Place and finish concrete fill for treads and platforms to comply with Division 03 Section "Cast-in-Place Concrete."

E. Attach handrails to wall with wall brackets.
1. Use type of bracket with predrilled hole for exposed bolt anchorage.

F. Adjusting and Cleaning:
1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting.

END OF SECTION 05511

SECTION 05521 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Steel pipe and tube railings at loading dock area.
      a. Provide removable railing as required at loading dock.
      b. Provide handrails to comply with code requirements.

B. See Division 05 Section "Metal Stairs" for steel tube railings associated with metal stairs.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   1. Handrails:
      a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
      b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   2. Top Rails of Guards:
      a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
      b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   3. Infill of Guards:
      a. Normal load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
      b. Infill load and other loads need not be assumed to act concurrently.

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.3 SUBMITTALS

A. Product Data: For mechanically connected railings, grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

PART 2 - PRODUCTS

2.1 METALS

A. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

B. Steel and Iron:
1. Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5 (mandrel drawn).
2. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
3. Plates, Shapes, and Bars: ASTM A 36/A 36M.
4. Castings: Either gray or malleable iron, unless otherwise indicated.
   a. Gray Iron: ASTM A 48/A 48M, Class 30, unless another class is indicated or required by structural loads.
   b. Malleable Iron: ASTM A 47/A 47M.

2.2 MISCELLANEOUS MATERIALS

A. Fasteners: Provide concealed fasteners, unless unavoidable or standard for railings indicated.
1. Steel Railings: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.

B. Anchors: Provide cast-in-place, chemical or torque-controlled expansion anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488.

C. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

D. Shop Primer for Galvanized Steel: Zinc-dust, zinc-oxide primer compatible with finish paint systems indicated, and complying with SSPC-Paint 5.

E. Grout and Anchoring Cement: Factory-packaged, nonshrink, nonmetallic grout complying with ASTM C 1107; or water-resistant, nonshrink anchoring cement; recommended by manufacturer for exterior use.

2.3 FABRICATION

A. General: Fabricate railings to comply with design, dimensions, and details required, but not less than that required to support structural loads.

B. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

C. Form changes in direction by bending .

D. Form curves by bending in jigs to produce uniform curvature; maintain cross section of member throughout bend without cracking or otherwise deforming exposed surfaces.

E. Close exposed ends of railing members with prefabricated end fittings.

F. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated.

G. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work, unless otherwise indicated.

2.4 FINISHES

A. Steel and Iron:
   1. Galvanized Railings: Hot-dip galvanized exterior railings, after fabrication, to comply with ASTM A 123/A 123M. Provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
   2. Shop-Primed Galvanized Railings: After galvanizing, clean railings, treat with metallic-phosphate process, and apply primer to comply with SSPC-PA 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation.
   1. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
   2. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).

B. Anchor posts in concrete by inserting into preset steel pipe sleeves and grouting annular space.

C. Anchor railing ends to concrete and masonry with round flanges connected to railing ends and anchored to wall construction with anchors and bolts.

D. Attach handrails to wall with wall brackets.
   1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.

E. Adjusting and Cleaning:
   1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting.
   2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05521

SECTION 05721 - ORNAMENTAL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Aluminum ornamental railings for Atrium Lobby stair and landings, handrails at Classroom 118 and for exterior railings at entrance steps and ramps.

B. See Division 05 Section "Metal Stairs" for steel tube railings associated with metal stairs.

C. See Division 05 Section "Pipe and Tube Railings" for steel tube railings at loading dock area.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   1. Handrails:
      a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
      b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   2. Top Rails of Guards:
      a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
      b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   3. Infill of Guards:
      a. Normal load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
      b. Infill load and other loads need not be assumed to act concurrently.

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.3 SUBMITTALS

A. Product Data: For railings assembled from standard components, grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work.
   1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples: For each exposed finish required.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

1.4 QUALITY ASSURANCE

A. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Retain paragraph and subparagraph below if testing is required to establish structural performance and it is known that manufacturers selected have not tested railings.

B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockups for each form and finish of railing consisting of two posts, top rail, infill area, and anchorage system components for interior and exterior locations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Livers Bronze Co., "Panel Rail" System, Style #18 or 19 or a comparable product from another manufacturer. This rail system design is selected based on aesthetic and performance requirements. Comparable products from another manufacturer meeting the aesthetic and performance requirements are acceptable.

2.2 METALS

A. Brackets, Flanges, and Anchors: Same metal and finish as supported rails, unless otherwise indicated.

B. Aluminum: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
   1. Extruded Bars and Shapes, Including Extruded Tubing: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.
   2. Extruded Structural Pipe and Round Tubing: ASTM B 429, Alloy 6063-T6.
   3. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

2.3 MISCELLANEOUS MATERIALS

A. Fasteners: Provide concealed fasteners, unless exposed fasteners are unavoidable.
   1. Aluminum Components: Type 316 stainless-steel fasteners.
   2. Dissimilar Metals: Type 316 stainless-steel fasteners.

B. Anchors: Provide chemical or torque-controlled expansion anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488.

C. Wood Rail Caps: At interior locations provide hardwood rail caps of red oak and profile "CH", with manufacturer's standard transparent finish and secured to metal subrail.

D. Grout and Anchoring Cement: Factory-packaged, nonshrink, nonmetallic grout complying with ASTM C 1107, or water-resistant, nonshrink, anchoring cement; recommended by manufacturer for exterior use.

2.4 FABRICATION

A. General: Fabricate railings to comply with design, dimensions, and details indicated, but not less than that required to support structural loads.

B. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

C. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings.

D. Form changes in direction by bending or by inserting prefabricated elbow fittings.

E. Form curves by bending in jigs to produce uniform curvature; maintain cross section of member throughout bend without cracking or otherwise deforming exposed surfaces.

F. Close exposed ends of hollow railing members with prefabricated end fittings.

G. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated.

H. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work, unless otherwise indicated.

2.5 FINISHES

A. Aluminum:
1. High-Performance Organic Coating Finish: Fluoropolymer three-coat system containing not less than 70 percent polyvinylidene fluoride resin by weight and complying with AAMA 2605.
   a. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation.
1. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
2. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).

B. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

C. Anchor posts in concrete by inserting into preset steel pipe sleeves or formed or core-drilled holes and grouting annular space.

D. Anchor posts to metal surfaces as indicated using fittings designed and engineered for this purpose.

E. Anchor railing ends to concrete and masonry with sleeves concealed within railing ends and anchored to wall construction with anchors and bolts.

F. Attach handrails to wall with wall brackets in manner to achieve design loads.

END OF SECTION 05721

SECTION 06105 – MISCELLANEOUS CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Wood blocking and nailers.
   2. Plywood backing panels.

1.2 SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.
   1. Include data for wood-preservative and fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   1. Factory mark each piece of lumber with grade stamp of grading agency.
   2. Provide dressed lumber, S4S, unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA C2.
   1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat all miscellaneous carpentry, unless otherwise indicated.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).

1. Use Exterior type for exterior locations and where indicated.
2. Use Interior Type A, unless otherwise indicated.

B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

C. Application: Treat items indicated on Drawings, and the following:
1. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
1. Blocking.
2. Nailers.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber with 19 percent maximum moisture content of any species.

C. For concealed boards, provide lumber with 15percent maximum moisture content and the following species and grades:
1. Mixed southern pine, No. 2 grade; SPIB.

2.5 PLYWOOD BACKING PANELS

A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.

2.6 FASTENERS

A. General: Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Power-Driven Fasteners: NES NER-272.

C. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

C. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. NES NER-272 for power-driven fasteners.
   2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

END OF SECTION 06105

SECTION 06402 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Interior standing and running trim.
   2. Flush wood paneling and wainscots.
   3. Wood cabinets.
   4. Plastic-laminate cabinets.
   5. Solid-surfacing-material countertops.
   6. Shop finishing of woodwork.

B. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips unless concealed within other construction before woodwork installation.

1.2 SUBMITTALS

A. Product Data: For solid-surfacing material, cabinet hardware and accessories andfinishing materials and processes.

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

C. Samples:
   1. Lumber and panel products for transparent finish, for each species and cut, finished on one side and one edge.
   2. Plastic-laminates, for each type, color, pattern, and surface finish.
   3. Melamine surfacing.
   4. Solid-surfacing materials.

D. SPiRiT Submittals:
   1. Credit IEQ 5.C4:
      a. Composite wood manufacturer's product data for each composite wood product used indicating that the bonding agent contains no urea formaldehyde.
      b. Adhesive manufacturer's product data for each adhesive used indicating that the adhesive contains no urea formaldehyde.

E. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of woodwork.

B. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards."

1. Provide AWI Quality Certification Program labels and certificates for woodwork.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wood Species and Cut for Transparent Finish: Red oak, plain sawn or sliced.

B. Wood Products:
1. Hardboard: AHA A135.4.
2. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
3. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.
4. Softwood Plywood: DOC PS 1, Medium Density Overlay.
5. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.

C. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.

D. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.

E. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.

F. Tempered Float Glass for Cabinet Doors: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 (clear), Quality-Q3, 6 mm thick, unless otherwise indicated.

2.2 FIRE-RETARDANT-TREATED MATERIALS

A. Provide fire-retardant-treated lumber, plywood, particleboard and fiberboard where required by code.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use Exterior Type or Interior Type A. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Kiln-dry material after treatment.

C. Fire-Retardant Particleboard: Panels made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture with flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E 84.

D. Fire-Retardant Fiberboard: ANSI A208.2 medium-density fiberboard panels made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture with flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E 84.

2.3 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural woodwork, except for items specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)."

B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 135 degrees of opening, self-closing.

C. Wire Pulls: Back mounted, solid metal.

D. Drawer Slides: BHMA A156.9, B05091.
1. Standard Duty (Grade 1, Grade 2, and Grade 3): Side mounted and extending under bottom edge of drawer; full-extension type; epoxy-coated steel with polymer rollers.
2. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.
3. Box Drawer Slides: Grade 1HD-100; for drawers not more than 6 inches (150 mm) high and 24 inches (600 mm) wide.
4. File Drawer Slides: Grade 1HD-200; for drawers more than 6 inches (150 mm) high or 24 inches (600 mm) wide.
5. Pencil Drawer Slides: Grade 1; for drawers not more than 3 inches (75 mm) high and 24 inches (600 mm) wide.

E. Door Locks: BHMA A156.11, E07121.

F. Drawer Locks: BHMA A156.11, E07041.

2.4 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, fire-retardant-treated, kiln-dried to less than 15 percent moisture content.

B. Adhesives, General: Do not use adhesives that contain urea formaldehyde.

2.5 FABRICATION

A. General: Complete fabrication to maximum extent possible before shipment to Project site. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.
1. Interior Woodwork Grade:
   a. Paneling, Wainscot and Running Trim to receive transparent finish: Premium
   b. All other interior woodwork: Custom.
2. Shop cut openings to maximum extent possible. Sand edges of cutouts to remove splinters and burrs. Seal edges of openings in countertops with a coat of varnish.

3. Install glass to comply with applicable requirements in Division 08 Section "Glazing" and in GANA's "Glazing Manual." For glass in wood frames, secure glass with removable stops.

B. Interior Standing and Running Trim:
1. For transparent-finished trim items wider than available lumber, use veneered construction. Do not glue for width.
2. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.

C. Flush Wood Paneling and Wainscots:
1. Lumber Trim and Edges: At fabricator's option, trim and edges indicated as solid wood (except moldings) may be either lumber or veneered construction compatible with grain and color of veneered panels.
2. Matching of Adjacent Veneer Leaves: Book match.
3. Veneer Matching within Panel Face: Running match.
4. Panel-Matching Method: In each separate area, use sequence-matched, uniform-size sets.
5. Fire-Retardant-Treated Paneling: Provide panels consisting of wood veneer. Panels shall have flame-spread index as required by code or less and smoke-developed index of 450 or less per ASTM E 84.

D. Wood Cabinets for Transparent Finish:
1. AWI Type of Cabinet Construction: Reveal overlay on face frame.
2. Reveal Dimension: 1/2 inch (13 mm) .
3. Grain Direction: Vertically for drawer fronts, doors, and fixed panels .
4. Matching of Veneer Leaves: Book match.
5. Veneer Matching within Panel Face: Running match.
6. Semiexposed Surfaces Other Than Drawer Bodies: Same species and cut indicated for exposed surfaces.
7. Drawer Sides and Backs: Solid hardwood lumber.
8. Drawer Bottoms: Hardwood plywood.
9. Provide dust panels of 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

E. Plastic-Laminate Cabinets:
1. AWI Type of Cabinet Construction: Flush overlay.
2. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate as follows:
   a. Horizontal Surfaces Other Than Tops: Grade HGS.
   b. Vertical Surfaces: Grade HGS.
   c. Edges: Grade HGS.
3. Colors, Patterns, and Finishes: As selected by Architect from laminate manufacturer's full range of solid colors and patterns in matte finish.
4. Provide dust panels of 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

F. Solid-Surfacing-Material Countertops:
1. Solid-Surfacing-Material Thickness: 3/4 inch (19 mm).
2. Colors, Patterns, and Finishes: As selected from manufacturer's full range.
3. Fabricate tops in one piece with field-applied backsplashes. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.

2.6 SHOP FINISHING

A. Finish architectural woodwork at fabrication shop. Defer only final touchup, cleaning, and polishing until after installation.

B. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling.

C. Transparent Finish:
1. Grade: Premium.
2. AWI Finish System: Acrylic lacquer .
3. Staining: Match approved sample for color.
4. Wash Coat for Stained Finish: Apply a wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
5. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas. Examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

B. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.

C. Install woodwork level, plumb, true, and straight to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm). Shim as required with concealed shims.

D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

F. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Scarf running joints and stagger in adjacent and related members. Fill gaps, if any, between top of base and wall with plastic wood filler, sand smooth, and finish same as wood base if finished.

G. Paneling: Anchor paneling to supporting substrate with concealed panel-hanger clips or splined connection strips. Do not use face fastening, unless covered by trim.

H. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation.

1. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches (400 mm) o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.

I. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop. Calk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."

END OF SECTION 06402

SECTION 07115 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Cold-applied, emulsified-asphalt dampproofing.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 PROJECT CONDITIONS

A. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

PART 2 - PRODUCTS

2.1 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Trowel Coats: ASTM D 1227, Type II, Class 1.

B. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.

C. Brush and Spray Coats: ASTM D 1227, Type III, Class 1.

D. VOC Content: Zero.

2.2 MISCELLANEOUS MATERIALS

A. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended by manufacturer.

B. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of projections and substances detrimental to work; fill voids, seal joints, and apply bond breakers if any, as recommended by prime material manufacturer.

3.2 APPLICATION, GENERAL

A. Comply with manufacturer's written recommendations unless more stringent requirements are indicated or required by Project conditions to ensure satisfactory performance of dampproofing.

B. Apply dampproofing to provide continuous plane of protection on exterior face of inner wythe of exterior masonry cavity walls.

3.3 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. On Masonry Backup for Dimension Stone Cladding: Apply primer and 1 brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

B. On Exterior Face of Inner Wythe of Cavity Walls: Apply primer and 1 brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

END OF SECTION 07115

SECTION 07162 - CRYSTALLINE WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes crystalline waterproofing for elevator pits.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Material test reports.

C. Warranty.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1.4 PROJECT CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit crystalline waterproofing to be performed according to manufacturer's written instructions and warranty requirements.

B. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after concrete and masonry substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.

C. Ambient Conditions: Proceed with waterproofing work only if temperature is maintained at 40 deg F (4.4 deg C) or above during work and cure period, and space is well ventilated and kept free of water.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and installer agrees to repair or replace components of crystalline waterproofing that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure to maintain watertight conditions within specified warranty period.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Crystalline Waterproofing: A prepackaged, gray-colored proprietary blend of portland cement, specially treated sand, and active chemicals that, when mixed with water and applied, penetrates by capillary action into concrete or masonry and reacts chemically with free lime in the presence of water to develop crystalline growth within concrete or masonry capillaries to produce an impervious, dense, waterproof concrete or masonry with properties.
   1. Permeability: 0 for water at 33 feet (10 m) when tested according to CE CRD-C 48.
   2. Compressive Strength: Minimum 3000 psi (20.7 MPa) when tested according to ASTM C 109/C 109M.

B. Patching Compound: Cementitious waterproofing and repair mortar for filling and patching tie holes, honeycombs, reveals, and other imperfections; with properties meeting or exceeding the following criteria:
   1. Compressive Strength: 7600 psi (52.44 MPa) at 28 days when tested according to ASTM C 109/C 109M.
   2. Flexural Strength: 710 psi (4.8 MPa) at 28 days when tested according to ASTM C 348.
   3. Shrinkage: Minus 0.093 percent at 28 days and plus 0.073 percent at 90 days when tested according to ASTM C 596.

C. Plugging Compound: Cementitious compound with hydrophobic properties; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead and horizontal surfaces not exposed to vehicular traffic); with properties meeting or exceeding the following criteria:
   1. Permeability: 30 feet (9 m) when tested according to CE CRD-C 48.
   2. Compressive Strength: 6000 psi (41.4 MPa) at 28 days when tested according to ASTM C 109/C 109M.
   3. Flexural Strength: 1000 psi (6.9 MPa) at 28 days when tested according to ASTM C 348.
   4. Bond Strength: 300 psi (2.1 MPa) at 14 days when tested according to ASTM C 321.

D. Water: Potable.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect other work from damage from cleaning, preparation, and application of crystalline waterproofing. Provide temporary enclosure to confine spraying operation and to ensure adequate ambient temperatures and ventilation conditions for application.

B. Stop active water leaks according to waterproofing manufacturer's written instructions.

C. Repair damaged or unsatisfactory concrete or masonry according to manufacturer's written instructions.

D. Surface Preparation: Comply with waterproofing manufacturer's written instructions to remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, curing compounds, and form-release agents to ensure that waterproofing bonds to concrete or masonry surfaces.

1. Clean concrete surfaces according to ASTM D 4258.
   a. Prepare smooth-formed and trowel-finished concrete by mechanical abrading or abrasive-blast cleaning according to ASTM D 4259.
2. Concrete Joints: Clean reveals according to waterproofing manufacturer's written instructions.

3.2 APPLICATION

A. General: Comply with waterproofing manufacturer's written instructions for application.
   1. Dampen surface with water and maintain damp condition until applying waterproofing.
   2. Apply waterproofing to negative-side surfaces.
   3. Number of Coats: Two for brush or spray application.
   4. Dampen surface between coats.

B. Final Coat Finish: Smooth.

C. Moist-cure waterproofing for three days immediately after application has set, followed by two days of air drying as recommended in writing by manufacturer.

D. Waterproofing Treatment Extensions: Extend waterproofing treatment as follows:
   1. Onto every substrate in elevator pit including sumps, and similar offsets and features.

3.3 PROTECTION

A. Protect applied crystalline waterproofing from rapid drying, severe weather exposure, and water accumulation. Maintain completed Work in moist condition for not less than three days by procedures recommended in writing by waterproofing manufacturer. Protect waterproofing from temperatures below 36 deg F (2 deg C).

END OF SECTION 07162

SECTION 07190 - WATER REPELLENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes clear repellent coatings for the following surfaces:
   1. Decorative Concrete Unit Masonry

B. Related Sections include the following:
   1. Division 4 Masonry Section 04810 "Unit Masonry Assemblies" for unit masonry assemblies.
   2. Division 7 Thermal and Moisture Protection Section 07920 "Joint Sealants" for joint sealants.
   3. Division 9 Finishes Section 09910 "Painting" for paints and coatings.

1.2 SUBMITTALS

A. Product Data: Include manufacturer's specifications, surface preparation, and application instructions, recommendations for water repellent for each surface to be treated, and protection and cleaning instructions. Include data substantiating that materials are recommended by manufacturer for applications indicated and comply with requirements.

B. Samples: Of substrate indicated to receive repellent, with specified repellent treatment applied to 8" x 16" sample.

C. Applicator Certificates: Signed by manufacturer certifying that the applicator complies with requirements.

D. Certification by water repellent manufacturer that products supplied comply with local regulations controlling use of VOCs.

1.3 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who employs only persons trained and approved by water repellent manufacturer for application of manufacturer's products.

B. Regulatory Requirements: Comply with applicable rules of pollution-control regulatory agency having jurisdiction in Project locale regarding VOCs and use of hydrocarbon solvents.

C. Field Samples: Architect will select one representative surface for substrate to receive repellents. Apply repellent to substrate, with either partial or full coverage as directed. Comply with application requirements of this Section.
   1. Obtain Architect's approval of field samples before applying repellents.
   2. Maintain field samples during construction in an undisturbed condition as a standard for judging the completed Work.

1.4 PROJECT CONDITIONS

A. Weather and Substrate Conditions: Do not proceed with application of repellent under any of the following conditions, except with written instruction of manufacturer:
   1. Ambient temperature is less than 40 deg F.
   2. Concrete surfaces and mortar have cured for less than 28 days.
   3. Rain or temperatures below 40 deg F are predicted within 24 hours.
   4. Application is earlier than 24 hours after surfaces have been wet.
   5. Substrate is frozen or surface temperature is less than 40 deg F.
   6. Windy condition exists that may cause water repellent to be blown onto vegetation or surfaces not intended to be coated.

1.5 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty, executed by the applicator and water repellent manufacturer, covering materials and labor, agreeing to repair or replace materials that fail to provide water repellency within the specified warranty period. Warranty does not include deterioration or failure of coating due to unusual weather phenomena, failure of prepared and treated substrate, formation of new joints and cracks in excess of 1/16 inch wide, fire, vandalism, or abuse by maintenance equipment.
   1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Provide products comparable to the following and approved for application by decorative concrete unit masonry manufacturer:
   1. Water Repellent Protection: 'Ground Face Concrete Masonry Water Repellent Protection (Field Applied): WRP-700' as distributed by Featherlite Building Products Corp.; Round Rock, Texas.
   2. Sealer: 'Ground Face Concrete Masonry Acrylic Sealer (Field Applied): FBP-707' as distributed by Featherlite Building Products Corp.; Round Rock, Texas.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrate of substances that might interfere with penetration or performance of repellents. Test for moisture content, according to repellent manufacturer's written instructions, to ensure surface is sufficiently dry.

B. Protect adjoining work, including sealant bond surfaces, from spillage or blow-over of repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of repellent being deposited on surfaces.

3.2 FIELD COAT APPLICATION

A. Interior Locations: Water-Repellent Protection
   1. After the final clean-down when the walls are dry, apply water repellent protection as specified herein to all walls laid with ground face concrete masonry units with one flood coat using an industrial pump sprayer.
   2. After water repellent protection has cured as recommended by manufacturer, apply one coat of sealer evenly as specified herein without runs or drips, using airless spray equipment.

3.3 CLEANING

A. Protective Coverings: Remove protective coverings from adjacent surfaces and other protected areas.

B. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by repellent application as work progresses. Repair damage caused by repellent application. Comply with manufacturer's written cleaning instructions.

END OF SECTION 07190

SECTION 07210 - BUILDING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Cavity-wall insulation.
   2. Concealed building insulation.
   3. Sound attenuation insulation.

1.2 PERFORMANCE REQUIREMENTS

A. Plenum Rating: Provide glass-fiber insulation where indicated in ceiling plenums whose test performance is rated as follows for use in plenums as determined by testing identical products per "Erosion Test" and "Mold Growth and Humidity Test" described in UL 181, or on comparable tests from another standard acceptable to authorities having jurisdiction.
   1. Erosion Test Results: Insulation shows no visible evidence of cracking, flaking, peeling, or delamination of interior surface of duct assembly, after testing for 4 hours at 2500-fpm (13-m/s) air velocity.
   2. Mold Growth and Humidity Test Results: Insulation shows no evidence of mold growth, delamination, or other deterioration due to the effects of high humidity, after inoculation with Chaetomium globosium on all surfaces and storing for 60 days at 100 percent relative humidity in the dark.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Verification: Full-size units for each type of exposed insulation indicated.

C. SPiRiT Submittals:
   1. Credit MR 4.C4: Product Data indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
      a. Include statement indicating costs for each product having recycled content.

D. Product test reports.

E. Research/Evaluation Reports: For foam-plastic insulation.

1.4 QUALITY ASSURANCE

A. Retain ASTM test method below based on product and kind of fire-resistance characteristic specified for each product in Part 2. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84 for surface-burning characteristics and other methods indicated with product, by UL or another testing and inspecting agency acceptable to authorities

having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60 lb/cu. ft. (26 kg/cu. m) , with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively.
1. Thickness: Provide 2-inch (51-mm) at cavity walls.

2.2 GLASS-FIBER BLANKET INSULATION

A. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

B. Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (blankets with reflective membrane facing), Class A (membrane-faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil-scrim-kraft, foil-scrim, or foil-scrim-polyethylene vapor-retarder membrane on 1 face.

C. Where glass-fiber blanket insulation is required, provide blankets in batt or roll form with thermal resistances indicated:
1. 3-1/2 inches (89 mm) thick with a thermal resistance of 13 deg F x h x sq. ft./Btu at 75 deg F (2.3 K x sq. m/W at 24 deg C).
2. 5-1/2 inches (140 mm) thick with a thermal resistance of 21 deg F x h x sq. ft./Btu at 75 deg F (3.7 K x sq. m/W at 24 deg C).
3. 6-1/2 inches (165 mm) thick with a thermal resistance of 19 deg F x h x sq. ft./Btu at 75 deg F (3.3 K x sq. m/W at 24 deg C).
4. 9-1/2 inches (241 mm) thick with a thermal resistance of 30 deg F x h x sq. ft./Btu at 75 deg F (5.2 K x sq. m/W at 24 deg C).

2.3 AUXILIARY INSULATING MATERIALS

A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

2.4 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate or angle formed from perforated galvanized carbon-steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square, welded to projecting copper-coated steel spindle 0.105 inch (2.67 mm) in diameter and of length capable of holding insulation of thickness indicated securely in position with 1-1/2-inch- (38-mm-) square or diameter self-locking washers complying with the following requirements:
1. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized steel sheet, with beveled edge for increased stiffness.

2. Where anchors are located in ceiling plenums or attic spaces, protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap.

B. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space between face of insulation and substrate to which anchor is attached.

C. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.

E. For preformed insulating units, provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.2 INSTALLATION OF CAVITY-WALL INSULATION

A. On units of foam-plastic board insulation, install pads of adhesive spaced approximately 24 inches (610 mm) o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates indicated.
   1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Division 04 Section "Unit Masonry."

3.3 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between foam-plastic insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

C. Set vapor-retarder-faced units with vapor retarder to warm side of construction, unless otherwise indicated.
   1. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

D. Install mineral-fiber insulation in cavities formed by framing members according to the following requirements:
   1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
   2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
   3. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures.
   4. Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
   5. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping stapling flanges to flanges of metal studs.

E. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
   1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
   2. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
   3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
   4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

3.4 INSTALLATION OF INSULATION IN CEILINGS FOR SOUND ATTENUATION

A. Install 3-inch- (76-mm-) thick, unfaced glass-fiber blanket insulation over suspended ceilings at partitions in a width that extends insulation 48 inches (1219 mm) on either side of partition.

END OF SECTION 07210

SECTION 07411 - METAL SOFFIT PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Metal soffit panels at eaves.

B. See Division 07 Section "Sheet Metal Roofing" for on-site, roll-formed sheet metal roofing.

C. Steel Sheet Thickness: Minimum thickness of base metal without metallic coatings or painted finishes.

1.2 SUBMITTALS

A. Product Data: For metal soffit panel.

B. Shop Drawings: Show layouts of metal soffit panels, including plans, elevations, sections, details, and attachments to other work.
   1. Include details of edge conditions, joints, panel profiles, corners, anchorages, and trim.

C. Samples: For each exposed finish.

D. Maintenance data.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Preinstallation Conference: Conduct conference at Project site.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal soffit panel assemblies that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures, including rupturing, cracking, or puncturing.
      b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Fluoropolymer Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANEL MATERIALS

A. Aluminum Sheet: Coil-coated sheet, ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
   1. Surface: Smooth, flat finish.
   2. Exposed Finishes:
      a. High-Performance Organic Finish: Three-coat, thermocured system with fluoropolymer coats containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
   3. Concealed Finish: White or light-colored acrylic or polyester backer finish.

B. Panel Sealants:
   1. Sealant Tape: Pressure-sensitive, gray polyisobutylene compound sealant tape with release-paper backing; 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
   2. Joint Sealant: ASTM C 920; as recommended in writing by metal roof panel manufacturer.
   3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.2 MISCELLANEOUS MATERIALS

A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating.
   1. Fasteners for Soffit Panels: Self-drilling or self-tapping 410 stainless or zinc-alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal roof panels.

B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 METAL SOFFIT PANELS

A. General: Provide factory-formed metal soffit panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.

B. Metal Soffit Panels:
   1. Profile: V-groove.
   2. Material: Aluminum sheet, 0.032 inch (0.8 mm) thick.
      a. Exterior Finish: Fluoropolymer.
      b. Color: As selected from manufacturer's full range.
   3. Panel Coverage: 12-inches (305-mm)
   4. Venting: Provide vented soffit panels as required to meet requirements for attic ventilation.
   5. Sealant: Factory applied within interlocking joint.

2.4 FABRICATION

A. General: Fabricate and finish metal soffit panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Where indicated, fabricate metal soffit panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will minimize noise from movements within panel assembly.

D. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 FIELD-ASSEMBLED METAL SOFFIT PANEL INSTALLATION

A. Metal Soffit Panels: Provide metal soffit panels full width of soffits. Install panels perpendicular to support framing.
   1. Flash and seal panels with weather closures where metal soffit panels meet walls and at perimeter of all openings.

3.2 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION 07411

SECTION 07610 - SHEET METAL ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following on-site, roll-formed sheet metal roofing:
   1. Standing-seam metal roofing.

1.2 PERFORMANCE REQUIREMENTS

A. Wind-Uplift Resistance: Capable of resisting a design negative uplift pressure required by 2003 International Building Code. Provide clips, fasteners, and clip spacings of type indicated and with capability to sustain, without failure, a load equal to at least 3 times the design negative uplift pressure.

B. Thermal Movements: Provide sheet metal roofing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal roofing thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

C. Water Infiltration: Provide sheet metal roofing that does not allow water infiltration to building interior, with metal flashing and connections of sheet metal roofing lapped to allow moisture to run over and off the material.

1.3 SUBMITTALS

A. Product Data: For each type of underlayment product indicated.

B. Shop Drawings: Show layouts of sheet metal roofing, including plans, elevations, and keyed references to termination points.
   1. Include details for forming, joining, and securing sheet metal roofing, including pattern of seams, termination points, expansion joints, roof penetrations, edge conditions, special conditions, connections to adjoining work, and accessory items.

C. Coordination Drawings: Drawn to scale and coordinating sheet metal roofing installation with penetrations and roof-mounted items.

D. Samples: For each exposed finish.

E. Roll-Forming Equipment Certificate: Issued by UL.

F. Product test reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of sheet metal roofing.

B. Custom-Fabricated Sheet Metal Roofing Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate sheet metal roofing.

C. Roll-Formed Sheet Metal Roofing Fabricator Qualifications: An authorized representative of roll-formed sheet metal roofing manufacturer for fabrication and installation of units.

D. Sheet Metal Roofing Standard: Comply with SMACNA's "Architectural Sheet Metal Manual."

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and qualities of materials and execution.
1. Build mockup of typical roof eave, including fascia, and soffit; approximately 48 inches (1200 mm) square by full thickness, including attachments, underlayment, and accessories.

F. Preinstallation Conference: Conduct conference at Project site.

1.5 WARRANTY

A. Special Installer's Warranty: Specified form in which Roofing Installer agrees to repair or replace components of custom-fabricated sheet metal roofing that fail in materials or workmanship within two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 ROOFING SHEET METALS

A. Zinc Sheet: Electrolytic, 99 percent pure zinc alloyed with 1 percent titanium and copper.
1. Available Manufacturers:
a. Rheinzink Canada Ltd.
b. VM ZINC North America - Sogem USA.
2. Finish: Preweathered.
3. Thickness: 0.031 inch (0.80 mm), unless otherwise indicated.

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: 30 to 40 mils (0.76 to 1.0 mm) thick minimum, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
   1. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.
   2. Low Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.

B. Slip Sheet: Building paper, minimum 5 lb/100 sq. ft. (0.24 kg/sq. m), rosin sized.

2.4 THERMAL INSULATION FOR SHEET METAL ROOFING

A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60-lb/cu. ft. (26-kg/cu. m) minimum density, unless otherwise indicated; with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively.
   1. Thickness: 4-inches (102-mm) throughout roof area.

2.5 SUBSTRATE BOARDS

A. Glass-Mat Gypsum Sheathing Board: ASTM C 1177/C 1177M; Type X, 5/8 inch (16 mm)..

B. Substrate-Board Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FMG 4470, designed for fastening substrate board to substrate.

2.6 MISCELLANEOUS MATERIALS

A. Fasteners: Self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
   1. Exposed Fasteners: Heads matching color of sheet metal roofing by means of plastic caps or factory-applied coating.
   2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
   3. Blind Fasteners: High-strength aluminum or stainless-steel rivets.

B. Solder for Zinc: ASTM B 32, 60 percent lead and 40 percent tin with low antimony, as recommended by manufacturer.

C. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.

D. Elastomeric Joint Sealant: ASTM C 920, of base polymer, type, grade, class, and use classifications required to produce joints in sheet metal roofing that will remain weathertight.

E. Expansion-Joint Sealant: For hooked-type expansion joints, which must be free to move, provide nonsetting, nonhardening, nonmigrating, heavy-bodied polyisobutylene sealant.

F. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat.

2.7 ACCESSORIES

A. Sheet Metal Roofing Accessories: Provide components required for a complete sheet metal roofing assembly including trim, copings, fasciae, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of sheet metal roofing, unless otherwise indicated.
   1. Clips: Minimum 0.0625-inch- (1.6-mm-) thick, stainless-steel panel clips designed to withstand negative-load requirements.
   2. Closures: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match sheet metal roofing profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

B. Flashing and Trim: Formed from 0.0179-inch- (0.45-mm-) thick, metallic-coated steel sheet. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent sheet metal roofing.

C. Gutters: Formed from 0.0179-inch- (0.45-mm-) thick, metallic-coated steel sheet. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2400-mm-) long sections, sized according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced 36 inches (900 mm) o.c., fabricated from same metal as gutters. Provide bronze, copper, or aluminum wire ball strainers at outlets. Finish gutters to match sheet metal roofing.

D. Downspouts: Formed from 0.0179-inch- (0.45-mm-) thick, metallic-coated steel sheet; in 10-foot- (3-m-) long sections, complete with formed elbows and offsets. Finish downspouts to match sheet metal roofing.

E. Roof Curbs: Fabricated from 0.0478-inch- (1.2-mm-) thick, metallic-coated steel sheet; with welded top box and bottom skirt, and integral full-length cricket. Fabricate curb subframing of minimum 0.0598-inch- (1.5-mm-) thick, angle-, C-, or Z-shaped steel sheet. Fabricate curb and subframing to withstand indicated loads, of size and height indicated. Finish roof curbs to match sheet metal roofing. Insulate roof curb with 1-inch- (25-mm-) thick, rigid insulation.

2.8 EQUIPMENT

A. Portable Roll-Forming Equipment: Manufacturer's standard UL-certified equipment capable of forming sheet metal roofing in profiles indicated.

2.9 FABRICATION

A. General: Fabricate roll-formed sheet metal roofing panels to comply with details shown and roll-formed sheet metal roofing manufacturer's written instructions.

B. Fabricate sheet metal roofing to allow for expansion in running work sufficient to prevent leakage, damage, and deterioration of the Work. Form exposed sheet metal work to fit substrates without excessive oil canning, buckling, and tool marks, true to line and levels indicated, and with exposed edges folded back to form hems.
   1. Lay out sheet metal roofing so cross seams, when required, are made in direction of flow with higher pans overlapping lower pans. Stagger cross seams.
   2. Fold and cleat eaves and transverse seams in the shop.
   3. Form and fabricate sheets, seams, strips, cleats, valleys, ridges, edge treatments, integral flashings, and other components of metal roofing to profiles, patterns, and drainage arrangements shown and as required for leakproof construction.

C. Metal Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturers of dissimilar metals or by fabricator.

D. Sheet Metal Accessories: Custom fabricate flashings and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

PART 3 - EXECUTION

3.1 PREPARATION

A. Substrate Board: Install substrate boards over roof deck on entire roof surface. Attach with substrate-board fasteners.
   1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.

B. Install flashings and other sheet metal to comply with requirements specified in Division 07 Section "Sheet Metal Flashing and Trim."

3.2 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free, on roof sheathing under sheet metal roofing. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply over entire roof, in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.

B. Apply slip sheet over underlayment before installing sheet metal roofing.

3.3 INSTALLATION, GENERAL

A. General: Install sheet metal roofing perpendicular to purlins or supports. Anchor sheet metal roofing and other components of the Work securely in place, with provisions for thermal and

structural movement. Install fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for a complete roofing system and as recommended by fabricator for sheet metal roofing.

1. Field cutting of sheet metal roofing by torch is not permitted.
2. Rigidly fasten eave end of sheet metal roofing and allow ridge end free movement due to thermal expansion and contraction. Predrill roofing.
3. Provide metal closures at peaks rake edges rake walls and each side of ridge caps.
4. Flash and seal sheet metal roofing with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws.
5. Locate roofing splices over, but not attached to, structural supports. Stagger roofing splices and end laps to avoid a four-panel lap splice condition.
6. Lap metal flashing over sheet metal roofing to allow moisture to run over and off the material.

B. Fasteners: Use fasteners of sizes that will not penetrate completely through substrate.
   1. Zinc Roofing: Use stainless-steel fasteners.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by fabricator of sheet metal roofing or manufacturers of dissimilar metals.

D. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

3.4 THERMAL INSULATION INSTALLATION

A. Board Insulation: Extend insulation in thickness indicated to cover entire roof. Comply with installation requirements in Division 07 Section "Thermal Insulation."

3.5 ON-SITE, ROLL-FORMED SHEET METAL ROOFING INSTALLATION

A. General: Install on-site, roll-formed sheet metal roofing to comply with sheet metal roofing manufacturer's written instructions for UL wind-uplift class indicated. Provide sheet metal roofing of full length from eave to ridge unless otherwise restricted by shipping limitations.

B. Standing-Seam Sheet Metal Roofing: Fasten sheet metal roofing to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended by manufacturer.
   1. Install clips to supports with self-tapping fasteners.
   2. Before panels are joined, apply continuous bead of sealant to top flange of lower panel.
   3. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so cleat, sheet metal roofing, and field-applied sealant are completely engaged.

3.6 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete sheet metal roofing assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 4 feet (1.2 m) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c. in between.
1. Tie downspouts to underground drainage system.

E. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet sheet metal roofing.

3.7 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal roofing within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.8 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as sheet metal roofing is installed. On completion of sheet metal roofing installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.

END OF SECTION 07610

SECTION 07620 – SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Formed wall flashing and trim.

1.2 SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Show layouts, profiles, shapes, seams, dimensions, and details for fastening, joining, supporting, and anchoring sheet metal flashing and trim.

C. Samples: For each type of sheet metal flashing and trim.

1.3 QUALITY ASSURANCE

A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

PART 2 - PRODUCTS

2.1 SHEET METALS

A. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, No. 2B finish, or

B. Zinc Sheet: Electrolytic, 99 percent pure zinc alloyed with 1 percent titanium and copper.
   1. Finish: Preweathered.

2.2 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.

B. Felt Underlayment: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
   1. Slip Sheet: Rosin-sized paper, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).

C. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.

1. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex washer head.

D. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.

E. Solder for Zinc: ASTM B 32, 60 percent lead and 40 percent tin with low antimony, as recommended by manufacturer.

F. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.

G. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane, polysulfide, or silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

H. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat.

2.3 REGLETS

A. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing with factory- mitered and -welded corners and junctions.
1. Material: Stainless steel, 0.0187 inch (0.5 mm) thick, or zinc, 0.040 inch (1.0 mm)

2.4 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.

B. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
1. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

C. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.

D. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with elastomeric sealant concealed within joints.

E. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.

F. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal, and in thickness not less than that of metal being secured.

2.5 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- (2400-mm-) long, but not exceeding 12 foot (3.6 m) long, sections, under copings, at shelf angles, and where indicated. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches (150 mm) beyond each side of wall openings. Form with 2-inch- (50-mm-) high end dams. Fabricate from the following material:
1. Stainless Steel: 0.0156 inch (0.4 mm) thick, or
2. Zinc: 0.031 inch (0.80 mm) thick.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
1. Torch cutting of sheet metal flashing and trim is not permitted.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.

C. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.

D. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and elastomeric sealant.

E. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
1. Space cleats not more than 12 inches (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.

F. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with elastomeric sealant concealed within joints.

G. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.
1. Zinc: Use stainless-steel fasteners.

H. Seal joints with elastomeric sealant as required for watertight construction.

I. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm) except where pretinned surface would show in finished Work.

1. Do not solder prepainted, metallic-coated steel sheet.

3.2 WALL FLASHING INSTALLATION

A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Reglets: Installation of reglets is specified in Division 04 Section "Unit Masonry Assemblies."

END OF SECTION 07620

SECTION 07811 – SPRAYED FIRE-RESISTIVE MATERIALS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes SFRMs applied to surfaces that are concealed from view behind other construction when the Work is completed.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show extent of sprayed fire-resistive material for each construction and fire-resistance rating, applicable fire-resistive design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction, and minimum thicknesses.

C. Product certificates.

D. Compatibility and adhesion test reports.

E. Research/evaluation reports.

F. Field quality-control test reports.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer approved by SFRM manufacturer to install manufacturer's products. A manufacturer's willingness to sell its SFRM to Contractor or to an installer engaged by Contractor does not in itself confer qualification on the buyer.

B. SFRM Testing: By a qualified testing and inspecting agency engaged by Contractor or manufacturer to test for compliance with specified requirements for performance and test methods.
   1. SFRMs are randomly selected for testing from bags bearing the applicable classification marking of UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
   2. Testing is performed on specimens of SFRMs that comply with laboratory testing requirements specified in Part 2 and are otherwise identical to installed fire-resistive materials, including application of accelerant, sealers, topcoats, tamping, troweling, rolling, and water overspray, if any of these are used in final application.
   3. Testing is performed on specimens whose application the independent testing and inspecting agency witnessed during preparation and conditioning. Include in test reports a full description of preparation and conditioning of laboratory test specimens.

C. Compatibility and Adhesion Testing: Engage a qualified testing and inspecting agency to test for compliance with requirements for specified performance and test methods.
   1. Test for bond per ASTM E 736 and requirements in UL's "Fire Resistance Directory" for coating materials. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.

2. Verify that manufacturer, through its own laboratory testing or field experience, has not found primers or coatings to be incompatible with SFRM.

D. Fire-Test-Response Characteristics: Where indicated, provide products identical to those tested for fire resistance per ASTM E 119 by a testing agency acceptable to authorities having jurisdiction.
1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
2. Identify products with appropriate markings of applicable testing and inspecting agency.

E. Provide products containing no detectable asbestos as determined according to the method specified in 40 CFR 763, Subpart E, Appendix E, Section 1, "Polarized Light Microscopy."

F. Preinstallation Conference: Conduct conference at Project site.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply SFRM when ambient or substrate temperature is 40 deg F (4 deg C) or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of SFRM. Use natural means or, if they are inadequate, forced-air circulation until fire-resistive material dries thoroughly.

C. Sequence and coordinate application of SFRM with other related work specified in other Sections to comply with the following requirements:
1. Provide temporary enclosure as required to confine spraying operations and protect the environment.
2. Provide temporary enclosures for applications to prevent deterioration of fire-resistive material due to exposure to weather and to unfavorable ambient conditions for humidity, temperature, and ventilation.
3. Avoid unnecessary exposure of fire-resistive material to abrasion and other damage likely to occur during construction operations subsequent to its application.
4. Do not apply fire-resistive material to metal roof deck substrates until concrete topping, if any, has been completed. For metal roof decks without concrete topping, do not apply fire-resistive material to metal roof deck substrates until roofing has been completed; prohibit roof traffic during application and drying of fire-resistive material.
5. Do not apply fire-resistive material to metal floor deck substrates until concrete topping has been completed.
6. Do not begin applying fire-resistive material until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
7. Defer installing ducts, piping, and other items that would interfere with applying fire-resistive material until application of fire protection is completed.
8. Do not install enclosing or concealing construction until after fire-resistive material has been applied, inspected, and tested and corrections have been made to defective applications.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form, signed by Contractor and by Installer, in which manufacturer agrees to repair or replace SFRMs that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Cracking, flaking, spalling, or eroding in excess of specified requirements; peeling; or delaminating of SFRM from substrates.
      b. Not covered under the warranty are failures due to damage by occupants and Owner's maintenance personnel, exposure to environmental conditions other than those investigated and approved during fire-response testing, and other causes not reasonably foreseeable under conditions of normal use.
   2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCEALED SFRM

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   1. Concealed Cementitious SFRM:
      a. Carboline Co., Fireproofing Products Div.; Pyrolite 15 High Yield.
      b. Grace, W. R. & Co. - Conn., Construction Products Div.; Monokote Type MK-6 .
      c. Isolatek International Corp.; Cafco 300.

B. Material Composition: Manufacturer's standard product:
   1. Concealed Cementitious SFRM: Factory-mixed, dry formulation of gypsum or portland cement binders, additives, and lightweight mineral or synthetic aggregates mixed with water at Project site to form a slurry or mortar for conveyance and application.

C. Physical Properties: Minimum values, unless otherwise indicated, or higher values required to attain designated fire-resistance ratings, measured per standard test methods referenced with each property as follows:
   1. Dry Density: 15 lb/cu. ft. (240 kg/cu. m) for average and individual densities, or greater if required to attain fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method."
   2. Thickness: Minimum average thickness required for fire-resistance design indicated according to the following criteria, but not less than 0.375 inch (9 mm), per ASTM E 605:
      a. Where the referenced fire-resistance design lists a thickness of 1 inch (25 mm) or more, the minimum allowable individual thickness of SFRM is the design thickness minus 0.25 inch (6 mm).
      b. Where the referenced fire-resistance design lists a thickness of less than 1 inch (25 mm) but more than 0.375 inch (9 mm), the minimum allowable individual thickness of SFRM is the greater of 0.375 inch (9 mm) or 75 percent of the design thickness.
      c. No reduction in average thickness is permitted for those fire-resistance designs whose fire-resistance ratings were established at densities of less than 15 lb/cu. ft. (240 kg/cu. m).
   3. Bond Strength: 150 lbf/sq. ft. (7.2 kPa) minimum per ASTM E 736 based on laboratory testing of 0.75-inch (19-mm) minimum thickness of SFRM.

4. Compressive Strength: 5.21 lbf/sq. in. (35.9 kPa) minimum per ASTM E 761. Minimum thickness of SFRM tested shall be 0.75 inch (19 mm) and minimum dry density shall be as specified but not less than 15 lb/cu. ft. (240 kg/cu. m).
5. Corrosion Resistance: No evidence of corrosion per ASTM E 937.
6. Deflection: No cracking, spalling, or delamination per ASTM E 759.
7. Effect of Impact on Bonding: No cracking, spalling, or delamination per ASTM E 760.
8. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) in 24 hours per ASTM E 859. For laboratory tests, minimum thickness of SFRM is 0.75 inch (19 mm), maximum dry density is 15 lb/cu. ft. (240 kg/cu. m), test specimens are not prepurged by mechanically induced air velocities, and tests are terminated after 24 hours.
9. Fire-Test-Response Characteristics: Provide SFRM with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   a. Flame-Spread Index: 10 or less.
   b. Smoke-Developed Index: 0.

2.2 AUXILIARY FIRE-RESISTIVE MATERIALS

A. General: Provide auxiliary fire-resistive materials that are compatible with SFRM and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: For use on each substrate and with each sprayed fire-resistive product, provide primer that complies with one or more of the following requirements:
   1. Primer's bond strength complies with requirements specified in UL's "Fire Resistance Directory" for coating materials based on a series of bond tests per ASTM E 736.
   2. Primer is identical to those used in assemblies tested for fire-test-response characteristics of SFRM per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

C. Adhesive for Bonding Fire-Resistive Material: Product approved by manufacturer of SFRM.

D. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required to comply with fire-resistance designs indicated and fire-resistive material manufacturer's written recommendations. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive SFRM.

E. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by manufacturer of SFRM.

F. Sealer for Sprayed-Fiber Fire-Resistive Material: Transparent-drying, water-dispersible, tinted protective coating recommended in writing by manufacturer of sprayed-fiber fire-resistive material.

G. Topcoat: Type recommended in writing by manufacturer of each SFRM.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of work. A substrate is in satisfactory condition if it complies with the following:
   1. Substrates comply with requirements in the Section where the substrate and related materials and construction are specified.
   2. Substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, incompatible paints, incompatible encapsulants, or other foreign substances capable of impairing bond of fire-resistive materials with substrates under conditions of normal use or fire exposure.
   3. Objects penetrating fire-resistive material, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
   4. Substrates are not obstructed by ducts, piping, equipment, and other suspended construction that will interfere with applying fire-resistive material.
   5. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Conduct tests according to fire-resistive material manufacturer's written recommendations to verify that substrates are free of substances capable of interfering with bond.

C. Cover other work subject to damage from fallout or overspray of fire-resistive materials during application.

D. Clean substrates of substances that could impair bond of fire-resistive material, including dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, and incompatible primers, paints, and encapsulants.

E. Prime substrates where recommended in writing by SFRM manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive SFRM.

F. Install metal lath and reinforcing fabric, as required, to comply with fire-resistance ratings and fire-resistive material manufacturer's written recommendations for conditions of exposure and intended use. Securely attach lath and fabric to substrate in position required for support and reinforcement of fire-resistive material. Use anchorage devices of type recommended in writing by SFRM manufacturer. Attach accessories where indicated or required for secure attachment of lath and fabric to substrate.

G. Coat substrates with bonding adhesive before applying fire-resistive material where required to achieve fire-resistance rating or as recommended in writing by SFRM manufacturer for material and application indicated.

H. Extend fire-resistive material in full thickness over entire area of each substrate to be protected. Unless otherwise recommended in writing by SFRM manufacturer, install body of fire-resistive covering in a single course.

I. Spray apply fire-resistive materials to maximum extent possible. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by SFRM manufacturer.

J. Where sealers are used, apply products that are tinted to differentiate them from SFRM over which they are applied.

K. Apply concealed SFRM in thicknesses and densities not less than those required to achieve fire-resistance ratings designated for each condition, but apply in greater thicknesses and densities if specified in Part 2 "Concealed SFRM" Article.

L. Apply water overspray to concealed sprayed-fiber fire-resistive material as required to obtain designated fire-resistance rating.

M. Cure concealed SFRM according to product manufacturer's written recommendations.

N. Apply sealer to concealed SFRM.

O. Apply topcoat to concealed SFRM.

P. Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

Q. Repair or replace work that has not successfully protected steel.

3.2 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections and prepare reports:
1. SFRM.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and prepare test reports.
1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

C. Tests and Inspections: Testing and inspecting of completed applications of SFRM shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with application of SFRM for the next area until test results for previously completed applications of SFRM show compliance with requirements. Tested values must equal or exceed values indicated and required for approved fire-resistance design.
1. Thickness for Structural Frame Members: From a sample of 25 percent of structural members per floor, taking 9 measurements at a single cross section for structural frame beams or girders, 7 measurements of a single cross section for joists and trusses, and 12 measurements of a single cross section for columns per ASTM E 605.
2. Bond Strength for Structural Framing Members: For each 10,000-sq. ft. (929 sq. m) area, or partial area, on each floor, cohesion and adhesion from one sample of size indicated for determining thickness of each type of construction and structural framing member, per ASTM E 736.
   a. Field test SFRM that is applied to flanges of wide-flange, structural-steel members on surfaces matching those that will exist for remainder of steel receiving fire-resistive material.
   b. If surfaces of structural steel receiving SFRM are primed or otherwise painted for coating materials, perform series of bond tests specified in UL's "Fire Resistance

Directory." Provide bond strength indicated in referenced UL fire-resistance criteria, but not less than 150 lbf/sq. ft. (7.2 kPa) minimum per ASTM E 736.

3. If testing finds applications of SFRM are not in compliance with requirements, testing and inspecting agency will perform additional random testing to determine extent of noncompliance.

D. Remove and replace applications of SFRM that do not pass tests and inspections for cohesion and adhesion, for density, or for both and retest as specified above.

E. Apply additional SFRM, per manufacturer's written instructions, where test results indicate that thickness does not comply with specified requirements, and retest as specified above.

END OF SECTION 07811

SECTION 07841 – THROUGH-PENETRATION FIRESTOP SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Extent firestopping work for fireproofing to include: penetrations where mechanical, electrical piping, conduit, cabletrays, ducts, other trade items pierce fire rated walls, and smoke barriers, and construction gaps.

B. Related Items: Expansion joint covers, mechanical and electrical devices requiring firestopping through fire rated walls, partitions such as fire dampers, electrical cabletrays, etc.

C. References: U.L. Fire Resistance Directory: Through-penetration firestop devices (XHCR); Fire resistance ratings (BXUV); Through-penetration firestop systems (XHEZ); Fill, void or cavity material (XHHW). Warnock Hersey. American Society For Testing and Materials Standards: ASTM E814-88: Standard Test Method For Fire Tests of Through-Penetration Firestops.

1.2 DEFINITIONS

A. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.

B. Barriers: Time rated firewalls, partitions, smoke barrier walls, partitions.

C. Firestopping: Methods, materials applied in penetrations, unprotected openings to limit spread of heat, fire, gasses, smoke.

D. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials not obtained.

E. System: Specific products, applications, classified, numbered by Underwriters Laboratories, Inc. to close specific barrier penetrations.

F. Sleeve: Metal fabrication or pipe section extending through thickness of barrier, used to permanently guard penetration. Sleeves described as part of penetrating system in other sections and may or may not be required.

1.3 SYSTEM DESCRIPTION

A. Design Requirements: Smoke barrier and Fire-rated construction: Maintain barrier, structural floor fire resistance ratings including resistance to cold smoke at all penetrations, connections with other surfaces, types of construction, at all separations required to permit building movement, sound or vibration absorption, and at other construction gaps.

1.4 QUALITY ASSURANCE

A. Firm experienced in installation, application of systems similar in complexity to those required for this project. Acceptable to or licensed by manufacturer, state or local authority where applicable. At least two (2) years experience with systems. Successfully completed at least five (5) comparable scale projects using this system.

B. Local and state regulatory requirements: Submit forms or acceptance for proposed assemblies not conforming to specific UL Firestop System numbers, or UL classified devices.

C. Materials tested to provide fire rating at least equal to that of construction.

1.5 DELIVERY AND STORAGE

A. Deliver products in original unopened packaging with legible manufacturer's identification. Coordinate delivery with scheduled installation date, allow minimum storage at site. Store materials in clean, dry, ventilated location. Protect from soiling, abuse, moisture, freezing when required. Follow manufacturer's instructions.

1.6 SUBMITTALS

A. Product data: Manufacturer's specifications, technical data including detailed specification of construction, fabrication and instructions.

1.7 SHOP DRAWINGS

A. Indicate dimensions, descriptions of materials, finishes, general construction, specific modifications, component connections, anchorage methods, hardware, installation procedures, plus following specific requirements:
   1. Details of each proposed assembly identifying intended products, applicable UL System number, or UL classified devices.
   2. Manufacturer or Manufacturer's Representative provide qualified engineering judgements, drawings related to non-standard applications as needed.
   3. Upon request, provide samples of material and products to be used.

PART 2 - PRODUCTS

2.1 THROUGH-PENETRATION FIRESTOPPING OF FIRE-RATED CONSTRUCTION

A. Systems or devices as specified and manufactured. By unique Fire Stop products, Inc. other manufacturers are acceptable, subject to prior approval, and that their system(s) conforms to construction type, penetrant type, annular space requirements, fire rating involved in each separate instance, and that system be symmetrical for wall applications. Systems or devices must be asbestos-free. Mortar systems must be Warnock Hersey approved.

2.2 ADDITIONAL REQUIREMENTS

A. Withstand passage of cold smoke either as inherent property of system, or by use of separate product included as part of U.L. system or device, designed to perform this function.

B. Acceptable manufacturers and products are those listed in U.L. Fire Resistance directory for U.L. System involved or Mortar systems approved by Warnock Hersey. All firestopping products from single manufacturer.

2.3 CONSTRUCTION-GAP FIRESTOPPING OF FIRE-RATED CONSTRUCTION

A. Firestopping at construction gaps between tops of partitions, underside of structural systems. Firestopping at construction gaps between partitions, adjacent partitions.

B. Penetrator Devices and Cable Tray Penetrations:
1. Basic – Penetrator System #W-L-3137 as manufactured by Unique Fire Stop Products, Inc. – Robertsdale, AL 36567.
2. U.L. Fire Rated for penetrating fire partitions shall be same rating(s) as partition. Refer to drawing for partition ratings.
3. Four-inch (4") diameter assembly where two (2) sleeves will be provided in line of the cable tray. The cable tray shall be cut off short of the sleeves on both sides of the wall. The gap between the sleeves and the wall penetration shall be fire caulked by the Contractor and he will install the collars around the sleeves at the walls. He will also provide a plastic bushing around the edges on both ends of the sleeve. Owner will do the cabling in the cable trays and through the sleeves and be responsible for caulking around the cables and sealing the sleeves completely to meet code requirements. Should a sleeve not be used, then the Owner shall fire caulk the open sleeve. This method shall be used for all open cable penetrations through fire rated walls. Smoke Barrier Walls are considered to be 1-hour fire rated walls.
4. A similar, Contractor-fabricated, sleeve that resembles the system described above will be used for all non-fire rated walls are expected to be penetrated. The caulking materials used do not have to be fire rated.

C. Cable Tray Wall Penetrators:
1. Substitute – Should the Owner request this type penetration, Contractor shall submit a cost per each unit (including taxes, overhead, etc.) in the space provided in the form of proposal.
2. System W-L-4029 F for fire rated walls and System W-L-4029 T for non-fire rated walls.
3. Product of Unique Fire Stop Products, Inc. – Robertsdale, AL 36567. Materials and methods described in U300 and U400 Series wall or partition designs in U.L. Fire Resistive Directory. Refer to drawings for partitions ratings.

2.4 ACCESSORIES

A. Fill, void or cavity materials: As classified under category XHHW in U.L. Fire Resistance Director or Mortars as approved by Warnock Hersey. Forming materials: As classified under category XHKU in U.L. Fire Resistance Directory.

PART 3 - EXECUTION

3.1 VERIFICATION OF CONDITIONS

A. Examine areas, conditions under which work performed, identify conditions detrimental to proper or timely completion. Verify barrier penetrations properly sized, in suitable condition for application of materials. Do not proceed until unsatisfactory conditions corrected. Proceed with installation only after penetrations of substrate, supporting brackets installed.

3.2 ENVIRONMENTAL REQUIREMENTS

A. Provide adequate ventilation if using solvent. Provide forced air ventilation during installation if required by manufacturer. Keep flammable materials away from sparks or flame. Provide masking, drop cloths to prevent contamination of adjacent surfaces by firestopping materials. Comply with manufacturer's recommendations for temperature, humidity conditions before, during and after installation of firestopping.

3.3 PREPARATION

A. Clean surfaces in contact with penetration seal materials, of dirt, grease, oil, loose materials, rust, other substances that may affect proper fitting, adhesion, or required fire resistance.

3.4 INSTALLATION

A. Firestopping: Install penetration seal materials in accord printed instructions U.L. Fire Resistance Directory of Mortars per Warnock Hersey approval and in accord with manufacturer's instruction. Seal holes or voids made by penetrations to ensure an effective smoke barrier. Protect materials from damage on surfaces subject to traffic. Where large openings created in walls, floors to permit installation of pipes, ducts or other items, close unused portions of opening with firestopping material tested for application. See U.L. Fire Resistance Directory, Warnock Hersey approvals. Install smoke stopping specified for firestopping.

3.5 FIELD QUALITY CONTROL

A. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas. Keep areas of work accessible until inspection by applicable code authorities. Perform under this section patching, repairing of firestopping caused by cutting or penetration by other trades.

3.6 ADJUSTING AND CLEANING

A. Clean up spills of liquid components. Neatly cut, trim materials as required. Remove equipment, materials, debris, leaving area in undamaged, clean condition.

END OF SECTION 07841

SECTION 07920 – JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes joint sealants for the following applications, including those specified by reference to this Section:
   1. Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
   2. Exterior joints in horizontal traffic surfaces.
   3. Interior joints in vertical surfaces and horizontal nontraffic surfaces.
   4. Interior joints in horizontal traffic surfaces.

B. See Division 08 Section "Glazing" for glazing sealants.

1.2 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.3 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Preconstruction field test reports.

D. Compatibility and adhesion test reports.

E. Product certificates..

1.4 QUALITY ASSURANCE

A. Preconstruction Compatibility and Adhesion Testing: Submit samples of materials that will contact or affect joint sealants to joint-sealant manufacturers for testing according to manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

B. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates according to the method in ASTM C 1193 that is appropriate for the types of Project joints.

C. Mockups: Build mockups incorporating sealant joints, as follows, to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution:
   1. Joints in mockups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this Section.

1.5 WARRANTY

A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Three (3) years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Three (3) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

2.3 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Multicomponent Pourable Urethane Sealant ES-1:
   1. Products:
      a. Bostik Findley; Chem-Calk 550.
      b. Meadows, W. R., Inc.; POURTHANE.
      c. Pecora Corporation; Urexpan NR-200.
      d. Tremco; THC-900 / 901.

e. Tremco; Vulkem 245.
2. Type and Grade: M (multicomponent) and P (pourable).
3. Class: 25.
4. Use Related to Exposure: T (traffic).
5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.

D. Single-Component Nonsag Urethane Sealant ES-2:
1. Products:
a. Bostik Findley; Chem-Calk 900 / 915.
b. Pecora Corporation; Dynatrol I-XL.
c. Tremco; DyMonic.
2. Type and Grade: S (single component) and NS (nonsag).
3. Class: 25..
4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.

E. Single-Component Mildew-Resistant Acid-Curing Silicone Sealant ES-3:
1. Products:
a. Dow Corning Corporation; 786 Mildew Resistant.
b. GE Silicones; Sanitary SCS1700.
c. Tremco; Tremsil 200, White.
2. Type and Grade: S (single component) and NS (nonsag).
3. Class: 25.
4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Joint Substrates: G, A, and, as applicable to joint substrates indicated, O.

2.4 SOLVENT-RELEASE JOINT SEALANTS

A. Butyl-Rubber-Based Solvent-Release Joint Sealant SRS-1: Comply with ASTM C 1085.
1. Products:
a. Bostik Findley; Bostik 300.
b. Pecora Corporation; BC-158.
c. Tremco; Tremco Butyl Sealant.

2.5 LATEX JOINT SEALANTS

A. Latex Sealant LS-1: Comply with ASTM C 834, Type O P, Grade NF.

B. Products:
1. Bostik Findley; Chem-Calk 600.
2. Pecora Corporation; AC-20+.
3. Tremco; Tremflex 834.

2.6 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant for Exposed and Concealed Joints AS-1: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 that effectively reduces

airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Products:
   a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
   b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.

2.7 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) or Type B (bicellular material with a surface skin) , as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F (minus 32 deg C). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.
   1. Use at all unit masonry control / expansion joints, and perimeter

D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant.
   a. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.
2. Remove laitance and form-release agents from concrete.
   a. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.2 INSTALLATION

A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

B. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.3 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application JS-1: Exterior horizontal nontraffic and traffic isolation and expansion joints of paving adjacent to building.
1. Joint Sealant: Multicomponent pourable urethane sealant ES-1.
2. Joint-Sealant Color: As selected by Architect from manufacturer's standard colors.

B. Joint-Sealant Application JS-2: Exterior vertical control and expansion joints in unit masonry.
1. Joint Sealant: Single-component nonsag urethane sealant ES-2.
2. Joint-Sealant Color: As selected by Architect from manufacturer's standard colors to match color(s) of adjacent masonry units.
3. Provide elastomeric tubing sealant backing to provide a secondary seal.

C. Joint-Sealant Application JS-3: Exterior butt joints between metal panels.
1. Joint Sealant: Single-component nonsag urethane sealant ES-2.
2. Joint-Sealant Color: As selected by Architect from manufacturer's standard colors to match color(s) of adjacent metal panels.
3. Provide elastomeric tubing sealant backing to provide a secondary seal.

D. Joint-Sealant Application JS-4: Exterior vertical joints between different materials listed above.
1. Joint Sealant: Single-component nonsag urethane sealant ES-2.
2. Joint-Sealant Color: As selected by Architect from manufacturer's standard colors to match color(s) of adjacent materials.
3. Provide elastomeric tubing sealant backing to provide a secondary seal.

E. Joint-Sealant Application JS-5: Exterior perimeter joints of exterior openings such as frames of doors, windows, and louvers.
1. Joint Sealant: Single-component nonsag urethane sealant ES-2.
2. Joint-Sealant Color: As selected by Architect from manufacturer's standard colors to match color(s) of adjacent materials.
3. Provide elastomeric tubing sealant backing to provide a secondary seal.

F. Joint-Sealant Application JS-6: Exterior control and expansion joints in ceilings and other overhead surfaces.
1. Joint Sealant: Single-component nonsag urethane sealant ES-2.
2. Joint-Sealant Color: As selected by Architect from manufacturer's standard colors to match color(s) of adjacent materials.

G. Joint-Sealant Application JS-7: Flashing at roofing & roof parapets.
1. Joint Sealant: Single-component nonsag urethane sealant ES-2.
2. Joint-Sealant Color: As selected by Architect from manufacturer's standard colors to match color(s) of adjacent materials.

H. Joint-Sealant Application JS-8: Vertical control and expansion joints on exposed interior surfaces of exterior walls and interior joints 3/8" wide or more.
   1. Joint Sealant: Single-component nonsag urethane sealant ES-2.
   2. Joint-Sealant Color: As selected by Architect from manufacturer's standard colors to match color(s) of adjacent materials.

I. Joint-Sealant Application JS-9: Interior joints between plumbing fixtures and adjoining walls, floors, and counters.
   1. Joint Sealant: Single-component mildew-resistant acid-curing silicone sealant ES-3.
   2. Joint-Sealant Color: White.

J. Joint-Sealant Application JS-10: Vertical joints ¼" wide or less on exposed surfaces of interior walls and partitions including where casework or similar construction abuts wall.
   1. Joint Sealant: Latex sealant LS-1.
   2. Joint-Sealant Color: Paintable.

K. Joint-Sealant Application JS-11: Perimeter joints between interior wall surfaces and frames of interior doors windows and elevator entrances.
   1. Joint Sealant: Latex sealant LS-1.
   2. Joint-Sealant Color: Paintable.

L. Joint-Sealant Application JS-12: Set thresholds in bed of sealant; keep all weep holes clear and remove excess sealant.
   1. Joint Sealant: Butyl-rubber-based solvent-release joint sealant SRS-1.

END OF SECTION 07920

SECTION 08110 – STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Standard hollow metal doors and frames.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.

C. Schedule: Prepared by or under the supervision of supplier.

1.3 QUALITY ASSURANCE

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated. based on testing at positive pressure according to NFPA 252 or UL 10C.

B. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, CS, Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, CS, Type B.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.
   1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Mineral-Fiber Insulation: ASTM C 665, Type I.

2.2 STANDARD HOLLOW METAL DOORS

A. General: Comply with ANSI/SDI A250.8.
   1. Design: Embossed panel unless otherwise indicated.
   2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
      a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
      b. Thermal-Rated (Insulated) Doors: R-value of not less than 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W) when tested according to ASTM C 1363.
   3. Vertical Edges for Single-Acting Doors: Manufacturer's standard.
   4. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- (1.0-mm-) thick, end closures or channels of same material as face sheets.
   5. Tolerances: SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

B. Exterior Doors and Interior Doors at First Floor: Face sheets fabricated from metallic-coated steel sheet. Comply with ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
   1. Exterior Doors: Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush).
   2. Interior Doors at First Floor: Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush).

C. Interior Doors above First Floor: Face sheets fabricated from cold-rolled steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
   1. All interior locations above first floor other than stairwells: Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush).
   2. All interior entrances to stairwells above the first floor: Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush) .

D. Hardware Reinforcement: ANSI/SDI A250.6.

2.3 STANDARD HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8.

B. Exterior Frames: Fabricated from metallic-coated steel sheet.
   1. Fabricate frames with mitered or coped corners.
   2. Fabricate frames as full profile welded unless otherwise indicated.
   3. Frames for Level 3 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.

C. Interior Frames: Fabricated from cold-rolled steel sheet.
   1. Fabricate frames with mitered or coped corners.
   2. Frames for Level 2 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
   3. Frames for Level 3 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
   4. Frames for Wood Doors: 0.053-inch- (1.3-mm-) thick steel sheet.

D. Hardware Reinforcement: ANSI/SDI A250.6.

2.4 FRAME ANCHORS

A. Jamb Anchors:
1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (50 mm) wide by 10 inches (250 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (1.0 mm) thick.
3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
4. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch (1.0 mm) thick, and as follows:
1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.5 STOPS AND MOLDINGS

A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch (0.8 mm) thick, same material as door face sheet.

B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated.

C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch (0.8 mm) thick, same material as frames.

D. Terminated Stops: Where indicated, terminate stops 6 inches (152 mm) above finish floor with a 45-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

2.6 LOUVERS

A. Provide sightproof louvers for interior doors, where indicated, that comply with SDI 111C, with blades or baffles formed of 0.020-inch- (0.5-mm-) thick, cold-rolled steel sheet set into 0.032-inch- (0.8-mm-) thick steel frame. Provide galvanized louvers where frames/doors required to be galvanized.

1. Fire-Rated Automatic Louvers: Movable blades closed by actuating fusible link, and listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated.

2.7 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch- (6.4-mm-thick by 25.4-mm-) wide steel.

C. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick.

2.8 FABRICATION

A. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

B. Hollow Metal Doors:
1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors. Seal joints in top edges of doors against water penetration.
2. Glazed Lites: Factory cut openings in doors.
3. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated.

C. Hollow Metal Frames: Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
5. Jamb Anchors: Provide number and spacing of anchors as follows:
   a. Masonry Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
      1) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
      2) Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.
      3) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high.
   b. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
      1) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
      2) Two anchors per head for frames more than 42 inches (1066 mm) wide and mounted in metal-stud partitions.
   c. Compression Type: Not less than two anchors in each jamb.
6. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers.
   a. Single-Door Frames: Three door silencers.
   b. Double-Door Frames: Two door silencers.

D. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 electrical Sections.

E. Stops and Moldings: Provide stops and moldings around glazed lites where required. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
4. Provide loose stops and moldings on inside of hollow metal work.
5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation required.

2.9 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
   1. Shop Primer: ANSI/SDI A250.10.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hollow Metal Frames: Comply with ANSI/SDI A250.11.
   1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
      a. At fire-protection-rated openings, install frames according to NFPA 80.
      b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
      c. Install frames with removable glazing stops located on secure side of opening.
      d. Install door silencers in frames before grouting.
      e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
      f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
      g. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.
   2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
      a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
   3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
   4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
   5. In-Place Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
   6. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
   7. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for

securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.

8. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

B. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
   1. Non-Fire-Rated Standard Steel Doors:
      a. Jambs and Head: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
      b. Between Edges of Pairs of Doors: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
      c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch (9.5 mm).
      d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch (19 mm).
   2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
   3. Smoke-Control Doors: Install doors according to NFPA 105.

C. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.

   1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (50 mm) o.c. from each corner.

3.2 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

C. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 08110

SECTION 08211 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Solid-core doors with wood-veneer faces.
   2. Factory finishing flush wood doors.
   3. Factory fitting flush wood doors to frames and factory machining for hardware.

1.2 SUBMITTALS

A. Product Data: For each type of door indicated. Include factory-finishing specifications.

B. SPiRiT Submittals:
   1. Certificates for Credit MR 4.C7: Chain-of-custody certificates certifying that flush wood doors comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
   2. Product Data for Credit IEQ 5.C4: For adhesives and composite wood products, indicating that product contains no urea formaldehyde.

C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
   1. Indicate dimensions and locations of mortises and holes for hardware.
   2. Indicate dimensions and locations of cutouts.
   3. Indicate requirements for veneer matching.
   4. Indicate doors to be factory finished and finish requirements.
   5. Indicate fire-protection ratings for fire-rated doors.

D. Samples: For factory-finished doors.

E. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Quality Standards Illustrated."

C. Forest Certification: Provide doors made with wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

D. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings required.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Warping (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section.
      b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm in a 76.2-mm) span.
   2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
   3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 DOOR CONSTRUCTION, GENERAL

A. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.

B. Fire-Protection-Rated Doors: Provide mineral core as needed to provide fire-protection rating required.
   1. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
   2. Pairs: Provide fire-retardant stiles that are listed and labeled for applications required without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

C. Mineral-Core Doors:
   1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating required.
   2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings required as needed to eliminate through-bolting hardware.
   3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

2.2 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:
   1. Grade: Premium, with Grade AA.
   2. Species: Red oak.
   3. Cut: Plain sliced (flat sliced).
   4. Assembly of Veneer Leaves on Door Faces: Running match.

5. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
6. Core: Structural composite lumber.
7. Construction: Five plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering.

2.3 LOUVERS AND LIGHT FRAMES

A. Metal Louvers:
1. Metal and Finish: Hot-dip galvanized steel, 0.040 inch (1.0 mm) thick, with baked-enamel- or powder-coated finish.

B. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating required.

2.4 FABRICATION

A. Factory fit doors to suit frame-opening sizes. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
1. Comply with requirements in NFPA 80 for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied.

C. Openings: Cut and trim openings through doors in factory.
1. Light Openings: Trim openings with moldings of material and profile indicated.
2. Glazing: Factory install glazing in doors. Comply with applicable requirements in Division 08 Section "Glazing."
3. Louvers: Factory install louvers in prepared openings.

2.5 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.

B. Finish doors at factory.

C. Transparent Finish:
1. Grade: Premium.
2. Finish: AWI conversion varnish or catalyzed polyurethane system.
3. Staining: As selected from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hardware: For installation, see Division 08 Section "Door Hardware."

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
   1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.

C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

END OF SECTION 08211

SECTION 08311 – ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes access doors and frames for walls and ceilings.

1.2 SUBMITTALS

A. Product Data: For each type of access door and frame indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each door face material in specified finish.

D. Schedule: Types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

1.3 QUALITY ASSURANCE

A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to assemblies tested for fire-test-response characteristics per the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1. NFPA 252 or UL 10B for vertical access doors and frames.
   2. ASTM E 119 or UL 263 for horizontal access doors and frames.

1.4 COORDINATION

A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed plumbing, mechanical, or other concealed work, and indicate in the schedule specified in "Submittals" Article.

PART 2 - PRODUCTS

2.1 STEEL MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
   1. ASTM A 123/A 123M, for galvanizing steel and iron products.
   2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.

B. Steel Sheet: Uncoated or electrolytic zinc-coated, ASTM A 591/A 591M with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS) with A60 (ZF180) zinc-iron-alloy (galvannealed) coating or G60 (Z180) mill-phosphatized zinc coating.

D. Steel Finishes: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Factory-Primed Finish: Manufacturer's standard shop primer.

E. Drywall Beads: 0.0299-inch (0.76-mm) zinc-coated steel sheet to receive joint compound.

2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Flush Access Doors and Frames with Exposed Trim: Fabricated from steel sheet.
1. Locations: Wall and ceiling.
2. Door: Minimum 0.0329-inch- (0.70-mm-) thick sheet metal.
3. Frame: Minimum 0.060-inch- (1.5-mm-) thick sheet metal with 1-inch- (25-mm-) wide, surface-mounted trim.
4. Hinges: Continuous piano.
5. Lock: Mortise cylinder.

B. Fire-Rated, Insulated, Flush Access Doors and Frames with Exposed Trim: Fabricated from steel sheet.
1. Locations: Wall and ceiling surfaces.
2. Fire-Resistance Rating: Not less than that of adjacent construction.
3. Temperature Rise Rating: 250 deg F (139 deg C) at the end of 30 minutes.
4. Door: Flush panel with a core of mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.0428 inch (1.1 mm).
5. Frame: Minimum 0.060-inch- (1.5-mm-) thick sheet metal with 1-inch- (25-mm-) wide, surface-mounted trim.
6. Hinges: Continuous piano.
7. Automatic Closer: Spring type.
8. Lock: Self-latching device with mortise cylinder lock.

2.3 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view, provide materials with smooth, flat surfaces without blemishes.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.

D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
1. For cylinder lock, furnish two keys per lock and key all locks alike.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.2 ADJUSTING AND CLEANING

A. Adjust doors and hardware after installation for proper operation.

B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08311

SECTION 08331 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of electric-motor-operated overhead coiling doors:
   1. Insulated service doors at exterior openings.
   2. Fire-rated service doors at interior openings.

B. See Division 05 Section "Metal Fabrications" for miscellaneous steel supports.

C. See Division 16 Sections for electrical service and connections for powered operators and accessories.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide overhead coiling doors capable of withstanding the effects of gravity loads and at exterior locations the wind load and the wind-borne debris requirements of Section 1609 of the 2003 International Building Code.

B. Operation-Cycle Requirements: Provide overhead coiling door components and operators capable of operating for not less than 20,000 cycles and for 10 cycles per day.

1.3 SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.

B. Shop Drawings: Include plans, elevations, sections, details, and attachment to other work.

C. Samples: For each exposed finish.

D. Oversize Construction Certification: For door assemblies required to be fire-rated and that exceed size limitations of labeled assemblies.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

B. Fire-Test-Response Characteristics: Provide assemblies complying with NFPA 80 that are identical to door and frame assemblies tested for fire-test-response characteristics per UL 10b and NFPA 252, and that are listed and labeled for fire ratings indicated by UL, FMG, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.

PART 2 - PRODUCTS

2.1 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Interlocking slats in a continuous length for width of door of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door.
   1. Stainless-Steel Door Curtain Slats: ASTM A 666, Type 304.
   2. Slat type: Flat profile.
   3. Insulation: Manufacturer's standard rigid cellular polystyrene or polyurethane-foam-type thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within metal slat faces.

B. Endlocks and Windlocks: Malleable-iron casings, secured to curtain slats to comply with wind load.

C. Bottom Bar: Manufacturer's standard to suit type of curtain slats.
   1. Astragal: Replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene; as a cushion bumper for interior door.

D. Curtain Jamb Guides: Steel angles or channels and angles, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain, and a continuous bar for holding windlocks.
   1. Provide galvanized steel components.

E. Hood: Form to act as weatherseal and entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface-mounted hoods, and provide fascia for any portion of between-jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sagging.
   1. Stainless-Steel Hoods: Minimum 0.025-inch- (0.65-mm-) thick stainless-steel sheet, Type 304.
   2. At fire-rated assemblies Include automatic drop baffle to guard against passage of smoke or flame.

F. Smoke Seals: UL-listed and -tested smoke-seal perimeter gaskets.

G. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets fitted to bottom and top of exterior doors, unless otherwise indicated. At door head, use 1/8-inch- (3-mm-) thick, replaceable, continuous sheet secured to inside of hood.
   1. Motor-Operated Doors: Combination bottom weatherseal and sensor edge.
   2. Jamb Seals: Replaceable, adjustable, continuous, flexible, 1/8-inch- (3-mm-) thick seals of flexible vinyl, rubber, or neoprene at door jambs for a weathertight installation.

H. Power-Operated Doors: Safety interlock switch to disengage power supply when door is locked.

I. Automatic-Closing Device: Inoperative during normal door operations; with governor unit complying with requirements of NFPA 80 and with an easily tested and reset release mechanism, and designed to be activated by the following:
   1. Building fire alarm and detection system and door-holder-release devices.

J. Counterbalancing Mechanism: Adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to door curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
   1. Mounting Brackets: Cast iron or cold-rolled steel plate.

K. Manual Door Operator for use in event of power failure: Chain hoist.

L. Electric Door Operator: Manufacturer's standard type, size, and capacity for door and operation-cycle requirements specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories. Comply with NFPA 70.
   1. Disconnect Device: Hand-operated for automatically engaging chain and sprocket operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount to be accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
   2. Door-Operator Type: Wall-, hood-, or bracket-mounted unit with electric motor, belt-reduction, gear-head-reduction, or worm-gear running-in-oil drive, and chain and sprocket secondary drive.

M. Electric Motors: High-starting torque, reversible, continuous-duty, polyphase, Class A insulated, electric motors complying with NEMA MG 1; with overload protection; sized to start, accelerate, and operate door in either direction from any position, at not less than 2/3 fps (0.2 m/s) and not more than 1 fps (0.3 m/s), without exceeding nameplate ratings or service factor. Coordinate wiring requirements and electrical characteristics of motors with building electrical system.
   1. Open dripproof-type motor, and controller with NEMA ICS 6, Type 1 enclosure.

N. Control Equipment: NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V, ac or dc, with remote, "open/close" key switch with "stop" push button control station.
   1. Interior units, full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
   2. Obstruction Detection Device: External automatic safety sensor capable of protecting full width of door opening. Activation of sensor immediately stops and reverses downward door travel.
   3. Provide electric operators with ADA-compliant audible alarm and visual indicator lights.

2.2 FINISHES

A. Stainless-Steel Finish: Bright, cold-rolled, unpolished finish: No. 2B finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install coiling doors and operating equipment complete with necessary hardware, jamb and head molding strips, anchors, inserts, hangers, and equipment supports
   1. Install fire-rated doors to comply with NFPA 80.

B. Lubricate bearings and sliding parts; adjust doors to operate easily, free of warp, twist, or distortion, and with weathertight fit around entire perimeter.

3.2 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain doors. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 08331

SECTION 08345 - VAULT DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Armory door for vault.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each exposed finish.

D. Product test reports.

E. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative of fire-rated security door manufacturer for installation and maintenance of units required for this Project.

B. Comply with vault door requirements in Federal Specification AA-D-600D Door, Vault, Security.

C. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 VAULT DOOR

A. Provide GSA-Approved and labeled Class 5-A Armory Door that conforms to Federal Specification AA-D-00600.
   1. Type IL or IR (left or right opwning swing with optical device.
   2. Style K- Key change combination lock
   3. Design S- single lock.
   4. Size: Clear opening 40-inches (1016 mm) wide by 78-inches (1981 mm) high.

B. Finish: Manufacturer's standard factory-applied paint finish, applied to door, frame, and wall flanges.

C. Escape Mechanism: Provide emergency operation of lock from vault side of door by means of inside door release fabricated from stainless-steel rod.

2.2 FABRICATION

A. Fabricate vault doors and frames rigid, neat in appearance, and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Weld exposed joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install vault door assemblies complete with doors, frames, and accessories and according to requirements of F.S. AA-D-600D.

B. Set vault door frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.

C. Adjust door hardware and operating mechanism for proper operation.

END OF SECTION 08345

SECTION 08411 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Exterior and interior aluminum-framed storefronts.
   2. Exterior and interior manual-swing aluminum doors.

1.2 PERFORMANCE REQUIREMENTS

A. General: Provide aluminum-framed systems, including anchorage, capable of withstanding, without failure, the effects of the following:
   1. Structural loads.
   2. Thermal movements.
   3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
   4. Dimensional tolerances of building frame and other adjacent construction.
   5. Failure includes the following:
      a. Deflection exceeding specified limits.
      b. Thermal stresses transferred to building structure.
      c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
      d. Noise or vibration created by wind and thermal and structural movements.
      e. Loosening or weakening of fasteners, attachments, and other components.
      f. Sealant failure.
      g. Failure of operating units to function properly.

B. Structural-Sealant Joints: Designed to produce tensile or shear stress in structural-sealant joints of less than 20 psi (138 kPa).

C. Structural Loads:
   1. Wind Loads: Per 2003 International Building Code requirements, including all UFC requirements and applicable codes.
   2. Seismic Loads: Per code where applicable.

D. Deflection of Framing Members Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.

E. Structural-Test Performance: Systems tested according to ASTM E 330 as follows:
   1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
   2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.4 percent of span.
   3. Test Durations: As required by design wind velocity but not less than 10 seconds.

F. Windborne-Debris-Impact-Resistance-Test Performance: ASTM E 1996, large and small missile tests.

G. Blast Resistance: Provide system capable of resisting airblast loadings of intensities and at glazing protection condition levels required, as determined from testing complete assemblies including glazing.
1. Comply with UFC documents pertaining to Antiterrorism Standards for Buildings.

H. Temperature Change (Range): Systems accommodate 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

I. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of systems of 0.06 cfm/sq. ft. (0.03 L/s per sq. m) of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft. (300 Pa).

J. Water Penetration Under Static Pressure: Systems do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 12 lbf/sq. ft. (300 Pa).

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Include structural analysis data for wind loads, seismic loads, wind borne debris requirements and blast resistance requirements, signed and sealed by the qualified professional engineer responsible for their preparation.
2. For entrances, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.

C. Samples: For each exposed finish.

D. Preconstruction Sealant Test Reports: For structural-sealant-glazed systems.

E. Product test reports.

F. Field quality-control test and inspection reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Acceptable to manufacturer and capable of preparation of data for aluminum-framed systems including Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 699 for testing indicated.

C. Preconstruction Sealant Testing: For structural-sealant-glazed systems, perform sealant manufacturer's standard tests for compatibility and adhesion of sealants with each material that will come in contact with sealants and each condition required by aluminum-framed systems.

1. Determine corrective measures required to prepare each material to ensure compatibility with and adhesion of sealants, including, but not limited to, specially formulated primers.

D. Structural-Sealant Glazing: Comply with recommendations in ASTM C 1401, "Guide for Structural Sealant Glazing."

E. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for fabrication and installation.
1. Build mockups as shown on Drawings.

1.5 WARRANTY

A. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Structural failures including, but not limited to, excessive deflection.
   b. Noise or vibration caused by thermal movements.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   d. Adhesive or cohesive sealant failures.
   e. Water leakage through fixed glazing and framing areas.
   f. Failure of operating components to function properly.
2. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
3. Extruded Structural Pipe and Tubes: ASTM B 429.
4. Structural Profiles: ASTM B 308/B 308M.

B. Steel Reinforcement: With manufacturer's standard corrosion-resistant primer.
1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.2 FRAMING SYSTEMS

A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   1. Construction: Nonthermal; interior structural silicone glazed; screw spline fabriction.
      a. Exterior locations: Center glazed to receive 1-5/16" impact resistant glazing.
      b. Interior locations: Center glazed for ¼" non-impact glazing.
      c. 2-1/2"x5" nominal dimensions.

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
   2. Reinforce members as required to receive fastener threads.

D. Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials. Form exposed flashing from sheet aluminum finished to match framing and of sufficient thickness to maintain a flat appearance without visible deflection.

E. Framing System Gaskets and Sealants: Manufacturer's standard recommended by manufacturer for joint type.

2.3 GLAZING SYSTEMS

A. Glazing: As specified in Division 08 Section "Glazing."

B. Glazing Gaskets: Manufacturer's standard compression types, replaceable, molded or extruded, that maintain uniform pressure and watertight seal.

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric types.

D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

E. Glazing Sealants: For structural-sealant-glazed systems, as recommended by manufacturer for joint type and as follows:
   1. Structural Sealant: ASTM C 1184, neutral-curing silicone formulation compatible with system components with which it comes in contact.
      a. Color: As selected from manufacturer's full range of colors.

2.4 DOORS

A. Doors: Manufacturer's standard glazed doors, for manual swing operation.
   1. Door Construction: 1-3/4-inch (44.5-mm) overall thickness, with minimum 0.125-inch-(3.2-mm-) thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deep penetration and fillet welded or that incorporate concealed tie rods.

2. Door Design: Medium stile; 3-1/2-inch (88.9-mm) nominal width .
   a. Accessible Doors: Smooth surfaced for width of door in area within 10 inches (255 mm) above floor or ground plane.
3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.
   a. Provide nonremovable glazing stops on outside of door.

2.5 DOOR HARDWARE

A. General: Provide heavy-duty units in sizes and types recommended by entrance system and hardware manufacturers for entrances and uses indicated.

B. Cylinders: As specified in Division 08 Section "Door Hardware."

C. Cylinder Keying: to be furnished by LAARNG.

D. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.

E. Weather Stripping: Manufacturer's standard replaceable components.
1. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
2. Sliding Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

F. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.

G. Silencers: BHMA A156.16, Grade 1.

2.6 ACCESSORY MATERIALS

A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 07 Section "Joint Sealants."

B. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

2.7 FABRICATION

A. Form aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformations.

2. Accurately fitted joints with ends coped or mitered.
3. Means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
4. Physical and thermal isolation of glazing from framing members.
5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
6. Provisions for field replacement of glazing from exterior.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing (without projecting stops).

E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device (dutchman) to retain glazing in place while structural sealant cures.

F. Door Frames: Reinforce as required to support loads imposed by door operation and for installing hardware.
1. At exterior doors, provide compression weather stripping at fixed stops.
2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.

G. Doors: Reinforce doors as required for installing hardware.
1. At pairs of exterior doors, provide sliding weather stripping retained in adjustable strip mortised into door edge.
2. At exterior doors, provide weather sweeps applied to door bottoms.

H. Hardware Installation: Factory install hardware to the greatest extent possible. Cut, drill, and tap for factory-installed hardware before applying finishes.

I. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 ALUMINUM FINISHES

A. High-Performance Organic Finish: Three-coat thermocured system with fluoropolymer topcoats containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
1. Color and Gloss: As selected from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Fit joints to produce hairline joints free of burrs and distortion.
2. Rigidly secure nonmovement joints.
3. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
4. Seal joints watertight, unless otherwise indicated.

B. Metal Protection:
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" and to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, without warp or rack.

F. Install glazing as specified in Division 08 Section "Glazing."
   1. Structural-Sealant Glazing:
      a. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
      b. Install weatherseal sealant according to Division 07 Section "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

G. Entrances: Install to produce smooth operation and tight fit at contact points.
   1. Exterior Entrances: Install to produce tight fit at weather stripping and weathertight closure.
   2. Field-Installed Hardware: Install surface-mounted hardware according to hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

H. Install perimeter joint sealants as specified in Division 07 Section "Joint Sealants" and to produce weathertight installation.

I. Erection Tolerances: Install aluminum-framed systems to comply with the following maximum tolerances:
   1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/4 inch (6 mm) over total length.
   2. Alignment:
      a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch (1.5 mm).
      b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch (0.8 mm).
   3. Diagonal Measurements: Limit difference between diagonal measurement to 1/8 inch (3 mm).

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Structural-Sealant Compatibility and Adhesion: Structural sealant shall be tested according to recommendations in ASTM C 1401.

1. Destructive test method, Method A, Hand Pull Tab (Destructive) in ASTM C 1401, Appendix X2 shall be used.
   a. A minimum of two areas on each building face shall be tested.
   b. Repair installation areas damaged by testing.

C. Structural-Sealant Glazing Inspection: After installation of aluminum-framed systems is complete, structural-sealant glazing shall be inspected and evaluated according to ASTM C 1401 recommendations.

D. Water Spray Test: Before installation of interior finishes has begun, a minimum area of 75 feet (23 m) by 1 story of aluminum-framed systems designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.

E. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 08411

SECTION 08712 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Commercial door hardware.
   2. Cylinders for doors specified in other Sections.
   3. Electrified door hardware.

B. See Division 08 door sections for astragals and door silencers.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Details of electrified door hardware including wiring diagrams.

C. Samples: For each exposed finish.

D. Product certificates and test reports.

E. Other Action Submittals:
   1. Door Hardware Sets: Prepared by or under the supervision of Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams.
      a. Format: Use same scheduling sequence and format as in the Contract Documents.
      b. Content: Include the following information:
         1) Identification number, location, hand, fire rating, and material of each door and frame.
         2) Type, style, function, size, quantity, and finish of each door hardware item. Include description and function of each lockset and exit device.
         3) Complete designations of every item required for each door or opening including name and manufacturer.
         4) Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.
   2. Keying Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing Owner's final keying instructions for locks.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by lock manufacturer.
   1. Installer's responsibilities include supplying and installing door hardware, and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

B. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

C. Source Limitations: Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

D. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.
   1. Test Pressure: Test at atmospheric pressure.

E. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system.

F. Preinstallation Conference: Conduct conference at Project site.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

B. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.5 COORDINATION

A. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Three years from date of Substantial Completion, except as follows:
      a. Electromagnetic and Delayed-Egress Locks: Five years from date of Substantial Completion.
      b. Exit Devices: Two years from date of Substantial Completion.
      c. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in this Section.
   1. Door Hardware Sets: Provide quantity, item, size, finish as required for complete operational system meeting Owner's requirements and complying with all code requirements.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware identified by descriptive titles corresponding to requirements specified in Part 2.

2.2 HINGES, GENERAL

A. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

B. Hinge Base Metal: Unless otherwise indicated, provide the following:
   1. Exterior Hinges: Stainless steel, with stainless-steel pin.
   2. Interior Hinges: Stainless steel, with stainless-steel pin.
   3. Hinges for Fire-Rated Assemblies: Stainless steel, with stainless-steel pin.

C. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for outswinging exterior doors and outswinging corridor doors with locks.

D. Fasteners: Comply with the following:
   1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
   2. Wood Screws: For wood doors.
   3. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
   4. Screws: Phillips flat-head; machine screws (drilled and tapped holes) for metal doors; wood screws for wood doors and frames. Finish screw heads to match surface of hinges.

2.3 HINGES

A. Template Hinge Dimensions: BHMA A156.7.

B. Antifriction-Bearing, Full-Mortise (Butt) Hinges: BHMA A156.1, heavy weight; Grade 1, with 4 ball bearings for all exterior locations and all interior locations with high frequency use and standard weight; Grade 2, with 2 ball bearings; button tips; nonrising removable pins at all medium to low frequency use interior locations.

C. Antifriction-Bearing, Swing-Clear, Full-Mortise (Butt) Hinges: BHMA A156.1, heavy weight; Grade 1, with 4 ball bearings for all exterior locations and all interior locations with high frequency use and standard weight; Grade 2, with 2 ball bearings; button tips; nonrising removable pins at all medium to low frequency use interior locations; reversible; with 3/32-inch (2.4-mm) swaging. Provide where required for swing-clear application.

2.4 LOCKS AND LATCHES, GENERAL

A. Accessibility Requirements: Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).

B. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 15 lbf (67 N) to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.

C. Electrified Locking Devices: BHMA A156.25.

D. Lock Trim:
1. Levers: Comply with ADA requirements.
2. Dummy Trim: Match lever lock trim and escutcheons.

E. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors.

F. Backset: 2-3/4 inches (70 mm), unless otherwise indicated.

G. Strikes: Manufacturer's standard strike with strike box for each latchbolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set.

2.5 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: Function numbers and descriptions indicated in door hardware sets comply with the following:
1. Mortise Locks: BHMA A156.13.

B. Mortise Locks: Stamped steel case with steel or brass parts; BHMA A156.13, Grade 1; Series 1000.

C. Push-Pull Latches: Consisting of paddle handles that retract latchbolt; capable of being mounted vertically or horizontally; and as follows:
1. Lever and Escutcheon Material: Stainless steel.
2. Latch Type: Mortise.
3. Lettering: Engrave with the words "Pull" and "Push."

2.6 ELECTROMAGNETIC LOCKS

A. General: BHMA A156.23; electrically powered, of strength and configuration indicated; with electromagnet attached to frame and armature plate attached to door.
1. Type: Full exterior or full interior, as required by application indicated.
2. Strength Ranking: As required.

B. Delayed-Egress Locks: BHMA A156.24.
1. Means of Egress Doors: Lock releases within 15 seconds after applying a force not more than 15 lbf (67 N) for not more than 3 seconds, as required by NFPA 101.
2. Security Grade: Activated from secure side of door by initiating device.
3. Movement Grade: Activated by door movement as initiating device.

2.7 EXIT DEVICES, GENERAL

A. Exit Devices: BHMA A156.3, Grade 1 .

B. Accessibility Requirements: Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).

C. Exit Devices for Means of Egress Doors: Comply with NFPA 101. Exit devices shall not require more than 15 lbf (67 N) to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.

D. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

E. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.

F. Outside Trim: Material and finish to match locksets, unless otherwise indicated.
   1. Match design for locksets and latchsets, unless otherwise indicated.

2.8 EXIT DEVICES

A. Mortise Exit Devices:
   1. Type: BHMA A156.3, Type 3.
   2. Actuating Bar: Cross bar.
   3. Material: Stainless steel .

2.9 LOCK CYLINDERS

A. Standard Lock Cylinders: BHMA A156.5, Grade 1.

B. High-Security Lock Cylinders: BHMA A156.30, Grade 1.

C. Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:
   1. Number of Pins: Per manufacturer and to suit requirements of project.
   2. High-Security Grade: BHMA A156.5, Grade 1A, listed and labeled as complying with pick- and drill-resistant testing requirements in UL 437 (Suffix A).

D. Permanent Cores: Manufacturer's standard; finish face to match lockset; with interchangeable cores.
   1. Manufacturer: Best Access Systems; Div. of The Stanley Works, or prior approved equal by LAARNG.

E. Construction Keying: Comply with the following:
   1. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.
      a. Furnish permanent cores to Owner for installation.

2.10 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference into key system.

B. Keys: Nickel silver; permanently inscribed with a visual key control number and including the notation "DO NOT DUPLICATE."
1. Quantity: In addition to one extra key blank for each lock, provide three cylinder change keys and five master, grand master, and great-grand master keys, as applicable.

2.11 KEY CONTROL SYSTEM

A. Key Control Cabinet: BHMA A156.5, Grade 1; multiple-drawer or wall-mounted, as approved by LAARNG, metal cabinet with baked-enamel finish; containing key-holding hooks, labels, 2 sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with key capacity of 150 percent of the number of locks.

B. Key Control System Software: BHMA A156.5, Grade 1; multiple-index system for recording and reporting key-holder listings, tracking keys and lock and key history, and printing receipts for transactions. Include instruction manual.
1. Manufacturers: Same as permanent core manufacturer.

2.12 OPERATING TRIM, GENERAL

A. Standard: BHMA A156.6.

B. Materials: Fabricate from stainless steel, unless otherwise indicated.

2.13 OPERATING TRIM

A. Push-Pull Plates: 1/8 inch (3.2 mm) thick, 4 inches wide by 16 inches high (102 mm wide by 406 mm high); with square corners, beveled edges, and raised integral lip; secured with exposed screws.

2.14 ACCESSORIES FOR PAIRS OF DOORS

A. Carry-Open Bars: Provide carry-open bars for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
1. Material: Polished brass or bronze, with strike plate.

B. Overlapping-with-Gasket Astragals: T-shaped metal, surface mounted on edge of door with screws; with integral gasket.

2.15 CLOSERS, GENERAL

A. Accessibility Requirements: Comply with the following maximum opening-force requirements:
1. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
2. Sliding or Folding Doors: 5 lbf (22.2 N) applied parallel to door at latch.

3. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

B. Door Closers for Means of Egress Doors: Comply with NFPA 101. Door closers shall not require more than 30 lbf (133 N) to set door in motion and not more than 15 lbf (67 N) to open door to minimum required width.

C. Hold-Open Closers/Detectors: Coordinate and interface integral smoke detector and closer device with fire alarm system.

D. Flush Floor Plates: Provide finish cover plates for floor closers unless thresholds are indicated. Match door hardware finish, unless otherwise indicated.

E. Recessed Floor Plates: Provide recessed floor plates with insert of floor finish material for floor closers unless thresholds are indicated. Provide extended closer spindle to accommodate thickness of floor finish.

F. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

G. Surface Closers: BHMA A156.4, Grade 1. Provide type of arm required for closer to be located on non-public side of door.

H. Concealed Closers: BHMA A156.4, Grade 1 .

I. Closer Holder Release Devices: BHMA A156.15.
1. Life-Safety Type: On release of hold open, door becomes self-closing. Automatic release is activated by smoke detection system or loss of power.

J. Coordinators: BHMA A156.3.

2.16 PROTECTIVE TRIM UNITS, GENERAL

A. Size: 1-1/2 inches (38 mm) less than door width on push side and 1/2 inch (13 mm) less than door width on pull side, by height specified in door hardware sets.

B. Metal Protective Trim Units: BHMA A156.6; beveled top and 2 sides; fabricated from the following material:
1. Material: 0.050-inch- (1.3-mm-) thick stainless steel.

2.17 STOPS AND HOLDERS, GENERAL

A. Stops and Bumpers: BHMA A156.16, Grade 1.
1. Provide floor stops for doors unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic. Where floor or wall stops are not appropriate, provide overhead holders.

B. Mechanical Door Holders: BHMA A156.16, Grade 1.

C. Combination Floor and Wall Stops and Holders: BHMA A156.8, Grade 1.

D. Electromagnetic Door Holders: Coordinate with fire detectors and interface with fire alarm system for labeled fire door assemblies.

2.18 DOOR GASKETING, GENERAL

A. Standard: BHMA A156.22.

B. General: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.
1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
3. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

C. Smoke-Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke-control ratings indicated, based on testing according to UL 1784.
1. Provide smoke-labeled gasketing on 20-minute-rated doors and on smoke-labeled doors.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Gasketing Materials: ASTM D 2000 and AAMA 701/702.

2.19 THRESHOLDS, GENERAL

A. Standard: BHMA A156.21.

B. Accessibility Requirements: Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.

C. Thresholds for Means of Egress Doors: Comply with NFPA 101. Maximum 1/2 inch (13 mm) high.

2.20 FABRICATION

A. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

B. Fasteners: Provide screws according to commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
1. Comply with NFPA 80 for fasteners of door hardware in fire-rated applications.

C. Finishes: BHMA A156.18, as indicated in door hardware sets.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Steel Doors and Frames: Comply with DHI A115 Series. Drill and tap doors and frames for surface-applied door hardware according to ANSI A250.6.

B. Wood Doors: Comply with DHI A115-W Series.

C. Mounting Heights: Mount door hardware units at heights indicated as follows unless otherwise indicated or required to comply with governing regulations.
1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

D. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

E. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

F. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room.
1. Configuration: Provide the least number of power supplies required to adequately serve doors with electrified door hardware.

G. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

H. Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
1. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.

3.2 DOOR HARDWARE SETS

A. Submit Door Hardware Schedule prepared by Architectural Hardware Consultant for review and approval of LAARNG.

1. Hardware schedule shall comply with requirements of SUBMITTALS noted above, and shall include all hardware required for complete operation of door, to meet use and code requirements.

END OF SECTION 08712

SECTION 08800 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
1. Doors.
2. Glazed curtain walls.
3. Glazed entrances.
4. Interior borrowed lites.
5. Storefront framing.

1.2 DEFINITIONS

A. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.

B. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.

C. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

D. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.3 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than

thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
   a. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet (10 m) above grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
      1) Basic Wind Speed: 130 mph (3 second gust, 50-year return)
      2) Importance Factor: I = 1.15.
      3) Exposure Category: B .
   b. Specified Design Snow Loads: As indicated in structural design criteria, but not less than snow loads applicable to Project as required by ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 7.0, "Snow Loads."
   c. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.
      1) Load Duration: 3 seconds.
   d. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:
   1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
   2. For laminated-glass lites, properties are based on products of construction indicated.
   3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
   4. Center-of-Glass Values: Based on using LBL-44789 WINDOW 5.0 computer program for the following methodologies:
      a. U-Factors: NFRC 100 expressed as Btu/ sq. ft. x h x deg F (W/sq. m x K).
      b. Solar Heat Gain Coefficient: NFRC 200.
      c. Solar Optical Properties: NFRC 300.

E. Windborne-Debris Resistance: Provide glazing materials capable of resisting impact from windborne debris based on the pass/fail criteria and testing information in ASTM E 1996 as determined from testing glazing materials in fenestration assemblies according to ASTM E 1886.

F. Blast Resistance: Provide glazing materials capable of resisting airblast loadings of intensities and at glazing protection condition levels as determined to be required by the AT/FP Risk Assessment Analysis and in accordance with UFC documents related to Antiterrorism / Force Protection.

1.4 SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Samples: 12-inch- (300-mm-) square, for each type of glass product indicated, other than monolithic clear float glass.

C. Glazing Schedule: Use same designations indicated on Drawings.

D. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer.

1.5 QUALITY ASSURANCE

A. Preconstruction Adhesion and Compatibility Testing: Submit to elastomeric glazing sealant manufacturers, for testing according to ASTM C 1087, samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that will contact or affect elastomeric glazing sealants:

B. Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.

C. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201.

D. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
1. GANA Publications: GANA Laminated Division's "Laminated Glass Design Guide" and GANA's "Glazing Manual."
2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."

E. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the Insulating Glass Certification Council or Associated Laboratories, Inc.

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build mockups as shown on Drawings.

1.6 WARRANTY

A. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form, made out to Owner and signed by laminated-glass manufacturer agreeing to replace laminated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
1. Warranty Period: Five years from date of Substantial Completion.

B. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
1. Warranty Period: 10 years from date of Substantial Completion.

C. Polycarbonate Sheet:

1. Form of Deterioration: Yellowing and loss of light transmission.
2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS

A. Annealed Float Glass: ASTM C 1036, Type I (transparent flat glass), Quality-Q3; of class indicated.

B. Heat-Treated Float Glass: ASTM C 1048; Type I (transparent flat glass); Quality-Q3; of class, kind, and condition indicated.
   1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed, unless otherwise indicated.
   2. Provide Kind HS (heat-strengthened) float glass in place of annealed float glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
   3. Provide Kind FT (fully tempered) float glass in place of annealed or Kind HS (heat-strengthened) float glass where safety glass is indicated.

C. Coated Spandrel Float Glass: Float glass complying with other requirements specified and with the following:
   1. Fallout Resistance: Provide spandrel units identical to those passing the fallout-resistance test for spandrel glass specified in ASTM C 1048.
   2. Factory apply manufacturer's standard opacifier of the following material to coated second surface of lites, with resulting products complying with Specification No. 89-1-6 in GANA Tempering Division's "Engineering Standards Manual."
      a. Polyester film laminated to glass with solvent-based adhesive.

D. Wired Glass: ASTM C 1036, Type II (patterned and wired flat glass), Class 1 (clear), Quality-Q-6; and of form and mesh pattern specified.

E. Laminated Glass: ASTM C 1172, and complying with other requirements specified and with the following:
   1. Interlayer: Polyvinyl butyral of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.

F. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article and in Part 2 "Insulating-Glass Units" Article.
   1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
   2. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
   3. Sealing System: Dual seal.
   4. Spacer Specifications: Manufacturer's standard spacer material and construction.

G. Glass-Clad Polycarbonate: ASTM C 1349, kinds and other requirements as specified in other Part 2 articles.

2.2 POLYCARBONATE GLAZING PRODUCTS

A. Polycarbonate Sheet: ASTM C 1349, Appendix X1, type as specified in other Part 2 articles.

B. Interlayer for Laminated-Polycarbonate Units: Clear polyurethane interlayer with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating polycarbonate sheets and installation.

C. Fabrication: Laminate polycarbonate sheets to interlayer to produce laminated units free of foreign substances, air, and glass pockets.

2.3 SPALL-RESISTANT GLAZING FILM

A. Spall-Resistant Film: Composite of clear polyvinyl butyral film and clear abrasion-resistant polyester film.
   1. Product: Subject to compliance with requirements, provide Spallshield by DuPont Glass Laminating Products or comparable product from other manufacturer.

B. Laminating Process: Laminate spall-resistant film to glazing assemblies in factory to produce laminated lites free of foreign substances, air, and glass pockets.

2.4 GLAZING GASKETS

A. Glazing Gaskets: As indicated in other Division 08 Sections "Aluminum Framed Entrances and Storefronts" and "Glazed Aluminum Curtain Walls".

2.5 GLAZING SEALANTS

A. General: Provide products of type indicated, complying with the following requirements:
   1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
   2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

B. Elastomeric Glazing Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant required.

C. Glazing Sealants for Fire-Resistive Glazing Products: Identical to products used in test assemblies to obtain fire-protection rating.

2.6 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products required.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800.

2.7 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

2.8 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

2.9 MONOLITHIC FLOAT-GLASS UNITS

A. Uncoated Clear Float-Glass Units: Class 1 (clear) annealed float glass except provide kind FT (fully tempered) float glass where safety glazing required.
   1. Thickness: 6.0 mm.
   2. Locations: Interior glazed units.

2.10 MONOLITHIC WIRED-GLASS UNITS

A. Polished Wired-Glass Units: Form 1 (wired glass, polished both sides), Quality-Q6, Mesh 1 (M1) (Diamond)] or 2 (M2) (Square), 6.0 mm thick.

2.11 INSULATING-GLASS UNITS

A. Glass-Clad Polycarbonate/Laminated-Glass Insulating-Glass Units:
1. Overall Unit Thickness: As determined by thicknesses of lites and interlayers and by interlayer dimension.
2. Interspace Content: Argon.
3. Interspace Dimension: As required.
4. Lite on Witness Side (interior side): Kind GCP (glass-clad polycarbonate), SC (Single Core) or MC (Multiple Core) consisting of outer and inner lites of heat-strengthened float glass with an interior core consisting of polycarbonate lite(s) and faced with a 0.037-inch-(0.94-mm-) thick spall-resistant polyester film laminated to face of lite on witness side.
   a. Outer Lite: Class 1 (clear) float glass.
      1) Thickness: As required.
   b. Inner Lite: Class 1 (clear) float glass.
      1) Thickness: As required.
   c. Single Core: Type I (standard, UV-stabilized) polycarbonate.
      1) Thickness: As required.
   d. Multiple Core: Type I (standard, UV-stabilized) polycarbonate of the following thicknesses and number:
      1) Outer Lites: As required.
      2) Single or Double Inner Lite: As required.
5. Lite on Threat Side (Exterior Side): Kind LHS (two or more lites of heat-strengthened float glass) laminated glass consisting of two lites.
   a. Outer Lite: Class 2 (tinted) float glass:
      1) Thickness: As required.
   b. Inner Lite: Class 1 (clear) float glass.
      1) Thickness: As required.
      2) Tint Color: Gray.
   c. Interlayer: Manufacturer's standard.
      1) Thickness: As required.
      2) Interlayer Color: Clear.
6. Thermal and Optical Performance Properties: As required to meet thermal performance of glazed units.
7. Windborne-Debris Resistance: Per International Building Code 2003 requirements.
8. Blast Resistance: As required to meet AT/FP Threat Analysis requirements and UFC Document requirements for Antiterrorism / Force Protection.

PART 3 - EXECUTION

3.1 GLAZING

A. General: Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
1. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
2. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

3. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
4. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
5. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
6. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
7. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

B. Tape Glazing: Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
1. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
2. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
3. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

C. Gasket Glazing (Dry): Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
1. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
2. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
3. Install gaskets so they protrude past face of glazing stops.

D. Sealant Glazing (Wet): Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
1. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
2. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.2 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.

B. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

END OF SECTION 08800

SECTION 08830 - MIRRORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Film-backed glass mirrors qualifying as safety glazing.

1.2 SUBMITTALS

A. Product Data: For mirror hardware.

B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work.

C. Samples: For each type of mirror product required, in the form indicated below:
   1. Mirrors, 12 inches (300 mm) square, including edge treatment on 2 adjoining edges.
   2. Mirror clips.
   3. Mirror trim, 12 inches (300 mm) long.

D. Product Certificates: For each type of mirror, signed by product manufacturer.

1.3 QUALITY ASSURANCE

A. Glazing Publications: Comply with GANA's "Glazing Manual" and GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors" unless more stringent requirements are indicated

B. Safety Glazing Products: For film-backed mirrors, provide products complying with testing requirements in 16 CFR 1201 for Category II materials.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors, protected from moisture including condensation.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form, made out to Owner and signed by mirror manufacturer agreeing to replace mirrors that deteriorate, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated in second subparagraph below.
   1. Deterioration of Mirrors: Defects developed from normal use that are attributable to the manufacturing process and not to causes other than glass breakage and practices for

maintaining and cleaning mirrors contrary to mirror manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

2. Warranty Period: Fiveyears from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SILVERED FLAT GLASS MIRROR MATERIALS

A. Clear Glass Mirrors: ASTM C 1503, Mirror Select Quality.
   1. Nominal Thickness: 6.0 mm.

2.2 MISCELLANEOUS MATERIALS

A. Setting Blocks: Elastomeric material with a Type A Shore durometer hardness of 85, plus or minus 5.

B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.

2.3 MIRROR HARDWARE

A. Top and Bottom Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece.
   1. Bottom Trim: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch (9.5 and 22 mm) in height, respectively, and a thickness of not less than 0.05 inch (1.3 mm).
   2. Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch (16 and 25 mm) in height, respectively, and a thickness of not less than 0.062 inch (1.57 mm).

B. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.

C. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

2.4 FABRICATION

A. Mirror Sizes: To suit Project conditions, cut mirrors to final sizes and shapes.

B. Cutouts: Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.

C. Mirror Edge Treatment: Flat polished edge .
   1. Seal edges of mirrors after edge treatment to prevent chemical or atmospheric penetration of glass coating.

2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

D. Film-Backed Safety Mirrors: Apply film backing with pressure-sensitive adhesive coating over mirror backing paint as recommended in writing by film-backing manufacturer to produce a surface free of bubbles, blisters, and other imperfections. Use adhesives and film backing compatible with mirror backing paint as certified by mirror manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.

B. Provide a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.

C. For wall-mounted mirrors, install with mirror hardware.
1. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
2. For mirror hardware in the form of continuous J-channels at bottom, provide setting blocks 1/8 inch (3 mm) thick by 4 inches (100 mm) long at quarter points. To prevent trapping water, provide, between setting blocks, 2 slotted weeps not less than 1/4 inch (6.4 mm) wide by 3/8 inch (9.5 mm) long.
3. For mirror hardware in the form of a continuous J-channel at bottom and continuous top trim at top, fasten J-channel directly to wall and attach top trim to continuous cleat fastened directly to wall.
4. Install mirror hardware in the form of J-channels that are fabricated in single lengths to fit and cover top and bottom edges of mirrors.

D. Protect mirrors from breakage and contaminating substances resulting from construction operations.

E. Do not permit edges of mirrors to be exposed to standing water.

F. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.

END OF SECTION 08830

SECTION 08911 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes conventionally glazed aluminum curtain walls installed as sticksystems.

1.2 PERFORMANCE REQUIREMENTS

A. General: Provide glazed aluminum curtain-wall systems, including anchorage, capable of withstanding, without failure, the effects of the following:
   1. Structural loads.
   2. Thermal movements
   3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
   4. Dimensional tolerances of building frame and other adjacent construction.
   5. Failure includes the following:
      a. Deflection exceeding specified limits.
      b. Thermal stresses transferred to building structure.
      c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
      d. Noise or vibration created by wind and thermal and structural movements.
      e. Loosening or weakening of fasteners, attachments, and other components.
      f. Sealant failure.

B. Structural Loads:
   1. Wind Loads: Per 2003 International Building Code requirements.
   2. Seismic Loads: Per code where applicable.

C. Structural-Test Performance: Systems tested according to ASTM E 330 as follows:
   1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
   2. When tested at 150percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 Insert number percent of span.
   3. Test Duration: As required by design wind velocity.

D. Windborne-Debris-Impact-Resistance-Test Performance: ASTM E 1996, large and small missile tests.

E. Blast Resistance: Provide system capable of resisting airblast loadings of intensities and at glazing protection condition levels required, as determined from testing complete assemblies including glazing.
   1. Refer to UFC 4-010-01, DoD Minimum Antiterrorism Standards for Buildings.

F. Deflection of Framing Members:

1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm).

G. Temperature Change (Range): Systems accommodate 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

H. Air Infiltration: For systems, maximum air leakage of 0.06 cfm/sq. ft. (0.03 L/s per sq. m) of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa).

I. Water Penetration Under Static Pressure: Systems do not evidence water penetration when tested according to ASTM E 331 at a minimum differential static pressure of 20 percent of positive design wind load, but not less than 12 lbf/sq. ft. (479 Pa).

J. Condensation Resistance: For systems, condensation-resistance factor (CRF) of not less than 66 when tested according to AAMA 1503.

K. Average Thermal Conductance: For systems, average U-factor of not more than 0.66 Btu/sq. ft. x h x deg F (3.75 W/sq. m x K) when tested according to AAMA 1503.

1.3 SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication and assembly of glazed aluminum curtain-wall systems.
1. Include structural analysis data for wind loads, seismic loads, wind borne debris requirements and blast resistance requirements, signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples: For each exposed finish.

D. Product test reports.

E. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Acceptable to manufacturer and capable of preparing data for glazed aluminum curtain-wall systems including Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockups as shown on Drawings.

C. Preinstallation Conference: Conduct conference at Project site.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of glazed aluminum curtain-wall systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Structural failures including, but not limited to, excessive deflection.
   b. Noise or vibration caused by thermal movements.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   d. Water leakage.
   e. Failure of operating components to function normally.
2. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
2. Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221 (ASTM B 221M).
3. Extruded Structural Pipe and Tubes: ASTM B 429.

B. Steel Reinforcement: With manufacturer's standard corrosion-resistant primer.
1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
2. Cold-Rolled Sheet and Strip: ASTM A 611.
3. Hot-Rolled Sheet and Strip: ASTM A 570/A 570M.

2.2 FRAMING SYSTEMS

A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: An integrated, outside glazed, captured curtain wall, pressure glazed system with concealed fastener joinery.
   a. 2-1/2"x6" or 7-1/2" nominal dimensions.

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Where fasteners are subject to loosening or turn out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
   2. Reinforce members as required to receive fastener threads.
   3. Use exposed fasteners with countersunk Phillips screw heads.
   4. Finish exposed portions to match framing system.
   5. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended by manufacturer.

D. Anchors: Three-way adjustable anchors that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

E. Concealed Flashing: Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer.

F. Framing Gaskets: As recommended by manufacturer for joint type.

G. Framing Sealants: As recommended by manufacturer for joint type.

2.3 GLAZING SYSTEMS

A. Glazing: As specified in Division 08 Section "Glazing."

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: As recommended by manufacturer for joint type.

2.4 ACCESSORY MATERIALS

A. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

2.5 FABRICATION

A. Form aluminum shapes before finishing.

B. Fabricate components that, when assembled, have the following characteristics:
   1. Sharp profiles, straight and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
   4. Physical and thermal isolation of glazing from framing members.
   5. Accommodations for thermal and mechanical movements of glazing and framing to prevent glazing-to-glazing contact and to maintain required glazing edge clearances.
   6. Provisions for reglazing from exterior.

C. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

D. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.6 ALUMINUM FINISHES

A. High-Performance Organic Finish: Three -coat thermocured system with fluoropolymer topcoats containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
   1. Color and Gloss: As selected from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Fit joints to produce hairline joints free of burrs and distortion.
   2. Rigidly secure nonmovement joints.
   3. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
   4. Seal joints watertight, unless otherwise indicated.

B. Metal Protection:
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Install components plumb and true in alignment with established lines and grades.

E. Install glazing as specified Division 08 Section "Glazing."

F. Install sealants as specified in Division 07 Section "Joint Sealants."

G. Install insulation materials as specified in Division 07 Section "Thermal Insulation."

H. Erection Tolerances: Install glazed aluminum curtain-wall systems to comply with the following maximum tolerances:
   1. Plumb: 1/8 inch in 10 feet (3 mm in 3 m); 1/4 inch in 40 feet (6 mm in 12 m).
   2. Level: 1/8 inch in 20 feet (3 mm in 6 m); 1/4 inch in 40 feet (6 mm in 12 m).
   3. Alignment:
      a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (13 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).

b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (13 to 25 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
c. Where surfaces are separated by reveal or protruding element of 1 inch (25 mm) wide or greater, limit offset from true alignment to 1/4 inch (6 mm).

4. Location: Limit variation from plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/2 inch (12.7 mm) over total length.

3.2 FIELD QUALITY CONTROL

A. Water Spray Test: After the installation of minimum area of 75-feet- (23-m-) by-2-story glazed aluminum curtain-wall system has been completed but before installation of interior finishes has begun, test a 2-bay area of system designated by Architect according to AAMA 501.2.
1. Repair or remove work where test results indicate water penetration of systems.
2. Perform additional testing to determine resistance to water penetration of replaced or additional work.

END OF SECTION 08911

SECTION 09111 – NON-LOAD-BEARING STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Non-load-bearing steel framing members for the following applications:
      a. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).
      b. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.).

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. Sound Transmission Characteristics: For STC-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

PART 2 - PRODUCTS

2.1 NON-LOAD-BEARING STEEL FRAMING, GENERAL

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
   1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
   2. Protective Coating: ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating, unless otherwise indicated.

2.2 SUSPENSION SYSTEM COMPONENTS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.

B. Hanger Attachments to Concrete:
   1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that

imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
   a. Type: Cast-in-place anchor, designed for attachment to concrete forms or Postinstalled, chemical anchor.
2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch (4.12-mm) diameter.

D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch (1.37 mm) and minimum 1/2-inch- (12.7-mm-) wide flanges.
1. Depth: 2-1/2 inches (64 mm) .

E. Furring Channels (Furring Members):
1. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22.2 mm) deep.
   a. Minimum Base Metal Thickness: 0.0312 inch (0.79 mm).
2. Resilient Furring Channels: 1/2-inch- (12.7-mm-) deep members designed to reduce sound transmission.
   a. Configuration: Asymmetrical or hat shaped.

F. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. Armstrong World Industries, Inc.; Drywall Grid Systems.
   b. Chicago Metallic Corporation; Drywall Furring System.
   c. USG Corporation; Drywall Suspension System.

2.3 STEEL FRAMING FOR FRAMED ASSEMBLIES

A. Steel Studs and Runners: ASTM C 645.
1. Minimum Base-Metal Thickness: 0.0312 inch (0.79 mm).

B. Slip-Type Head Joints: Where indicated, provide one of the following:
1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- (50.8-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (50.8-mm-) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
   a. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
      1) Steel Network Inc. (The); VertiClip SLD or VertiTrack VTD Series.
      2) Superior Metal Trim; Superior Flex Track System (SFT).

C. Firestop Track: As specified in Division 07 Section "Fire-Resistive Joint Systems."

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
   1. Minimum Base-Metal Thickness: 0.0312 inch (0.79 mm).

E. Cold-Rolled Channel Bridging: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges.
   1. Depth: 1-1/2 inches (38.1 mm).
   2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38.1 by 38.1 mm), 0.068-inch- (1.73-mm-) thick, galvanized steel.

F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
   1. Minimum Base Metal Thickness: 0.0179 inch (0.45 mm) .
   2. Depth: As indicated on Drawings .

G. Resilient Furring Channels: 1/2-inch- (12.7-mm-) deep, steel sheet members designed to reduce sound transmission.
   1. Configuration: Asymmetrical or hat shaped .

H. Cold-Rolled Furring Channels: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges.
   1. Depth: As indicated on Drawings .
   2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare-steel thickness of 0.0312 inch (0.79 mm).
   3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.

2.4 AUXILIARY MATERIALS

A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide the following:
   1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.
   1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

3.2 INSTALLING SUSPENSION SYSTEMS

A. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

B. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
      a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
      a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
   3. Do not attach hangers to steel roof deck.
   4. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
   5. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
   6. Do not connect or suspend steel framing from ducts, pipes, or conduit.

C. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

D. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

3.3 INSTALLING FRAMED ASSEMBLIES

A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

B. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
   1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
   2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
      a. Install two studs at each jamb, unless otherwise indicated.
      b. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
   3. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
   a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

C. Direct Furring:
   1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.

D. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

END OF SECTION 09111

SECTION 09220 - PORTLAND CEMENT PLASTER

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Nonstructural steel framing and furring.
   2. Exterior portland cement plasterwork (stucco) on metal lath plaster bases.
      a. Locations: Soffit at building entrances.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each type of textured finish coat indicated; 12 by 12 inches (305 by 305 mm), and prepared on rigid backing.

1.3 QUALITY ASSURANCE

A. Mockups: Before plastering, install mockups of at least 100 sq. ft. (9 sq. m) in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 PROJECT CONDITIONS

A. Comply with ASTM C 926 requirements.

B. Exterior Plasterwork: Apply plaster when ambient temperature is greater than 40 deg F (4.4 deg C).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2.2 NONSTRUCTURAL STEEL FRAMING MEMBERS, GENERAL

A. Components, General: Comply with ASTM C 1063. For steel sheet components not included in ASTM C 1063, comply with ASTM C 645 requirements for metal, unless otherwise indicated.

B. Cold-Rolled Channels: Base metal thickness of 0.0538 inch (1.37 mm) with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.

C. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch (1.21-mm) diameter, unless otherwise indicated.

2.3 STEEL FRAMING FOR SOFFITS

A. Suspended Furring:
1. Main Runners (Carrying Channels): Cold-rolled channels, in depth required.
2. Cross Furring: Cold-rolled channels, 3/4 inch (19.1 mm) deep.

B. Direct Furring: Cold-rolled channels, 3/4 inch (19.1 mm) deep.

C. Tie Wire:
1. For tying main runners directly to beams or joists (where wire hangers are used between beams or joists), use double loop of 0.1205-inch- (3.06-mm-) diameter wire.
2. For saddle tying cross furring to main runners use 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.

D. Rod Hangers: ASTM A 510 (ASTM A 510M), mild carbon steel, ASTM A 153/A 153M, hot-dip galvanized.
1. Diameter: As required to meet wind pressure requirements.

2.4 METAL LATH

A. Expanded-Metal Lath: ASTM C 847 with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
1. Diamond-Mesh Lath: Flat.
   a. Weight: 3.4 lb/sq. yd. (1.8 kg/sq. m).
2. Flat Rib Lath: Rib depth of not more than 1/8 inch (3.1 mm).
   a. Weight: 3.4 lb/sq. yd. (1.8 kg/sq. m).

2.5 ACCESSORIES

A. General: Comply with ASTM C 1063 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.

B. Zinc Accessories:
1. Casing Beads: Fabricated from zinc; square-edged style; with expanded flanges.
2. Control Joints: Fabricated from zinc; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.

2.6 MISCELLANEOUS MATERIALS

A. Water for Mixing: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.

B. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 1/2 inch (13 mm) long, free of contaminants, manufactured for use in portland cement plaster.

C. Steel Drill Screws: For metal-to-metal fastening, ASTM C 1002 or ASTM C 954, as required by thickness of metal being fastened; with pan head that is suitable for application; in lengths required to achieve penetration through joined materials of not fewer than three exposed threads.

D. Fasteners for Attaching Metal Lath to Substrates: Complying with ASTM C 1063.

E. Isolation Strip at Exterior Walls:
   1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.1 mm) thick, in width to suit steel stud size.

2.7 PLASTER MATERIALS

A. Portland Cement: ASTM C 150, Type I or II.

B. Lime: ASTM C 206, Type S; or ASTM C 207, Type S.

C. Sand Aggregate: ASTM C 897.

D. Ready-Mixed Finish-Coat Plaster: Mill-mixed water repellent Portland cement, aggregates, coloring agents, and proprietary ingredients.
   1. Available Products:
      a. Degussa, Sonowall; Thoro Stucco.
      b. Florida Stucco Corp.; Florida Stucco.
      c. Highland Stucco & Lime Products, Inc.; Repel® Exterior Stucco.
   2. Color: As selected by Architect from manufacturer's full range.

2.8 PLASTER MIXES

A. General: Comply with ASTM C 926 for applications indicated.
   1. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed 1 lb of fiber/cu. ft. (16 kg of fiber/cu. m) of cementitious materials. Reduce aggregate quantities accordingly to maintain workability.

B. Portland Cement Base-Coat Mixes:
   1. Over Metal Lath: Scratch and brown coats for three-coat plasterwork.

C. Factory-Prepared Finish-Coat Mixes: For ready-mixed finish-coat plasters, comply with manufacturer's written instructions.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

3.2 INSTALLING NONSTRUCTURAL STEEL FRAMING, GENERAL

A. General: Comply with requirements in ASTM C 1063 for applications indicated.
   1. Comply with ASTM C 754 for installation of items not addressed in ASTM C 1063.

B. Install supplementary framing, blocking, and bracing at terminations in plaster assemblies to support fixtures, heavy trim, or similar construction.

C. Isolate steel framing from building structure to prevent transfer of loading imposed by structural movement.

D. Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.

3.3 INSTALLING STEEL FRAMING FOR SOFFITS

A. Suspend soffit hangers from building structure as follows:
   1. Install hangers plumb and free of contact with insulation or other objects within soffit plenum that are not part of supporting structural or soffit suspension system. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   2. Rod Hangers: Secure to structure, including intermediate framing members, by attaching to fasteners that are secure and appropriate for substrate and hanger, in a manner that will not cause hangers to deteriorate or otherwise fail.
   3. Do not support soffits directly from permanent metal forms. Secure to fastener devices that extend through forms.
   4. Do not attach hangers to steel deck tabs.
   5. Do not attach hangers to steel roof deck. Attach hangers to structural members.
   6. Do not connect steel framing to or suspend it from ducts, pipes, or conduit.

B. Sway-brace suspended steel framing with hangers used for support.

C. Install steel framing components for soffits in sizes and spacings required by the referenced steel framing and installation standards.

3.4 INSTALLING METAL LATH

A. Expanded-Metal Lath: Install according to ASTM C 1063.
   1. Horizontal Framing: Install flat diamond-mesh or flat rib lath.

3.5 INSTALLING ACCESSORIES

A. Install according to ASTM C 1063 and at locations indicated on Drawings.

B. Control Joints: Install control joints in specific locations as follows:
   1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
      a. Horizontal and other Nonvertical Surfaces: 100 sq. ft. (9.3 sq. m).
   2. At distances between control joints of not greater than 18 feet (5.5 m) o.c.
   3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
   4. Where control joints occur in surface of construction directly behind plaster.
   5. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

3.6 PLASTER APPLICATION

A. General: Comply with ASTM C 926.

B. Plaster Finish Coats: Apply per manufacturer's recommendations.
   1. Texture: Sprayed, medium texture.

3.7 CUTTING AND PATCHING

A. Cut, patch, replace, and repair plaster as necessary to accommodate other work and to restore cracks, dents, and imperfections. Repair or replace work to eliminate blisters, buckles, crazing (check cracking), dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

END OF SECTION 09220

SECTION 09250 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Interior gypsum board.
   2. Tile backing panels.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For the following products:
   1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.
   2. Textured Finishes: Manufacturer's standard size for each textured finish indicated and on same backing indicated for Work.

C. SPiRiT Submittals: For Credit IEQ 5.C4, manufacturers' product data for adhesives used to laminate gypsum board panels to substrates, including printed statement of VOC content.

1.3 QUALITY ASSURANCE

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

C. Mockups: Before beginning gypsum board installation, install mockups of at least 100 sq. ft. (9 sq. m) in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Install mockups for the following:
      a. Each level of gypsum board finish indicated for use in exposed locations.
      b. Each texture finish indicated.
   2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
   3. Simulate finished lighting conditions for review of mockups.
   4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 INTERIOR GYPSUM BOARD

A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. G-P Gypsum.
b. Lafarge North America Inc.
c. National Gypsum Company.
d. USG Corporation.

B. Regular Type:
1. Thickness: 1/2 inch (12.7 mm).
2. Long Edges: Tapered.

C. Type X:
1. Thickness: 5/8 inch (15.9 mm).
2. Long Edges: Tapered.

D. Special Type X: Having improved fire resistance over standard Type X, and complying with requirements of fire-resistance-rated assemblies indicated on Drawings.
1. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
2. Long Edges: Tapered.

E. Ceiling Type: Manufactured to have more sag resistance than regular-type gypsum board.
1. Thickness: 1/2 inch (12.7 mm).
2. Long Edges: Tapered.

F. Abuse-Resistant Type: Manufactured to produce greater resistance to surface indentation and through-penetration (impact resistance) than standard, regular-type and Type X gypsum board.
1. Core: 5/8 inch (15.9 mm), Type X.
2. Long Edges: Tapered.

G. Moisture- and Mold-Resistant Type: With moisture- and mold-resistant core and surfaces.
1. Core: 5/8 inch (15.9 mm), Type X.
2. Long Edges: Tapered.

2.2 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A108.1.
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
a. Custom Building Products; Wonderboard.
b. FinPan, Inc.; Util-A-Crete Concrete Backer Board.
c. USG Corporation; DUROCK Cement Board.
2. Thickness: 1/2 inch (12.7 mm).

2.3 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.
   1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc .
   2. Shapes:
      a. Cornerbead.
      b. LC-Bead: J-shaped; exposed long flange receives joint compound.
      c. L-Bead: L-shaped; exposed long flange receives joint compound.
      d. U-Bead: J-shaped; exposed short flange does not receive joint compound.
      e. Expansion (control) joint.

2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:
   1. Interior Gypsum Wallboard: Paper.
   2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
   1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
   2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
   3. Fill Coat: For second coat, use setting-type, sandable topping compound.
   4. Finish Coat: For third coat, use setting-type, sandable topping compound.

D. Joint Compound for Tile Backing Panels:
   1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.5 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
   1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
   1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
   2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

E. Acoustical Sealant: As specified in Division 07 Section "Joint Sealants."

F. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation."

2.6 TEXTURE FINISHES

A. Primer: As recommended by textured finish manufacturer.

PART 3 - EXECUTION

3.1 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

3.2 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:
1. Regular Type: Vertical surfaces, unless otherwise indicated.
2. Type X: Where required for fire-resistance-rated assembly .
3. Special Type X: Where required for specific fire-resistance-rated assembly indicated.
4. Ceiling Type: Ceiling surfaces.
5. Abuse-Resistant Type: As indicated on Drawings.
6. Moisture- and Mold-Resistant Type: At all vertical and ceiling surfaces in restrooms, locker rooms and shower areas not receiving ceramic tile.

3.3 APPLYING TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A108.1, at locations indicated to receive tile.

B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.4 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:
1. Cornerbead: Use at outside corners.
2. LC-Bead: Use at exposed panel edges.
3. L-Bead: Use where indicated.
4. U-Bead: Use at exposed panel edges .

3.5 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below:
1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for acoustical tile .
3. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.
   a. Primer and its application to surfaces are specified in other Division 09 Sections.
4. Level 5: Where indicated on Drawings.
   a. Primer and its application to surfaces are specified in other Division 09 Sections.

E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.6 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.
1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09250

SECTION 09265 – GYPSUM BOARD SHAFT-WALL ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Shaft-wall enclosures.
   2. Chase enclosures.
   3. Stair enclosures.
   4. Horizontal enclosures.

1.2 SUBMITTALS

A. Product Data: For each gypsum board shaft-wall assembly indicated.

1.3 QUALITY ASSURANCE

A. Fire-Resistance Ratings: Provide materials and construction identical to those of assemblies with fire-resistance ratings determined according to ASTM E 119 by a testing and inspecting agency.

B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. G-P Gypsum.
   2. National Gypsum Company.
   3. USG Corporation.

2.2 GYPSUM BOARD SHAFT-WALL ASSEMBLIES, GENERAL

A. Provide materials and components complying with requirements of fire-resistance-rated assemblies indicated.
   1. Provide panels in maximum lengths available to eliminate or minimize end-to-end butt joints.
   2. Provide auxiliary materials complying with gypsum board shaft-wall assembly manufacturer's written recommendations.

2.3 PANEL PRODUCTS

A. Gypsum Liner Panels: Comply with ASTM C 442/C 442M.
   1. Type X: Manufacturer's proprietary liner panels with moisture-resistant paper faces.
      a. Core: 1 inch (25.4 mm) thick.
      b. Long Edges: Double bevel.
   2. Moisture- and Mold-Resistant Type X: Manufacturer's proprietary liner panels and with moisture- and mold-resistant core and surfaces; comply with ASTM D 3273.
      a. Core: 1 inch (25.4 mm) thick.
      b. Long Edges: Double bevel.

B. Gypsum Board: As specified in Division 09 Section "Gypsum Board."

2.4 NON-LOAD-BEARING STEEL FRAMING

A. Framing Members: Comply with ASTM C 754 for conditions indicated.

B. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
   1. Protective Coating: Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized, unless otherwise indicated.

2.5 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced product standards and manufacturer's written recommendations.

B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes specified in Division 09 Section "Gypsum Board" that comply with gypsum board shaft-wall assembly manufacturer's written recommendations for application indicated.

C. Gypsum Board Joint-Treatment Materials: As specified in Division 09 Section "Gypsum Board."

D. Laminating Adhesive: Adhesive or joint compound recommended by manufacturer for directly adhering gypsum face-layer panels to backing-layer panels in multilayer construction.

E. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

F. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft-wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
   1. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

G. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing), produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

2.6 GYPSUM BOARD SHAFT-WALL ASSEMBLIES

A. Fire-Resistance Rating: As indicated .

B. STC Rating: As indicated .

C. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.
1. Depth: As indicated .
2. Minimum Base-Metal Thickness: As indicated .

D. Runner Tracks: Manufacturer's standard J-profile track with long-leg length as standard with manufacturer, but at least 2 inches (51 mm) long and in depth matching studs.
1. Minimum Base-Metal Thickness: Matching steel studs .

E. Jamb Struts: Manufacturer's standard J-profile strut with long-leg length of 3 inches (76 mm), in depth matching studs, and not less than 0.0329 inch (0.84 mm) thick.

F. Room-Side Finish: Gypsum board.

G. Shaft-Side Finish: As indicated by fire-resistance-rated assembly design designation.

H. Insulation: Sound attenuation blankets.

PART 3 - EXECUTION

3.1 PREPARATION

A. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft-wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft-wall assemblies to comply with requirements specified in Division 07 Section "Applied Fireproofing."
1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runner tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (610 mm) o.c.

B. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft-wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.2 INSTALLATION

A. General: Install gypsum board shaft-wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and the following:
1. ASTM C 754 for installing steel framing except comply with framing spacing indicated.
2. Division 09 Section " Gypsum Board" for applying and finishing panels.

B. Do not bridge architectural or building expansion joints with shaft-wall assemblies; frame both sides of expansion joints with furring and other support.

C. Install supplementary framing in gypsum board shaft-wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, and similar items that cannot be supported directly by shaft-wall assembly framing.
   1. At elevator hoistway entrance door frames, provide jamb struts on each side of door frame.
   2. Where handrails directly attach to gypsum board shaft-wall assemblies, provide galvanized steel reinforcing strip with 0.0312-inch (0.79-mm) minimum thickness of base (uncoated) metal, accurately positioned and secured behind at least 1 gypsum board face-layer panel.

D. Integrate stair hanger rods with gypsum board shaft-wall assemblies by locating cavity of assemblies where required to enclose rods.

E. At penetrations in shaft wall, maintain fire-resistance rating of shaft-wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

F. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels, while maintaining continuity of fire-rated construction.

G. Control Joints: Install control joints at locations indicated on Drawings, while maintaining fire-resistance rating of gypsum board shaft-wall assemblies.

H. Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly. Install acoustical sealant to withstand dislocation by air-pressure differential between shaft and external spaces; maintain an airtight and smoke-tight seal; and comply with ASTM C 919 requirements or with manufacturer's written instructions, whichever are more stringent.

I. In elevator shafts where gypsum board shaft-wall assemblies cannot be positioned within 4 inches (102 mm) of the shaft face of structural beams, floor edges, and similar projections into shaft, install 1/2- or 5/8-inch- (13- or 16-mm-) thick, gypsum board cants covering tops of projections. No recesses allowed (at steel beams especially).
   1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches (610 mm) o.c. with screws fastened to shaft-wall framing.
   2. Where steel framing is required to support gypsum board cants, install framing at 24 inches (610 mm) o.c. and extend studs from the projection to shaft-wall framing.

J. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.3 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09265

SECTION 09310 – CERAMIC TILE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Unglazed ceramic mosaic tile.
   2. Glazed wall tile.
   3. Stone thresholds installed as part of tile installations.
   4. Waterproof membrane for tile installations.

B. Related Sections: The following sections contain requirements that relate to this Section:
   1. Division 9 – Section "Gypsum Board" for walls specified for tile substrates.

1.2 SUBMITTALS

A. Product Data: For each product indicated.

B. Samples:
   1. Each type, composition, color, and finish of tile.
   2. Assembled samples with grouted joints for each type, composition, color, and finish of tile.
   3. Stone thresholds in 6-inch (150-mm) lengths.

C. Master grade certificates for each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

D. SPiRiT Submittals:
   1. Credit IEQ 5.C4: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.

1.3 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.
   1. Build mockup of each type of floor tile installation.
   2. Build mockup of each type of wall tile installation.
   3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

B. Single-Source Responsibility: Obtain tile and variety of tile from a single source with resources to provide products of consistent quality in appearance and physical properties. Obtain setting and grouting of a uniform quality from one manufacturer for each cementitious and admixture component and from one source or producer for each aggregate.

C. Installer Qualifications: Engage an experienced Installer who has successfully completed tile installations similar to that indicated for Project.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement of ANSI A137.1 for labeling sealed tile packages.

B. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.

C. Handle tile with temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If despite these precautions coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.5 PROJECT CONDITIONS

A. Maintain environmental conditions and protect work during and after installation to comply with referenced standards and manufacturer's printed recommendations.

B. Maintain temperatures at 50 deg F or more in tiled areas during installation and for seven (7) days after completion, unless higher temperatures are required by referenced installation standard or manufacturer's instructions.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.

PART 2 - PRODUCTS

2.1 TILE PRODUCTS

A. ANSI Ceramic Tile Standard: Provide Standard grade tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.

B. Unglazed Ceramic Mosaic Tile: Factory-mounted flat tile as follows:
   1. Location: At all floor and shower stalls of toilet rooms,
   2. Composition: Porcelain.
   3. Module Size: 2 by 2 inches (50.8 by 50.8 mm).
   4. Nominal Thickness: 1/4 inch (6.35 mm).
   5. Face: Plain with cushion edges.

C. Glazed Wall Tile: Flat tile as follows:
   1. Module Size: 4-1/4 by 4-1/4 inches (108 by 108 mm) .
   2. Thickness: 5/16 inch (8 mm).
   3. Face: Plain with cushion edges.
   4. Mounting: Factory back-mounted.

D. Glazed Wall Tile Trim Units: Matching characteristics of adjoining flat tile and coordinated with sizes and coursing where applicable.
   1. Base: Coved, module size 4-1/4 by 4-1/4 inches (108 by 108 mm) .
   2. Wainscot Cap: Bullnose, or surface bullnose, depending on application, module size 4-1/4 by 4-1/4 inches (108 by 108 mm) .
   3. External Corners: Bullnose, or surface bullnose, depending on application.
   4. Internal Corners: Field-butted square corners except with coved base and cap angle pieces designed to fit with stretcher shapes.

E. Ceramic Mosaic Trim Units: Matching characteristics of adjoining flat tile and coordinated with sizes and coursing where applicable.
   1. Base Cove: Cove, module size 2 by 1 inch (50.8 by 25.4 mm).
   2. Base Cap: Bullnose or surface bullnose, depending on application, module size 2 by 2 inches (50.8 by 50.8 mm).
   3. Wainscot Cap: Bullnose or surface bullnose, depending on application, module size 2 by 2 inches (50.8 by 50.8 mm).
   4. External Corners: Bullnose or surface bullnose, depending on application, module size 2 by 1 inch (50.8 by 25.4 mm).
   5. Internal Corners: Cove, module size 2 by 1 inch (50.8 by 25.4 mm).

2.2 ACCESSORY MATERIALS

A. Thresholds: Fabricate to provide transition between adjacent floor finishes. Bevel edges at 1:2 slope, limit height of bevel to 1/2 inch (12.7 mm) or less, and finish bevel to match face of threshold.

   1. Marble Thresholds: ASTM C 503 with a minimum abrasion resistance of **[10]** **[12]** per ASTM C 1353 or ASTM C 241 and with honed finish.
      a. Description: Uniform, fine- to medium-grained white stone with gray veining.

B. Waterproofing and Crack-Suppression Membranes for Thin-Set Tile Installations: Manufacturer's standard product that complies with ANSI A118.10.

2.3 SETTING AND GROUTING MATERIALS

A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.1A.

B. Dry-Set Portland Cement Mortar (Thin Set): ANSI A118.1.
   1. For wall applications, provide nonsagging mortar.

C. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.
   1. Prepackaged dry-mortar mix combined with liquid-latex additive.
   2. For wall applications, provide nonsagging mortar.

D. Chemical-Resistant, Water-Cleanable, Tile-Setting and -Grouting Epoxy: ANSI A118.3, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Water-Cleanable, Tile-Setting Epoxy Adhesive: ANSI A118.3, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Organic Adhesive: ANSI A136.1, Type I, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Polymer-Modified Tile Grout: ANSI A118.7, color as indicated.
1. Polymer Type: Dry, redispersible form, prepackaged with other dry ingredients.

2.4 MISCELLANEOUS MATERIALS

A. Elastomeric Sealants: Elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements in Division 07 Section "Joint Sealants."
1. Use sealants that have a VOC content of 250g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. One-Part, Mildew-Resistant Silicone: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for in-service exposures of high humidity and extreme temperatures.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.

B. Fill cracks, holes, and depressions with trowelable leveling and patching compound according to tile-setting material manufacturer's written instructions.

C. Remove protrusions, bumps, and ridges by sanding or grinding.

D. Blending: For tile exhibiting color variations, use factory blended tile or blend tiles at Project site before installing.

E. Field-Applied Temporary Protective Coating: Where indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.2 INSTALLATION, GENERAL

A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods for the different types of installations and substrates occurring in project.

B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods for the different types of installations and substrates occurring in project.

C. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Grind cut edges of tile abutting trim, finish, or built-in items. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

E. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.

F. Lay out tile wainscots to next full tile beyond dimensions indicated.

G. Expansion Joints: Locate expansion joints and other sealant-filled joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
   1. Locate joints in tile surfaces directly above joints in concrete substrates.
   2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

H. Grout tile to comply with requirements of ANSI A108.10, unless otherwise indicated.
   1. For chemical-resistant epoxy grouts, comply with ANSI A108.6.

I. Install waterproofing to comply with ANSI A108.13 and waterproofing manufacturer's written instructions to produce waterproof membrane of uniform thickness bonded securely to substrate.
   1. Do not install tile over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

J. For installations indicated below, follow procedures in ANSI A108 Series tile installation standards for providing 95 percent mortar coverage.
   1. Tile floors in wet areas.

K. Install tile on floors with the following joint widths:
   1. Ceramic Mosaic Tile: 1/16 inch (1.6 mm).

L. Stone Thresholds: Install stone thresholds at locations indicated; set in same type of setting bed as abutting field tile, unless otherwise indicated.

M. Install metal lath and scratch coat for walls to comply with ANSI A108.1A, Section 4.1.

N. Install tile on walls with the following joint widths:
   1. Ceramic Mosaic Tile: 1/16 inch (1.6 mm).
   2. Glazed Wall Tile: 1/16 inch (1.6 mm).

END OF SECTION 09310

SECTION 09402 - RESINOUS MATRIX TERRAZZO FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Thin-set epoxy-resin terrazzo flooring and base.
   2. Precast terrazzo units

B. Related Sections:
   1. Division 07 Section "Joint Sealants" for sealants installed with terrazzo.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. SPiRiT Submittals:
   1. Product Data for Credit MR 4.C4: For marble chips, aggregates, indicating percentages by weight of postindustrial recycled content.
      a. Include statement that indicates cost for each product having recycled content.
   2. Product Data for Credit IEQ 5C.4: For adhesives, including printed statement of VOC content and chemical components.

C. Shop Drawings: Include terrazzo installation requirements. Include plans, elevations, sections, component details, and attachments to other work.

D. Samples: For each type, material, color, and pattern of terrazzo, accessory and precast unit required showing the full range of color, texture, and pattern variations expected.

E. Installer certificates.

F. Qualification data.

G. Material certificates.

H. Maintenance data.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who is acceptable to terrazzo manufacturer to install manufacturer's products.
   1. Engage an installer who is certified in writing by terrazzo manufacturer as qualified to install manufacturer's products.
   2. Engage an installer who is a contractor member of NTMA.

B. NTMA Standards: Comply with NTMA's "Terrazzo Specifications and Design Guide" and with written recommendations for terrazzo type indicated unless more stringent requirements are specified.

C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

D. Preinstallation Conference: Conduct conference at Project site.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting terrazzo installation.

B. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.

C. Close spaces to traffic during terrazzo application and for not less than 24 hours after application unless manufacturer recommends a longer period.

D. Control and collect dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.

PART 2 - PRODUCTS

2.1 EPOXY-RESIN TERRAZZO

A. Materials:
1. Flexible Reinforcing Membrane: Manufacturer's resinous membrane for substrate crack preparation and reflective crack reduction.
   a. Reinforcement: Fiberglass scrim.
2. Primer: Manufacturer's product recommended for substrate and use indicated.
3. Epoxy-Resin Matrix: Manufacturer's standard recommended for use indicated and in color required for mix indicated.
   a. Physical Properties without Marble Chips and Aggregates:
      1) Hardness: 60 to 85 per ASTM D 2240, Shore D.
      2) Minimum Tensile Strength: 3000 psi (20.7 MPa) per ASTM D 638 for a 2-inch (51-mm) specimen made using a "C" die per ASTM D 412.
      3) Minimum Compressive Strength: 10,000 psi (6.9 MPa) per ASTM D 695, Specimen B cylinder.
      4) Chemical Resistance: No deleterious effects by contaminants listed below after seven-day immersion at room temperature per ASTM D 1308.
         a) Distilled water.
         b) Mineral water.
         c) Isopropanol.
         d) Ethanol.
         e) 0.025 percent detergent solution.
         f) 1.0 percent soap solution.
         g) 10 percent sodium hydroxide.

h) 10 percent hydrochloric acid.
i) 30 percent sulfuric acid.
j) 5 percent acetic acid.

b. Physical Properties with Marble Chips or Aggregates: For resin blended with a ground and polished composite of marble, granite, onyx or glass chips grouted, and cured per requirements in NTMA's "Terrazzo Specifications and Design Guide," comply with the following:
1) Flammability: Self-extinguishing, maximum extent of burning 0.25 inch (6.35 mm) per ASTM D 635.
2) Thermal Coefficient of Linear Expansion: 0.0025 inch/inch per deg F (0.0025 mm/mm per 0.5556 deg C) for temperature range of minus 12 to plus 140 deg F (minus 24 to plus 60 deg C) per ASTM D 696.

4. Marble Chips or Aggregates: Complying with NTMA gradation standards for mix indicated and containing no deleterious or foreign matter.
a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C 131.
b. 24-Hour Absorption Rate: Less than 0.75 percent.
c. Dust Content: Less than 1.0 percent by weight.
d. Postindustrial Recycled Content: 40 percent.
5. Finishing Grout: Resin based.

B. Terrazzo: Comply with NTMA's "Terrazzo Specifications and Design Guide" and manufacturer's written instructions for matrix and marble-chip proportions and mixing.
1. Formulated Mix Color and Pattern: As selected by Architect from manufacturer's full range.

2.2 STRIP MATERIALS

A. Thin-Set Divider Strips: L-type angle or T-type, 1/4 inch (6.4 mm) deep.
1. Material: White-zinc alloy or Brass.
2. Top Width: 1/8 inch (3.2 mm) .

B. Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material, thickness, and color of divider strips and in depth required for topping thickness indicated.

C. Accessory Strips: Match divider strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:
1. Base-bead strips for exposed top edge of terrazzo base.
2. Edge-bead strips for exposed edges of terrazzo.
3. Nosings for terrazzo stair treads and landings.

D. Abrasive Strips: Silicon carbide or aluminum oxide, or combination of both, in epoxy-resin binder and set in channel.
1. Width: 1/2 inch (12.7 mm).
2. Depth: As required by terrazzo thickness.
3. Length: 4 inches (100 mm) less than stair width .
4. Color: As selected by Architect from manufacturer's full range.

2.3 MISCELLANEOUS ACCESSORIES

A. Strip Adhesive: Epoxy-resin adhesive recommended by adhesive manufacturer for this use and acceptable to terrazzo manufacturer.

1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Anchoring Devices:
1. Provide mechanical anchoring devices for strip materials as required for secure attachment to substrate.

C. Patching and Fill Material: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.

D. Joint Compound: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.

E. Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by sealer manufacturer for use on terrazzo type indicated.

F. Sealer: Slip- and stain-resistant penetrating-type sealer that is chemically neutral with pH factor between 7 and 10; does not affect color or physical properties of terrazzo; is recommended by sealer manufacturer; and complies with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated.

2.4 PRECAST TERRAZZO

A. Precast Terrazzo Units: Precast epoxy-resin terrazzo stair tread units.

B. Precast Terrazzo Stair Treads: 1/2 inch (12.7 mm) thick with rounded nosing edge.
1. Abrasive Strips: Abrasive nosing strip and two-line abrasive inserts at nosings.
2. Color, Pattern, and Finish: Match adjacent poured-in-place terrazzo flooring.

C. Precast Terrazzo Finishing:
1. Finish exposed-to-view edges or reveals to match face finish.
2. Ease exposed edges to 1/8-inch (3-mm) radius.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances, including oil, grease, and curing compounds, that might impair terrazzo bond. Provide clean, dry, and neutral substrate for terrazzo application.

B. Concrete Slabs:
1. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with terrazzo.
a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
b. Repair damaged and deteriorated concrete according to terrazzo manufacturer's written recommendations.

c. Use patching and fill material to fill holes and depressions in substrates according to terrazzo manufacturer's written instructions.

2. Verify that concrete substrates are visibly dry and free of moisture.
3. Moisture Testing:
   a. Test for moisture content by method recommended in writing by terrazzo manufacturer. Proceed with installation only after substrates pass testing.

C. Protect other work from dust generated by grinding operations. Control dust to prevent air pollution and comply with environmental protection regulations.

D. Installation of terrazzo indicates acceptance of surfaces and conditions.

3.2 EPOXY-RESIN TERRAZZO INSTALLATION

A. General:
1. Comply with NTMA's written recommendations for terrazzo and accessory installation.
2. Place, rough grind, grout, cure grout, fine grind, and finish terrazzo according to manufacturer's written instructions and NTMA's "Terrazzo Specifications and Design Guide."
3. Installation Tolerance: Limit variation in terrazzo surface from level to 1/4 inch in 10 feet (6 mm in 3 m); noncumulative.
4. Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.
5. Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.

B. Thickness: 3/8 inch (9.5 mm) nominal.

C. Flexible Reinforcing Membrane:
1. Prepare and prefill substrate cracks with membrane material.
2. Install membrane to produce full substrate coverage in areas to receive terrazzo.
3. Reinforce membrane with fiberglass scrim.
4. Prepare membrane according to manufacturer's written instructions before applying substrate primer.

D. Primer: Apply to terrazzo substrates according to manufacturer's written instructions.

E. Strip Materials:
1. Divider and Control-Joint Strips:
   a. Locate divider strips in locations indicated.
   b. Install control-joint strips back to back directly above concrete-slab control joints .
   c. Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.
2. Accessory Strips: Install accessory strips as required to provide a complete installation.
3. Abrasive Strips: Install with surface of abrasive strip positioned 1/32 inch (0.8 mm) higher than terrazzo surface.

F. Fine Grinding: Grind with stones 120 grit or finer until all grout is removed from surface. Repeat rough grinding, grout coat, and fine grinding if large voids exist after initial fine grinding. Produce surface with a minimum of 70 percent aggregate exposure.

G. Repair: Remove and replace terrazzo areas that evidence lack of bond with substrate. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by Architect.

3.3 PRECAST TERRAZZO INSTALLATION

A. Install precast terrazzo units using method recommended NTMA and manufacturer unless otherwise indicated.

B. Installation Tolerance: Set units with alignment level and true to dimensions, varying 1/8-inch (3.2-mm) maximum in length, height, or width; noncumulative.

C. Do not install units that are chipped, cracked, discolored, or not properly finished.

D. Seal joints between units with joint compound matching precast terrazzo matrix .

3.4 CLEANING AND PROTECTION

A. Cleaning:
1. Remove grinding dust from installation and adjacent areas.
2. Wash surfaces with cleaner according to NTMA's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow to dry thoroughly.

B. Sealing:
1. Seal surfaces according to NTMA's written recommendations.
2. Apply sealer according to sealer manufacturer's written instructions.

C. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Substantial Completion.

END OF SECTION 09402

SECTION 09511 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes acoustical panels and exposed suspension systems for ceilings.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each exposed finish.

C. Product test reports.

D. Research/evaluation reports.

E. Maintenance data.

1.3 QUALITY ASSURANCE

A. Acoustical Testing Agency Qualifications: An independent testing laboratory or an NVLAP-accredited laboratory.

B. Fire-Test-Response Characteristics:
   1. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
      a. Identify materials with appropriate markings of applicable testing and inspecting agency.
   2. Surface-Burning Characteristics: Acoustical panels complying with ASTM E 1264 for Class A, when tested per ASTM E 84.
      a. Smoke-Developed Index: 450 or less.

C. Seismic Standard: Comply with the following:
   1. ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

1.4 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Acoustical Ceiling Panels: Full-size panels equal to 2.0 percent of quantity installed.
   2. Suspension System Components: Quantity of each exposed component equal to 2.0 percent of quantity installed.

PART 2 - PRODUCTS

2.1 ACOUSTICAL PANEL CEILINGS, GENERAL

A. Acoustical Panel Standard: Comply with ASTM E 1264.

B. Metal Suspension System Standard: Comply with ASTM C 635.

C. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
   1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are required.

D. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

E. Wire Hangers, Braces, and Ties: Zinc-coated carbon-steel wire; ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
   1. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) diameter wire.
   2. Provide stainless-steel wire complying with ASTM A 580/A 580M, Type 304, nonmagnetic at all high humidity areas and through out first floor ceilings.

F. Seismic perimeter stabilizer bars, seismic struts, and seismic clips, if required.

G. Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.

2.2 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING

A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc.; Cirrus, or a comparable product.

B. Classification: Provide panels complying with ASTM E 1264 for type and form as follows:
   1. Type and Form: Type III, mineral base with painted finish; Form 1, nodular .
   2. Provide fire-resistance-rated panels where required.

C. Color: White.

D. Light Reflectance (LR): ASTM E 1477; White Panel: Light Reflectance: 0.86.

E. Noise Reduction Coefficient (NRC): ASTM C 423; Classified with UL label on product carton, 0.70.

F. Ceiling Attenuation Class (CAC): ASTM C 1414; Classified with UL label on product carton, 35.

G. Mold/Mildew Inhibitor: The front and back of panels shall be treated with manufacturer's standard biocide that inhibits or retards the growth of mold or mildew, ASTM D 3273.

H. Flame Spread: ASTM E 1264; Class A (UL)

I. Edge Profile: Angled Tegular

J. Thickness: 3/4 inch (19 mm) .

K. Modular Size: 24 by 24 inches (610 by 610 mm) .

2.3 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILING

A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc.; Prelude Plus XL Fire Guard or a comparable product at first floor ceilings and all high humidity areas such as locker rooms and where required for fire rated ceilings.
1. Double-Web, Fire-Rated where required, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation, with prefinished 15/16-inch- (24-mm-) wide metal caps on flanges.
a. Structural Classification: Heavy-duty system.
b. End Condition of Cross Runners: Override (stepped) type.
c. Cap Material: Aluminum cold-rolled sheet.
d. Cap Finish: Painted white.

B. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc.; Prelude XL or a comparable product at all locations not specified to receive Prelude Plus XL Fire Guard.
1. Double-Web, Fire-Rated where required, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation, with prefinished 15/16-inch- (24-mm-) wide metal caps on flanges.
a. Structural Classification: Intermediate or heavy-duty system as required for application.
b. End Condition of Cross Runners: Override (stepped) type.
c. Cap Material: Steel cold-rolled sheet.
d. Cap Finish: Painted white.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with ASTM C 636 and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders.

C. Suspend ceiling hangers from building's structural members, plumb and free from contact with insulation or other objects within ceiling plenum. Splay hangers only where required and, if

permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers, use trapezes or equivalent devices. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

1. Do not support ceilings directly from permanent metal forms or floor deck; anchor into concrete slabs.
2. Do not attach hangers to steel deck tabs.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.

E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

END OF SECTION 09511

SECTION 09651 - RESILIENT FLOOR TILE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Vinyl composition floor tile.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. SPiRiT Submittals:
   1. Product Data for Credit IEQ 5.C4: For adhesives, including printed statement of VOC content and chemical components.

C. Samples: Full-size units of each color and pattern of floor tile required.

D. Maintenance data.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
   1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

1.4 PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer in spaces to receive floor tile.

B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer.

C. Close spaces to traffic during floor tile installation.

D. Close spaces to traffic for 48 hours after floor tile installation.

E. Install floor tile after other finishing operations, including painting, have been completed.

1.5 EXTRA MATERIALS

A. Deliver to Owner. Furnish extra materials matching products installed as described below, packaged with protective covering for storage, identified with labels clearly describing contents.

1. Not less than (1) box for each 20 boxes or fraction thereof, of each class, wearing surface, color, pattern, size of resilient floor tile installed. If fewer than 20 boxes are used, furnish one (1) box minimum.

PART 2 - PRODUCTS

2.1 VINYL COMPOSITION FLOOR TILE

A. Tile Standard: ASTM F 1066, Class 2, through-pattern tile.

B. Wearing Surface: Smooth.

C. Thickness: 0.125 inch (3.2 mm).

D. Size: 12 by 12 inches (305 by 305 mm).

E. Colors and Patterns: As selected by Architect from full range of industry colors.

2.2 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit floor tile and substrate conditions indicated.
   1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      a. Vinyl Composition Floor Tile Adhesives: Not more than 50 g/L.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.
   1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
   4. Moisture Testing: Perform tests recommended by floor covering manufacturer. Proceed with installation only after substrates pass testing.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install floor tiles until they are same temperature as space where they are to be installed.
   1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

F. Apply concrete slab primer, if recommended by flooring manufacturer, prior to applying adhesive. Apply according to manufacturer's directions.

3.2 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.

G. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.3 CLEANING AND PROTECTION

A. Perform following operations immediately after completing installation:
   1. Remove visible all surface blemishes using cleaner recommended by manufacturers.
   2. Sweep or vacuum floor thoroughly.
   3. Do not wash floor until after time period recommended by resilient floor tile manufacturer.
   4. Damp-mop tile to remove black marks and soil.

B. Protect flooring against mars, marks, indentations, other damage from construction operations, placement of equipment, fixtures during remainder of construction period. Use protection methods indicated, recommended by manufacturer.

1. Apply protective floor polish to tile surfaces that are free from soil, visible adhesive, surface blemishes.
   a. Use commercially available, metal, cross-linked acrylic product acceptable to manufacturer.
   b. Coordinate selection of floor polish with Owner's maintenance service.
2. Cover with undyed, untreated building paper until inspection for Substantial Completion.
3. Do not move heavy, sharp objects directly over floors. Place plywood or hardboard panels over floors, under objects while they are being moved. Slide or roll objects over panels without moving panels.

C. Clean floors not more than four (4) days prior to dates scheduled for inspections intended to establish date of Substantial Completion in each area of Project. Clean floors using method recommended by manufacturer.
   1. Strip protective floor polish that was applied after completing installation prior to cleaning. Clean floor coverings by method recommended by manufacturer.
   2. Polishing of floors as directed by LARNG.

END OF SECTION 09651

SECTION 09653 – RESILIENT WALL BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Resilient base.
   2. Resilient stair accessories.
   3. Resilient molding accessories.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. SPiRiT Submittals:
   1. Product Data for Credit IEQ 5.C4: For adhesives, including printed statement of VOC content and chemical components.

C. Samples: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches (300 mm) long, of each resilient product color, texture, and pattern required.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
   1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

1.4 PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer in spaces to receive resilient products.

B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer.

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 RESILIENT BASE

A. Resilient Base Standard: ASTM F 1861.
   1. Material Requirement: Type TS (rubber, vulcanized thermoset) .

2. Manufacturing Method: Group I (solid, homogeneous) .
3. Style: Cove (base with toe) .

B. Minimum Thickness: 0.125 inch (3.2 mm) .

C. Height: 6 inches (152 mm).

D. Lengths: Coils in manufacturer's standard length.

E. Outside Corners: Preformed.

F. Inside Corners: Preformed.

G. Finish: As selected by Architect from manufacturer's full range.

H. Colors and Patterns: As selected by Architect from full range of industry colors.

2.2 RESILIENT STAIR ACCESSORIES

A. Resilient Stair Treads Standard: ASTM F 2169.
1. Material Requirement: Type TS (rubber, vulcanized thermoset) .
2. Surface Design:
   a. Class 2, Pattern: Raised-disc design .
3. Manufacturing Method: Group 1, tread with embedded abrasive strips or Group 2, tread with contrasting color for the visually impaired.

B. One-piece nosing, tread and riser.

C. Thickness: 0.16 inch (4 mm) overall thickness.

D. Size: Lengths and depths to fit each stair tread in one piece.

E. Stringers: Of same thickness as risers, height and length after cutting to fit risers and treads and to cover stair stringers; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.

F. Colors and Patterns: As selected by Architect from full range of industry colors.

2.3 RESILIENT MOLDING ACCESSORY

A. Resilient Edge Strips: Use a 1/8-inch homogeneous vinyl or rubber composition, tapered or bullnose edge, color to match flooring, or as selected by Architect from standard colors available; not less than 1-inch wide.

2.4 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
   1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      a. Cove Base Adhesives: Not more than 50 g/L.
      b. Rubber Floor Adhesives: Not more than 60 g/L.

C. Stair-Tread-Nose Filler: Two-part epoxy compound recommended by resilient tread manufacturer to fill nosing substrates that do not conform to tread contours.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates for Resilient Stair Treads and Accessories: Prepare according to ASTM F 710.
   1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.
   4. Moisture Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient products until they are same temperature as the space where they are to be installed.
   1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.2 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

3.3 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Stair Accessories:
   1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
   2. Tightly adhere to substrates throughout length of each piece.

C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install resilient edge strips at edges of carpet resilient floor covering that would otherwise be exposed.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.

B. Cover resilient products until Substantial Completion.

END OF SECTION 09653

SECTION 09680 - CARPET

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes tufted carpet.

1.2 SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Show the following:
1. Carpet type, color, and dye lot.
2. Seam locations.
3. Pattern type, repeat size, location, direction, and starting point.
4. Pile direction.
5. Insets and borders.
6. Edge, transition, and other accessory strips.
7. Transition details to other flooring materials.

C. Samples: For each color and texture required.
1. Carpet: 12-inch- (300-mm-) square Sample.
2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- (300-mm-) long Samples.

D. SPiRiT Submittals:
1. Credit IEQ 5.C4: Manufacturers' product data for carpet and installation adhesive, including printed statement of VOC content.

E. Product Schedule: For carpet.

F. Maintenance data.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.

B. Mockups: Before installing carpet, build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104, Section 5, "Storage and Handling."

1.5 PROJECT CONDITIONS

A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."

1.6 WARRANTY

A. Special Warranty for Carpet: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, excess static discharge, and delamination.
   1. Warranty Period: 10 years from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Carpet: Full-width rolls equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd. (8.3 sq. m).

PART 2 - PRODUCTS

2.1 TUFTED CARPET

A. Basis-of-Design Product: Subject to compliance with requirements, provide Mannington Commercial, Inc. – "Balanced" broadloom carpet or a comparable product.
   1. Fiber Type: Type 6.6 nylon.
   2. Dye Method: Solution dyed.
   3. Pile Characteristic: Enhanced graphics loop pile.
   4. Average Density: 5806 oz./cu. yd. (0.215 g/cu. cm.).
   5. Weight Density: 116,129 oz./cu. yd. (4.31g/cu. cm.).
   6. Pile Thickness: 0.124 inches (3.15 mm) for finished carpet tile.
   7. Stitches: 13.5 stitches per inch (0.53 stiches per mm).
   8. Gage: 10 ends per inch (0.39 ends per mm).
   9. Surface Pile Weight: 20 oz./sq. yd. (678 g/sq. m).
   10. Primary Backing: 100% woven synthetic.
   11. Secondary Backing: Ultra Bac Plus
   12. Width: 12 feet (3.7 m) .

B. Applied Soil-Resistance Treatment: Manufacturer's standard material.

C. Antimicrobial Treatment: Manufacturer's standard material.

D. Performance Characteristics: As follows:
   1. Methenamine Pill Test (ASTM-D-2859): Passes
   2. Flooring Radiant Panel Test (ASTM-E-648): Class 1 (Direct Glue)
   3. N.B.S. Smoke Chamber Test (ASTM-E-662): Less than 450 (Flamming Mode)
   4. Electrostatic Propensity: Less than 3.0 kV per AATCC 134.
   5. VOC Limits: Provide carpet that complies with the following limits for VOC content when tested according to ASTM D 5116:
      a. Total VOCs: 0.5 mg/sq. m x h.
      b. 4-PC (4-Phenylcyclohexene): 0.05 mg/sq. m x h.
      c. Formaldehyde: 0.05 mg/sq. m x h.
      d. Styrene: 0.4 mg/sq. m x h.

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended or provided by carpet manufacturer.
   1. VOC Limits: Provide adhesives that comply with the following limits for VOC content when tested according to ASTM D 5116:
      a. Total VOCs: 10.00 mg/sq. m x h.
      b. Formaldehyde: 0.05 mg/sq. m x h.
      c. 2-Ethyl-1-Hexanol: 3.00 mg/sq. m x h.

C. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with CRI 104 and carpet manufacturer's written installation instructions for the following:
   1. Direct-Glue-Down Installation: Comply with CRI 104, Section 9, "Direct Glue-Down Installation."

B. Comply with carpet manufacturer's written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.

C. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

D. Install pattern parallel to walls and borders.

END OF SECTION 09680

SECTION 09681 – CARPET TILE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes modular, tufted carpet tile.

1.2 SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Show the following:
1. Carpet tile type, color, and dye lot.
2. Pattern of installation.
3. Insets and borders.
4. Edge, transition, and other accessory strips.
5. Transition details to other flooring materials.

C. Samples: For each color and texture required.
1. Carpet Tile: Full-size Sample.
2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- (300-mm-) long Samples.

D. SPiRiT Submittals:
1. Credit IEQ 5.C4: Manufacturers' product data for carpet tile and installation adhesive, including printed statement of VOC content.

E. Product Schedule: For carpet tile.

F. Maintenance data.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.

B. Mockups: Before installing carpet tile, build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Approved mockups may become part of the completed Work if undamaged at time of Substantial Completion.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104, Section 5, "Storage and Handling."

1.5 PROJECT CONDITIONS

A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."

B. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.6 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, dimensional stability, excess static discharge, and delamination.
1. Warranty Period: 15 years from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd. (8.3 sq. m).

PART 2 - PRODUCTS

2.1 CARPET TILE

A. Basis-of-Design Product: Subject to compliance with requirements, provide Mannington Commercial, Inc. – "Means" modular carpet tile or a comparable product.
1. Fiber Type: DSDN® solution dyed nylon.
2. Pile Characteristic: Patterned loop pile.
3. Average Density: 7,200 oz./cu. yd. (0.267 g/cu. cm.).
4. Weight Density: 144,000 oz./cu. yd. (5.34 g/cu. cm.).
5. Pile Thickness: 0.100 inches (2.54 mm) for finished carpet tile.
6. Stitches: 9.6 stitches per inch (0.38 stiches per mm).
7. Gage: 12 ends per inch (0.47 ends per mm).
8. Surface Pile Weight: 20 oz./sq. yd. (678 g/sq. m).
9. Primary Backing: 100% woven synthetic.
10. Primary Precoat: 100% vinyl non-aqueous closed cell polymer.

11. Secondary Backing: .Infinity™ modular reinforced vinyl composite closed cell polymer with recycled content.
12. Size: 18 by 18 inches (457 by 457 mm).

B. Applied Soil-Resistance Treatment: Manufacturer's standard material.

C. Antimicrobial Treatment: Manufacturer's standard material.

D. Performance Characteristics: As follows:
1. Methenamine Pill Test (ASTM-D-2859): Passes
2. Flooring Radiant Panel Test (ASTM-E-648): Class 1 (Direct Glue)
3. N.B.S. Smoke Chamber Test (ASTM-E-662): Less than 450 (Flamming Mode)
4. Dimensional Stability: 0.2 percent or less per ISO 2551 (Aachen Test).
5. Electrostatic Propensity: Less than 3.0 kV per AATCC 134.
6. VOC Limits: Provide carpet tile that complies with the following limits for VOC content when tested according to ASTM D 5116:
   a. Total VOCs: 0.5 mg/sq. m x h.
   b. 4-PC (4-Phenylcyclohexene): 0.05 mg/sq. m x h.
   c. Formaldehyde: 0.05 mg/sq. m x h.
   d. Styrene: 0.4 mg/sq. m x h.

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
1. VOC Limits: Provide adhesives that comply with the following limits for VOC content when tested according to ASTM D 5116:
   a. Total VOCs: 10.00 mg/sq. m x h.
   b. Formaldehyde: 0.05 mg/sq. m x h.
   c. 2-Ethyl-1-Hexanol: 3.00 mg/sq. m x h.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer.

C. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

D. Install pattern parallel to walls and borders.

END OF SECTION 09681

SECTION 09720 - WALL COVERINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Dry erase wallcovering.
   2. Tray and trim.
   3. Accessories.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show location and extent of each wall-covering type. Indicate seams and termination points.

C. Samples: For each type of wall covering, tray and trim required.

D. Maintenance data.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Provide wall coverings and adhesives with the following fire-test-response characteristics as determined by testing identical products applied with identical adhesives to substrates per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
   1. Surface-Burning Characteristics: As follows, per ASTM E 84:
      a. Flame-Spread Index: 25 or less.
      b. Smoke-Developed Index: 450 or less.

B. Mockups: Build mockups to demonstrate appearance and aesthetic effects and set quality standards for installation.
   1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Rolls of Wall-Covering Material: Full-size units equal to 5 percent of amount of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in Part 2 "Wall-Covering Products" Article.

2.2 WALL-COVERING PRODUCTS

A. General: Provide rolls of each type of wall covering from the same run number or dye lot.

B. Dry Erase Wallcovering:
1. Available Products:
   a. Walltalkers Wallcoverings, erase-rite® manufactured by RJF International Corporation.
2. Weight: 18 ounces (558 g) ply.
3. Width: 50 inches (1270 mm).
4. Backing Fiber Content: Polyester cellulose.
5. Backing Material: Nonwoven.
6. Coating: Pigmented vinyl capped with dry erase non-glare film.
7. Surface: Smooth low gloss vinyl surface for projection and dry erase markers.
8. Colors: As selected from manufacturer's full range.

2.3 TRIM, TRAY, AND PRESENTATION RAILS

A. Aluminum Tray: Clear satin, anodized aluminum, snap-on marker and eraser tray with clips.

B. Aluminum Trim: Clear satin, anodized aluminum, snap-on trim with clips.

C. End Caps: 1/2 inch anodized tray end cap for marker and eraser tray.

D. Wood Tray and Trim: Provide wood tray in random lengths of 8 feet to 12 feet.
1. Species: Oak
2. Finish: Unfinished, Refer to other Division 9 Section, Painting, for surfaces to receive transparent finish.
3. Location: In offices and other rooms receiving wood standing and running trim.

2.4 ACCESSORIES

A. Adhesives: Heavy-duty clear or clay based premixed vinyl adhesive.

B. Substrate Primer/Sealer: White pigmented acrylic base primer/sealer specifically formulated for use with vinyl wallcoverings.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
   1. Moisture Content: Maximum of 4 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.
   2. Gypsum Board: Prime with primer recommended by wall-covering manufacturer.

B. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

C. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.2 INSTALLATION

A. Install each strip horizontally and in same sequence as cut from the roll.

B. Install wall covering with no gaps or overlaps, no lifted or curling edges, and no visible shrinkage.

C. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.
   1. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without any overlay or spacing between strips.

END OF SECTION 09720

SECTION 09841 – ACOUSTICAL WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes back-mounted acoustical wall panels.

B. Related Sections include the following:
1. Division 9 Section "Painting".

1.2 SUBMITTALS

A. Product Data: For each type of panel edge, core material, and mounting indicated.

B. Shop Drawings: For acoustical wall panels. Include mounting devices and details.
1. Field Measurements: Verify locations of acoustical wall panels by field measurements before fabrication and indicate measurements on Shop Drawings.

C. Coordination Drawings: Show intersections with adjacent work.

D. Samples: For each fabric and sample panels.

E. Product certificates and test reports.

F. Maintenance data.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Provide acoustical wall panels with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify acoustical wall panels with appropriate marking sof applicable testing and inspecting agency.:
1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials, fabrication, and installation.

C. Preinstallation Conference: Conduct conference at Project site.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of acoustical wall panels that fail in performance, materials, or workmanship within specified warranty period.

1. Failure in performance includes, but is not limited to, acoustical performance.
2. Failures in materials include, but are not limited to, fabric sagging, distorting, or releasing from panel edge; or warping of core.
3. Warranty Period: One year from date of Substantial Completion.

1.5 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Acoustical Wall Panels: Full-size units including mounting devices equal to 2 percent of amount installed, but no fewer than two panels of each typical size.

PART 2 - PRODUCTS

2.1 CORE MATERIALS

A. Glass-Fiber Board: ASTM C 612, Type IA or Types IA and IB; density as specified, unfaced, dimensionally stable, molded rigid board, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 BACK-MOUNTED, EDGE-REINFORCED ACOUSTICAL WALL PANELS WITH GLASS-FIBER BOARD CORE

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Golterman & Sabo; Pinta PP

B. Panel Construction: Manufacturer's standard panel construction consisting of facing material laminated to front face, edges, and back border of dimensionally stable, rigid glass-fiber board core; with edges chemically hardened to reinforce panel perimeter against warpage and damage.

C. Nominal Core Density: 6 to 7 lb/cu. ft. (96 to 112 kg/cu. m).

D. Facing Material: Paintable scrim fiber facing sheet

E. Nominal Core Thickness and Overall System NRC: 2 inches (51 mm) and not less than NRC 1.00.

F. Panel Edge Detail: Square.

G. Corner Detail: Square to form continuous profile to match edge detail.

H. Finish: Latex paint as specified in Section 09900.
   1. Paint finish shall cover the face and edges of panels.

2.3 FABRICATION

A. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch (1.6 mm) for the following:
   1. Thickness.
   2. Edge straightness.
   3. Overall length and width.
   4. Squareness from corner to corner.

B. Back-Mounting Devices: Concealed on backside of panel, recommended to support weight of panel, with base-support bracket system where recommended by manufacturer for additional support of panels, and as follows:
   1. Adhesive: Use only adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Metal "Z" Clips: Two-part panel clips, with one part of each clip mechanically attached to back of panel and the other part to wall substrate, designed to allow for panel removal.
   3. As recommended by manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install acoustical wall panels in locations indicated on finish schedule with vertical surfaces and edges plumb, top edges level and in alignment with other panels, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Anchor panels securely to supporting substrate.

C. Installation Tolerances: As follows:
   1. Variation from Level and Plumb: Plus or minus 1/16 inch (1.6 mm).
   2. Variation of Panel Joints from Hairline: Not more than 1/16 inch (1.6 mm) wide.

D. Clean panels, on completion of installation, to remove dust and other foreign materials according to manufacturer's written instructions.

E. Replace acoustical wall panels that cannot be cleaned and repaired before time of Substantial Completion.

END OF SECTION 09841

SECTION 09910 – PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes surface preparation and the application of paint systems on the following interior substrates:
   1. Concrete.
   2. Concrete masonry units (CMU).
   3. Steel.
   4. Galvanized metal.
   5. Wood.
   6. Gypsum board.

B. This Section includes surface preparation and the application of paint systems on the following exterior substrates:
   1. Steel.
   2. Galvanized metal.
   3. Plastic trim fabrications.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each finish and for each color and texture required.

C. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

D. SPiRiT Submittals: For Credit IEQ 5.C4, manufacturers' product data for paints, including printed statement of VOC content and chemical components.

1.3 QUALITY ASSURANCE

A. MPI Standards:
   1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
   2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

B. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
      a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
      b. Other Items: Architect will designate items or areas required.

2. Apply benchmark samples after permanent lighting and other environmental services have been activated.
3. Final approval of color selections will be based on benchmark samples.
   a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.

1.4 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
   1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

PART 2 - PRODUCTS

2.1 PAINT, GENERAL

A. Material Compatibility:
   1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. Chemical Components of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions; these requirements do not apply to primers or finishes that are applied in a fabrication or finishing shop:
   1. Flat Paints and Coatings: VOC content of not more than 50 g/L.
   2. Nonflat Paints and Coatings: VOC content of not more than 150 g/L.
   3. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
   4. Restricted Components: Paints and coatings shall not contain any of the following:
      a. Acrolein.
      b. Acrylonitrile.
      c. Antimony.
      d. Benzene.
      e. Butyl benzyl phthalate.
      f. Cadmium.
      g. Di (2-ethylhexyl) phthalate.
      h. Di-n-butyl phthalate.
      i. Di-n-octyl phthalate.
      j. 1,2-dichlorobenzene.
      k. Diethyl phthalate.
      l. Dimethyl phthalate.
      m. Ethylbenzene.
      n. Formaldehyde.
      o. Hexavalent chromium.

p. Isophorone.
q. Lead.
r. Mercury.
s. Methyl ethyl ketone.
t. Methyl isobutyl ketone.
u. Methylene chloride.
v. Naphthalene.
w. Toluene (methylbenzene).
x. 1,1,1-trichloroethane.
y. Vinyl chloride.

C. Colors: As selected by Architect from manufacturer's full range .

2.2 BLOCK FILLERS

A. Interior/Exterior Latex Block Filler: MPI #4.
1. Sherwin Williams – PrepRite Int./Ext. Block Filler, B25W25
2. VOC Content: E Range of E3.

2.3 PRIMERS/SEALERS

A. Interior Latex Primer/Sealer: MPI #50.
1. Sherwin Williams – PrepRite 400 Interior Latex Primer, B28W400
2. VOC Content: E Range of E2.
3. Environmental Performance Rating: EPR 2.

B. Bonding Primer (Water Based): MPI #17.
1. Sherwin Williams – PrepRite Bonding Primer, B51W50
2. VOC Content: E Range of E3.

2.4 METAL PRIMERS

A. Quick-Drying Alkyd Metal Primer: MPI #76.
1. Sherwin Williams – Industrial & Marine Kem Kromik Alkyd Primer, B50W21
2. VOC Content: E Range of E2.

B. Cementitious Galvanized-Metal Primer: MPI #26.
1. Sherwin Williams – Opti-Bond Multi Surface Coating, B50W100
2. VOC Content: E Range of E1.

2.5 WOOD PRIMERS

A. Interior Latex-Based Wood Primer: MPI #39.
1. Sherwin Williams – PrepRite ProBlock Int./Ext. Latex Primer/Sealer, B51W20
2. VOC Content: E Range of E3.
3. Environmental Performance Rating: EPR 3.

2.6 LATEX PAINTS

A. Interior Latex (Low Sheen): MPI #44 (Gloss Level 2).
1. Sherwin Williams – ProMar 200 Interior Latex Eg-Shel, B20W2251
2. VOC Content: E Range of E3.
3. Environmental Performance Rating: EPR 3.

B. Interior Latex (Semigloss): MPI #54 (Gloss Level 5).
1. Sherwin Williams – ProMar 200 Interior Latex Gloss, B21W251
2. VOC Content: E Range of E2.
3. Environmental Performance Rating: EPR 3 .

C. Exterior Latex (Semigloss): MPI #11 (Gloss Level 5).
1. Sherwin Williams – A-100 Exterior Gloss Latex, A8W16
2. VOC Content: E Range of E3.

2.7 ALKYD PAINTS

A. Interior Alkyd (Semigloss): MPI #47 (Gloss Level 5).
1. Shewin Williams – ProMar 200 Alkyd Semi-Gloss, B34W251
2. VOC Content: E Range of E1.
3. Environmental Performance Rating: EPR 1.

B. Exterior Alkyd Enamel (Semigloss): MPI #94 (Gloss Level 5).
1. Sherwin Williams – Classic 00 Int./Ext. Semi-Gloss Oil, A40W51
2. VOC Content: E Range of E1.

2.8 QUICK-DRYING ENAMELS

A. Quick-Drying Enamel (Semigloss): MPI #81 (Gloss Level 5).
1. Sherwin Williams – Industrial & Marine Industrial Enamel, B54 Series
2. VOC Content: E Range of E2.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
1. Concrete: 12 percent.
2. Masonry (CMU): 12 percent.
3. Wood: 15 percent.
4. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
   1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION AND APPLICATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

D. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
   1. Mechanical Work:
      a. Uninsulated metal piping.
      b. Uninsulated plastic piping.
      c. Pipe hangers and supports.
      d. Tanks that do not have factory-applied final finishes.
      e. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
      f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
      g. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
   2. Electrical Work:
      a. Switchgear.
      b. Panelboards.
      c. Electrical equipment that is indicated to have a factory-primed finish for field painting.

E. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

F. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.3 INTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:
   1. Latex System: MPI INT 3.1E.
      a. Prime Coat: Interior latex matching topcoat.
      b. Intermediate Coat: Interior latex matching topcoat.
      c. Topcoat: Interior latex (semigloss).

B. CMU Substrates:
1. Latex System: MPI INT 4.2A.
a. Prime Coat: Interior/exterior latex block filler.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (semigloss).

C. Steel Substrates:
1. Quick-Drying Enamel System: MPI INT 5.1A.
a. Prime Coat: Quick-drying alkyd metal primer.
b. Intermediate Coat: Quick-drying enamel matching topcoat.
c. Topcoat: Quick-drying enamel (semigloss).

D. Galvanized-Metal Substrates:
1. Alkyd System: MPI INT 5.3C.
a. Prime Coat: Cementitious galvanized-metal primer.
b. Intermediate Coat: Interior alkyd matching topcoat.
c. Topcoat: Interior alkyd (semigloss).

E. Dressed Lumber Substrates: Including architectural woodwork, doors.
1. Latex System: MPI INT 6.3T.
a. Prime Coat: Interior latex-based wood primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (semigloss).

F. Gypsum Board Substrates:
1. Latex System: MPI INT 9.2A.
a. Prime Coat: Interior latex primer/sealer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (eggshell) .

3.4 EXTERIOR PAINTING SCHEDULE

A. Steel Substrates:
1. Quick-Drying Enamel System: MPI EXT 5.1A.
a. Prime Coat: Quick-drying alkyd metal primer.
b. Intermediate Coat: Quick-drying enamel matching topcoat.
c. Topcoat: Quick-drying enamel (semigloss).

B. Galvanized-Metal Substrates:
1. Alkyd System: MPI EXT 5.3B.
a. Prime Coat: Cementitious galvanized-metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (semigloss).

C. Plastic Trim Fabrication Substrates:
1. Latex System: MPI EXT 6.8A.
a. Prime Coat: Bonding primer (water based).
b. Intermediate Coat: Exterior latex matching topcoat.
c. Topcoat: Exterior latex (semigloss).

D. Stucco Substrates: Elastomeric textured coating specified in Section 09963 Elastomeric Coatings.

END OF SECTION 09910

SECTION 09963 – ELASTOMERIC COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes surface preparation and application of elastomeric coatings.

1.2 SUBMITTALS

A. Product Data: For each product specified. Include crack fillers, block fillers, and primers.

B. Samples: For each elastomeric coating and for each color required.

1.3 QUALITY ASSURANCE

A. Benchmark Samples (Mockups): Comply with procedures specified in PDCA P5.
   1. Wall Surfaces: Prepare samples on at least 100 sq. ft. (9.3 sq. m) of wall surface.

1.4 WARRANTY

A. Elastomeric Coating Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace elastomeric coatings that fail within specified warranty period. Failures include, but are not limited to, water penetration through the coating.
   1. Warranty Period: Five year(s) from date of Substantial Completion.

1.5 EXTRA MATERIALS

A. Furnish extra elastomeric coating materials from same production run as materials applied. Package materials in unopened, factory-sealed containers for storage and identify with labels describing contents. Deliver extra materials to Owner.
   1. Quantity: Furnish 2 gal. (7.5 L) of each color and finish of elastomeric coating materials applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

B. Products:

C. Manufacturers Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. ICI Dulux Paint Centers, Inc. (ICI Dulux Paint).
2. PPG Industries, Inc.; Pittsburgh Paints (Pittsburgh Paints).
3. Sonneborn, Div. of ChemRex, Inc. (Sonneborn).
4. Sto Concrete Restoration; Sto Finish Systems Division (Sto).
5. Tamms Industries, Inc. (Tamms).
6. Tnemec Company, Inc. (Tnemec).

2.2 ELASTOMERIC COATING MATERIALS, GENERAL

A. Material Compatibility: Provide crack fillers, block fillers, primers, elastomeric finish-coat materials, and related materials that are compatible with one another and substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Colors and Textures: As selected from manufacturer's full range.

2.3 CRACK FILLERS

A. Crack Fillers: Factory-formulated acrylic emulsion crack fillers compatible with substrate and finish-coat materials indicated as recommended by elastomeric coating manufacturer for width of crack.

2.4 PRIMERS

A. Concrete and Masonry Primer: Factory-formulated, alkali-resistant, acrylic-latex primer.
   1. ICI Dulux Paint; Aquacrylic GRIPPER 3210 Acrylic Primer: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).
   2. Pittsburgh Paints; Speedhide Alkali Resistant Primer 6-603: Applied at a dry film thickness of not less than 1.5 mils (0.038 mm).
   3. Sonneborn; Colorflex Sealer #751: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).
   4. Sto; Flexible Coating CR212 Thinned 1:5 with 1 Gal. (3.8 L) of Water per Each 5 Gal. (19 L) of CR212: Applied at a dry film thickness of not less than 10 mils (0.254 mm).
   5. Tamms; H/P Primer: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).

B. Stucco Primer: Factory-formulated stucco primer.
   1. ICI Dulux Paint; Aquacrylic GRIPPER 3210 Acrylic Primer: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).
   2. Pittsburgh Paints; primer not required.
   3. Sonneborn; primer not required.
   4. Sto; Flexible Coating CR212 Thinned 1:5 with 1 Gal. (3.8 L) of Water per Each 5 Gal. (19 L) of CR212: Applied at a dry film thickness of not less than 10 mils (0.254 mm).
   5. Tamms; H/P Primer: Applied at a dry film thickness of not less than 1.3 mils (0.033 mm).
   6. Tnemec; Elasto-Grip Series 151: Applied at a dry film thickness of not less than 3.5 mils (0.090 mm).

2.5 ELASTOMERIC FINISH-COAT MATERIALS

A. Smooth Elastomeric Finish: Smooth, factory-formulated, 100 percent acrylic elastomeric coating.
   1. ICI Dulux Paint; Decra-Flex 2260-XXXX Smooth Elastomeric Coating System: Applied at a dry film thickness of not less than 6.0 mils (0.15 mm).
   2. Pittsburgh Paints; Pitt-Flex Exterior Masonry Coating 100 Percent Acrylic Elastomeric 4-110: Applied at a dry film thickness of not less than 5.5 mils (0.140 mm).
   3. Sonneborn; Sonocoat Colorflex Waterproof Elastomeric Coating: Applied at a dry film thickness of not less than 8.0 mils (0.020 mm).
   4. Sto; Flexible Coating CR212: Applied at a dry film thickness of not less than 10 mils (0.254 mm).
   5. Tamms; Tammolastic Smooth Elastomeric Decorative and Protective Coating: Applied at a dry film thickness of not less than 10 mils (0.254 mm).
   6. Tnemec; Enviro-Crete Series 156 Smooth: Applied at a dry film thickness of not less than 8.0 mils (0.021 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for coating application. Comply with procedures specified in PDCA P4.
   1. Proceed with coating application only after unsatisfactory conditions have been corrected and surfaces are thoroughly dry.
   2. Start of coating application will be construed as Applicator's acceptance of surface conditions.

B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
   1. Notify Architect about anticipated problems when using coatings specified over substrates primed by others.

3.2 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, light fixtures, and similar items already installed that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
   1. After completing coating operations, reinstall items removed, using workers skilled in trades involved.

B. Surface Preparation: Clean and prepare surfaces to be coated according to manufacturer's written instructions for particular substrate conditions and as specified.
   1. Provide barrier coats over incompatible primers or remove and reprime.
   2. Cementitious Surfaces: Prepare brick, concrete, concrete unit masonry, stucco, and similar surfaces to receive elastomeric coatings. Remove efflorescence, chalk, dust, dirt, release agents, grease, oils, and similar impediments to good adhesion by water blasting followed by a clear water rinse.

a. Remove mildew and neutralize surfaces according to manufacturer's written instructions before patching materials are applied.
b. Roughen as required to remove glaze. Use abrasive blast-cleaning methods if recommended by coating manufacturer.
c. If hardeners or sealers have been used to improve concrete curing, use mechanical methods for surface preparation.
d. Determine alkalinity and moisture content of surfaces to be coated by performing appropriate tests. If surfaces are sufficiently alkaline to cause finish paint to blister and burn, correct this condition before application. Do not apply coatings over surfaces where moisture content exceeds that permitted in manufacturer's written instructions.

3. Crack Repair: Fill cracks according to manufacturer's written instructions before coating surfaces.

3.3 APPLICATION

A. General: Apply elastomeric coatings according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Do not paint over conditions detrimental to formation of a durable coating film, such as dirt, rust, scale, grease, moisture, and scuffed surfaces.
2. Provide finish coats compatible with primers used.

B. Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

C. Protect work of other trades from damage whether being coated or not. Correct damage by cleaning, repairing, replacing, and recoating as approved by Architect. Leave in an undamaged condition.

D. Provide "Wet Paint" signs to protect newly coated finishes. Remove temporary protective wrappings provided by others to protect their work after completing coating operations.
1. After construction activities of other trades are complete, touch up and restore damaged or defaced coated surfaces. Comply with procedures specified in PDCA P1.

3.4 COATING SCHEDULE

A. Stucco (Portland Cement Plaster): Provide the following elastomeric coating systems over exterior stucco surfaces:
1. Smooth Elastomeric Finish: Two finish coat(s) over a primer if required by manufacturer.
a. Primer: Stucco primer.
b. Finish Coats: Smooth elastomeric finish.

END OF SECTION 09963

SECTION 10115 - TOILET AND SHOWER COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes plastic-laminate units as follows:
   1. Toilet Enclosures: Overhead braced.
   2. Urinal Screens: Overhead braced.

B. This Section also includes solid-polymer shower cubicles.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each exposed finish.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE UNITS

A. Plastic Laminate: NEMA LD 3, HGS, 0.048-inch (1.2-mm) nominal thickness.
   1. Color and Pattern: One color and pattern in each room as selected from manufacturer's full range of colors and patterns.

B. Door, Panel, and Pilaster Construction: Plastic-laminate facing sheets are pressure laminated to core material without splices or joints in facings or cores. Laminate is applied to edges before broad surfaces to seal edges and prevent laminate from being pried loose. Exposed core material is sealed at cutouts to protect core from moisture.
   1. Core Material: ANSI A208.1, Grade M-2 particleboard with 45-lb (20.4-kg) density.
   2. Doors and Panels: Finished to not less than 1 inch (25 mm) thick.
   3. Pilasters: Provide construction to comply with the following:
      a. Finished to not less than 1-1/4 inches (32 mm) thick and with internal, 0.1196-inch-(3.0-mm-) thick steel-sheet reinforcement.

C. Pilaster Shoes and Sleeves (Caps): Stainless steel, ASTM A 666, Type 302 or 304.

D. Brackets (Fittings):
   1. Stirrup Type: Ear or U-brackets, stainless steel.

2.2 SOLID-POLYMER SHOWER CUBICLES

A. Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch (25 mm) thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.
   1. Color and Pattern: One color and pattern in each room as selected from manufacturer's full range of colors and patterns.
   2. Dividing Panels: 78-inches (1981 mm) high.
   3. Pilasters: 82-inches (2083 mm) high; mounted within a one-piece plastic shoe with star-head security pin, stainless steel barrel bolts.

B. Pilaster Shoes: Manufacturer's standard design; polymer.
   1. Polymer Color and Pattern: Matching pilaster.

C. Brackets (Fittings):
   1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.

D. Headrail: Heavy aluminum extrusion (6463-T5 alloy) with bright-dipped anodized finish in anti-grip configuration.
   1. Headrail shall be fastened to tops of pilasters and headrail brackets by thru-bolting with star-head security pin, stainless steel barrel bolts (no cadium plated bolts allowed).
   2. Brackets: 18 gauge stainless steel.

2.3 ACCESSORIES

A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
   1. Material: Stainless steel.

B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.

C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match hardware, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use hot-dip galvanized or other rust-resistant, protective-coated steel.

2.4 FABRICATION

A. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, fasteners, and anchors at pilasters to suit floor conditions. Make provisions for setting and securing continuous head rail at top of each pilaster. Provide shoes at pilasters to conceal supports and leveling mechanism.

B. Doors: Unless otherwise indicated, provide 24-inch- (610-mm-) wide in-swinging doors for standard toilet compartments and 36-inch- (914-mm-) wide out-swinging doors with a minimum 32-inch- (813-mm-) wide clear opening for compartments indicated to be accessible to people with disabilities.
   1. Hinges: Manufacturer's standard self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees.

2. Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with accessibility requirements of authorities having jurisdiction at compartments indicated to be accessible to people with disabilities.
3. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent door from hitting compartment-mounted accessories.
4. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
5. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with accessibility requirements of authorities having jurisdiction. Provide units on both sides of doors at compartments indicated to be accessible to people with disabilities.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
   1. Maximum Clearances:
      a. Pilasters and Panels: 1/2 inch (13 mm).
      b. Panels and Walls: 1 inch (25 mm).
   2. Stirrup Brackets: Secure panels to walls and to pilasters with not less than three brackets attached at midpoint and near top and bottom of panel.
      a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
      b. Align brackets at pilasters with brackets at walls.

3.2 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 10115

SECTION 10200 – LOUVERS AND VENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes fixed, extruded-aluminum louvers and wall vents (brick vents).

B. See Division 08 Section Hollow Metal Doors and Frames" for louvers in hollow-metal doors and frames.

C. See Division 08 Section "Flush Wood Doors" for louvers in wood doors.

D. See Division 15 Sections for louvers that are a part of mechanical equipment.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide louvers capable of withstanding the effects of gravity loads and wind loads based on a uniform pressure of 77.5 lb/sq.ft. acting inward or outward, without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors.

B. Thermal Movements: Provide louvers that allow for thermal movements resulting from a temperature change (range) of 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces, by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

C. Air-Performance, Water-Penetration, and Wind-Driven Rain Ratings: As demonstrated by testing manufacturer's stock units according to AMCA 500-L.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. For louvers specified to bear AMCA seal, include printed catalog pages showing AMCA Certified Ratings Seals.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work.
   1. Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.
   2. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples: For each type of finish.

D. Product test reports.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy 3003 or 5005.

C. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

A. Fabricate frames to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

B. Join frame members to each other and to louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal Storm-Resistant Louver:
1. Frame and Blade Nominal Thickness: Not less than 0.060 inch (1.5 mm) for blades and 0.080 inch (2.0 mm) for frames.
2. Performance Requirements:
   a. Free Area: Not less than 5.0 sq. ft. (0.46 sq. m) for 48-inch- (1.2-m-) wide by 48-inch- (1.2-m-) high louver.
   b. Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 600-fpm (3.0-m/s) free-area velocity.
   c. Wind-Driven Rain Performance: Not less than 99percent effectiveness when subjected to a rain fall rate of 8 inches (200 mm) per hour and a wind speed of 50 mph (22.4 m/s) at a core area intake velocity of 300 fpm (1.5 m/s) .

B. Horizontal, Drainable-Blade Louver:
1. Frame and Blade Nominal Thickness: Not less than 0.060 inch (1.5 mm) for blades and 0.080 inch (2.0 mm) for frames.
2. Performance Requirements:
   a. Free Area: Not less than 7.0 sq. ft. (0.65 sq. m) for 48-inch- (1.2-m-) wide by 48-inch- (1.2-m-) high louver.
   b. Point of Beginning Water Penetration: Not less than 1050 fpm (5.3 m/s).
   c. Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 700-fpm (3.6-m/s) free-area velocity.
3. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 BLANK-OFF PANELS

A. Uninsulated, Blank-off Panels:

1. Aluminum sheet for aluminum louvers, not less than 0.050-inch (1.2-mm) nominal thickness, unless otherwise indicated.
2. Panel Finish: Same type of finish applied to louvers, but black color.
3. Attach blank-off panels to back of louver frames with clips or stainless-steel, sheet metal screws.

2.5 LOUVER SCREENS

A. General: Provide screen at interior face of each exterior louver.

B. Louver Screen Frames: Same kind and form of metal as indicated for louver to which screens are attached.

C. Louver Screening:
1. Bird Screening: Aluminum, 1/2-inch- (12.7-mm-) square mesh, 0.063-inch (1.6-mm) wire.

2.6 FINISHES

A. Aluminum, High-Performance Organic Finish: Three-coat thermocured system with fluoropolymer coats containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
1. Color and Gloss: As selected from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

D. Repair damaged finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

END OF SECTION 10200

SECTION 10505 - METAL LOCKERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. All-welded, athletic metal lockers.
   2. Locker benches.

B. See Division 06 Section " Miscellaneous Carpentry" for furring, blocking, and shims required for installing metal lockers and concealed within other construction before metal locker installation.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Show concrete base,sloping tops, filler panels, recess trim and other accessories.
   2. Include locker identification system.

C. Samples: For each exposed finish.

D. Maintenance data.

1.3 QUALITY ASSURANCE

A. Accessibility Requirements:
   1. Provide not less than 1 shelf located no higher than 54 inches (1372 mm) above the floor for side reach.
   2. Provide 1 shelf located at bottom of locker no lower than 15 inches (381 mm) above the floor for forward reach.
   3. Provide hardware that does not require tight grasping, pinching, or twisting of the wrist, and that operates with a force of not more than 5 lbf (22.2 N).

B. Preinstallation Conference: Conduct conference at Project site.

1.4 COORDINATION

A. Coordinate size and location of concrete bases for metal lockers.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures.
   b. Faulty operation of latches and other door hardware.
2. Damage from deliberate destruction and vandalism is excluded.
3. Warranty Period for All-Welded Metal Lockers: Lifetime from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS) Type B, suitable for exposed applications.

B. Expanded Metal: ASTM F 1267, Type II (flattened), Class I, 3/4-inch (19-mm) steel mesh, with at least 70 percent open area.

C. Fasteners: Zinc- or nickel-plated steel, slotless-type exposed bolt heads, and self-locking nuts or lock washers for nuts on moving parts.

D. Anchors: Select material, type, size, and finish required for secure anchorage to each substrate.
   1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance.
   2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.2 ALL-WELDED, ATHLETIC METAL LOCKERS

1. Locker Arrangement: Single tier.

B. Sizes: 36-inches (914 mm) wide x 24-inches (610 mm) deep, 72-inches (1829 mm) tall.

C. Body: Assembled by welding body components together. Fabricate from unperforated, cold-rolled steel sheet with backs 0.0428 inch (1.1 mm) thick, and tops, bottoms, and shelves 0.0528 inch (1.35 mm) thick:

D. Expanded-Metal Sides: Fabricated from 0.0897-inch- (2.3-mm-) thick expanded metal; welded to 0.0966-inch- (2.5-mm-) thick steel angles or 0.0528-inch- (1.35-mm-) thick, steel channel frames.

E. Frames: Channel formed; fabricated from 0.0528-inch- (1.35-mm-) thick, cold-rolled steel sheet or 0.0966-inch- (2.5-mm-) thick steel angles; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral door strike full height on vertical main frames.

F. Expanded-Metal Doors: Fabricated from 0.0897-inch- (2.3-mm-) thick expanded metal; welded to 0.0966-inch- (2.5-mm-) thick steel angle frame; with 0.0897-inch- (2.3-mm-) thick, cold-rolled steel sheet lock panel backed by 0.0528-inch- (1.35-mm-) thick, cold-rolled steel sheet retainer welded to door frame.

G. Hinges: Self-closing; welded to door and attached to door frame with not less than 2 factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.
   1. Continuous Hinges: Manufacturer's standard, steel continuous hinge; side or top mounted as required by locker configuration.

H. Recessed Door Handle and Latch: Stainless-steel cup with integral door pull, recessed so locking device does not protrude beyond face of door; pry resistant.
   1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in cylinder locks, or padlocks; positive automatic and prelocking.
      a. Latch Hooks: Equip doors 48 inches (1219 mm) and higher with 3 latch hooks ; fabricated from minimum 0.1116-inch- (2.8-mm-) thick steel; welded to full-height door strikes; with resilient silencer on each latch hook.
      b. Latching Mechanism: Manufacturer's standard rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

I. Combination Padlocks: Provided by Owner.

J. Equipment: Equip each metal locker with identification plate and the following, unless otherwise indicated:
   1. Single-Tier Units: Shelf, one double-prong ceiling hook, and two single-prong wall hooks.
   2. Coat Rods: For each compartment of single-tier metal lockers.

K. Accessories:
   1. Continuous Sloping Tops: Fabricated from minimum 0.0428-inch- (1.1-mm-) thick, cold-rolled steel sheet; approximately 20-degree pitch.
   2. Recess Trim: Fabricated from 0.0428-inch- (1.1-mm-) thick, cold-rolled steel sheet.
   3. Filler Panels: Fabricated from 0.0428-inch- (1.1-mm-) thick, cold-rolled steel sheet.
   4. Boxed End Panels: Fabricated from 0.0528-inch- (1.35-mm-) thick, cold-rolled steel sheet.

L. Finish: Powder coat.
   1. Color(s): As selected from manufacturer's full range.

2.3 LOCKER BENCHES

A. Bench Tops: Manufacturer's standard 1-piece units, of the following material, minimum 9-1/2 inches (240 mm) wide by 1-1/4 inches (32 mm) thick, with rounded corners and edges:
   1. Laminated maple with one coat of clear sealer on all surfaces, and one coat of clear lacquer on top and sides.

B. Freestanding Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top; complete with fasteners, and as follows:
   1. Stainless Steel: 1/8-inch-thick by 3-inch- (3-mm-thick by 76-mm-) wide channel or 1/4-inch-thick by 3-inch- (6-mm-thick by 76-mm-) wide bar stock, shaped into trapezoidal form; with nonskid pads at bottom.

2.4 FABRICATION

A. General: Fabricate metal lockers square, rigid, and without warp; with metal faces flat and free of dents or distortion. Make exposed metal edges free of sharp edges and burrs, and safe to touch.
   1. Form body panels, doors, shelves, and accessories from one-piece steel sheet, unless otherwise indicated.
   2. Provide fasteners, filler plates, supports, clips, and closures as required for a complete installation.

B. Unit Principle: Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.

C. All-Welded Construction: Factory preassemble metal lockers by welding all joints, seams, and connections, with no bolts, nuts, screws, or rivets used in assembly of main locker groups. Factory weld main locker groups into one-piece structures. Grind exposed welds flush.

D. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated.

E. Coat Rods: Fabricated from 1-inch- (25-mm-) diameter steel; nickel plated.

F. Identification Plates: Manufacturer's standard etched, embossed, or stamped aluminum plates; with numbers and letters at least 3/8 inch (9 mm) high.

G. Continuous Sloping Tops: Fabricated in lengths as long as practicable, without visible fasteners at splice locations; finished to match lockers. Sloped top corner fillers, mitered.

H. Recess Trim: Fabricated with minimum 2-1/2-inch (64-mm) face width and in lengths as long as practicable; finished to match lockers.

I. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip joint filler angle formed to receive filler panel.

J. Finished End Panels: Designed for concealing unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers. Provide one-piece panels for double-row (back-to-back) locker ends.

2.5 STEEL SHEET FINISHES

A. Powder-Coat Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard baked-polymer thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install level, plumb, and true; shim as required, using concealed shims.

1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches (910 mm) o.c. Install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion, using concealed fasteners.
2. Anchor single rows of metal lockers to walls near top and bottom of lockers.
3. Anchor back-to-back metal lockers to floor.

B. All-Welded Metal Lockers: Connect groups of all-welded metal lockers together with standard fasteners, with no exposed fasteners on face frames.

C. Equipment and Accessories: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
1. Attach hooks with at least two fasteners.
2. Identification Plates: Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
3. Attach recess trim to recessed metal lockers with concealed clips.
4. Attach filler panels with concealed fasteners.
5. Attach sloping top units to metal lockers, with closures at exposed ends.
6. Attach finished end panels with fasteners only at perimeter to conceal exposed ends of nonrecessed metal lockers.

D. Freestanding Locker Benches: Place benches in locations indicated on Drawings.

E. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.

END OF SECTION 10505

SECTION 10520 – FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fire protection cabinets for fire extinguishers, portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each exposed product and for each color and texture specified.

D. Maintenance data.

1.3 QUALITY ASSURANCE

A. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

C. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

D. Coordinate sizes and locations of fire protection cabinets with wall depths.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of hydrostatic test according to NFPA 10.
      b. Faulty operation of valves or release levers.
   2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

B. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:
   1. Sheet: ASTM B 209 (ASTM B 209M).
   2. Extruded Shapes: ASTM B 221 (ASTM B 221M).

C. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.2 FIRE PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher.

B. Cabinet Construction: 1-hour fire rated.
   1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.0428-inch- (1.1-mm-) thick, cold-rolled steel sheet lined with minimum 5/8-inch- (16-mm-) thick, fire-barrier material. Provide factory-drilled mounting holes.

C. Cabinet Material: Steel sheet.

D. Semirecessed Cabinet: Cabinet box partially recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend). Provide where walls are of insufficient depth for recessed cabinets but are of sufficient depth to accommodate semirecessed cabinet installation.
   1. Rolled-Edge Trim: 2-1/2-inch (64-mm) backbend depth.

E. Cabinet Trim Material: Same material and finish as door.

F. Door Material: Extruded-aluminum shapes.

G. Door Style: Fully glazed panel with frame.

H. Door Glazing: Tempered float glass (clear) .

I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

J. Accessories:
   1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
   2. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
   3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.

a. Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER."
   1) Location: Applied to cabinet glazing.
   2) Application Process: Pressure-sensitive vinyl letters.
   3) Lettering Color: White.
   4) Orientation: Vertical.

K. Finishes:
1. Manufacturer's standard baked-enamel paint for the following:
   a. Interior of cabinet.
2. Aluminum: Clear anodic .

2.3 FABRICATION

A. Fire Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated. Miter and weld joints and grind smooth.

2.4 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket indicated.
1. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose Dry-Chemical Type: UL-rated 2A-10B:C, 5 lb. capacity for Class A, B and C fires, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.
1. Provide at all locations, except provide 4A-60B:C, 10 lb. capacity at Mechanical and Equipment Rooms

2.5 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
   a. Orientation: Vertical.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine walls and partitions for suitable framing depth and blocking where semirecessed cabinets will be installed and prepare recesses as required by type and size of cabinet and trim style.

B. Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

C. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.

D. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.

E. Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

F. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

G. Identification: Apply vinyl lettering at locations indicated.

H. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

I. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10520

SECTION 10605 - WIRE MESH PARTITIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following items fabricated from wire mesh:
   1. Standard-duty, interior partitions.

B. See Division 08 Section "Door Hardware" for lock cylinders and keying for wire mesh partition doors and gates.

1.2 SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each exposed finish.

D. Maintenance data.

1.3 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Wire: ASTM A 510 (ASTM A 510M).

B. Steel Plates, Channels, Angles, and Bars: ASTM A 36/A 36M.

C. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

D. Steel Pipe: ASTM A 53/A 53M, Schedule 40, unless another weight is indicated or required by structural loads.

E. Square Steel Tubing: Cold-formed structural-steel tubing, ASTM A 500.

F. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating designation.

G. Panel-to-Panel Fasteners: Manufacturer's standard steel bolts.

H. Postinstalled Expansion Anchors in Concrete: Fabricated from corrosion-resistant materials; with capability to sustain, without failure, load imposed within factors of safety required, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

I. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated and fabricated from corrosion-resistant materials; with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, within factors of safety required, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

2.2 STANDARD-DUTY WIRE MESH PARTITIONS

A. Mesh: 0.135-inch- (3.5-mm-) diameter, intermediate-crimp steel wire woven into 1-1/2-inch (38-mm) diamond mesh.

B. Vertical Panel Framing: 1-1/4-by-5/8-by-0.0966-inch (32-by-16-by-2.5-mm) cold-rolled, C-shaped steel channels with 1/4-inch- (6-mm-) diameter bolt holes spaced not more than 18 inches (450 mm) o.c. along center of framing.

C. Horizontal Panel Framing: 1-by-1/2-by-1/8-inch (25-by-13-by-3-mm) cold-rolled steel channels.

D. Horizontal Panel Stiffeners: 1-by-1/2-by-1/8-inch (25-by-13-by-3-mm) cold-rolled steel channels with wire woven through, or two 1-by-3/8-by-1/8-inch (25-by-9.5-by-3-mm) cold-rolled steel channels bolted or riveted toe to toe through mesh.

E. Top Capping Bars: 2-1/4-by-1-inch (57-by-25-mm) cold-rolled steel channels.

F. Posts for 90-Degree Corners: 1-1/4-by-1-1/4-by-1/8-inch (32-by-32-by-3-mm) steel angles with 1/4-inch- (6-mm-) diameter bolt holes aligning with bolt holes in vertical framing; with floor anchor clips.

G. Line Posts: 3-inch-by-4.1-lb (76-mm-by-1.9-kg) or 3-1/2-by-1-1/4-by-0.1265-inch (89-by-32-by-3.2-mm) steel channels; with 5-by-18-by-1/4-inch (125-by-450-by-6-mm) steel base plates punched for attachment to floor.

H. Floor Shoes: Steel, cast iron, or cast aluminum, 2 inches (50 mm) high; sized to suit vertical framing, drilled for attachment to floor, and with set screws for leveling adjustment.

I. Swinging Doors: Fabricated from same mesh as partitions, with framing fabricated from 1-1/4-by-1/2-by-1/8-inch (32-by-13-by-3-mm) steel channels or C-channels, banded with 1-1/4-by-1/8-inch (32-by-3-mm) flat steel bar cover plates on 3 sides, and with 1/8-inch- (3-mm-) thick angle strike bar and cover on strike jamb.
   1. Hinges: Full-surface type, 3-by-3-inch (76-by-76-mm) steel, 1-1/2 pairs per door; bolted, riveted, or welded to door and jamb framing.
   2. Cylinder Lock: Mortise type operated by key outside and recessed knob inside.

J. Accessories: Adjustable filler panels and wall clips.

K. Finishes: Hot-dip galvanized, at first floor; baked-enamel finish at second floor.
   1. Color: As selected from manufacturer's full range.

2.3 FABRICATION

A. General: Fabricate wire mesh items from components of sizes not less than those indicated. Use larger-size components as recommended by wire mesh item manufacturer. Provide bolts, hardware, and accessories as required for complete installation.
   1. Fabricate wire mesh items to be readily disassembled.
   2. Welding: Weld corner joints of framing and finish sand .

B. Standard- Duty Wire Mesh Partitions: Fabricate wire mesh partitions with cutouts for pipes, ducts, beams, and other items indicated. Finish edges of cutouts to provide a neat, protective edge.
   1. Mesh: Securely clinch mesh to framing.
   2. Framing: Fabricate framing with mortise and tenon corner construction.
      a. Provide horizontal stiffeners as indicated or, if not indicated, as required by panel height and as recommended by wire mesh partition manufacturer. Weld horizontal stiffeners to vertical framing.
      b. Fabricate partition and door framing with slotted holes for connecting adjacent panels.
   3. Fabricate wire mesh partitions with 3 inches (76 mm) of clear space between finished floor and bottom horizontal framing.
   4. Doors: Align bottom of door with bottom of adjacent panels.
      a. For doors that do not extend full height of partition, provide transom over door, fabricated from same mesh and framing as partition panels.
   5. Hardware Preparation: Mortise, reinforce, drill, and tap doors and framing as required to install hardware.

2.4 FINISHES

A. Baked-Enamel Finish: Manufacturer's standard one-coat, baked-enamel finish with minimum dry film thickness of 1 mil (0.025 mm).

PART 3 - EXECUTION

3.1 ERECTION

A. Wire Mesh Partitions:
   1. Anchor wire mesh partitions to floor with 3/8-inch- (9.5-mm-) diameter, postinstalled expansion anchors at 12 inches (305 mm) o.c. through anchor clips or floor shoes located at each post and corner.
      a. Shim anchor clips as required to achieve level and plumb installation.
      b. Adjust wire mesh partition posts in floor shoes to achieve level and plumb installation.
   2. Anchor wire mesh partitions to walls at 12 inches (305 mm) o.c. through back corner panel framing with fasteners appropriate to substrate.
   3. Secure top capping bars to top framing channels with 1/4-inch- (6-mm-) diameter "U" bolts spaced not more than 28 inches (700 mm) o.c.
   4. Provide line posts as follows:
      a. On each side of sliding door openings.
      b. For partitions that are 7 to 9 feet (2.1 to 2.7 m) high, spaced at 15 to 20 feet (4.6 to 6.1 m) o.c.

c. For partitions that are 10 to 12 feet (3.0 to 3.7 m) high, located between every other panel.
d. For partitions that are more than 12 feet (3.7 m) high, located between each panel.

5. Where standard-width wire mesh partition panels do not fill entire length of run, provide adjustable filler panels to fill openings.
6. Install doors complete with door hardware.
7. Bolt accessories to wire mesh partition framing.

B. Adjust doors to operate easily without binding.

END OF SECTION 10605

SECTION 10651 - OPERABLE PANEL PARTITIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Electrically operated, acoustical panel partitions.

1.2 PERFORMANCE REQUIREMENTS

A. Acoustical Performance: Provide operable panel partitions tested by a qualified testing agency for the following acoustical properties according to test methods indicated:
   1. Sound-Transmission Requirements: Operable panel partition assembly tested for laboratory sound-transmission loss performance according to ASTM E 90, determined by ASTM E 413, and rated for not less than the STC indicated.
   2. Acoustical Performance Requirements: Installed operable panel partition assembly, identical to partition tested for STC, tested for NIC according to ASTM E 336, determined by ASTM E 413, and rated for 10 dB less than STC value indicated.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Indicate storage and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Samples: For each type of exposed material, finish, covering, or facing indicated.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinated with each other, based on input from installers of the items involved:

E. Setting Drawings: For embedded items and cutouts required in other work, including support-beam, mounting-hole template.

F. Product certificates.

G. Product test reports.

H. Field quality-control reports.

I. Operation and maintenance data.

J. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified according to Division 01 Section "Quality Requirements" for testing indicated.

C. Fire-Test-Response Characteristics: Provide panels with finishes meeting one of the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1. Surface-Burning Characteristics: As determined by testing per ASTM E 84.
      a. Flame-Spread Index: 25 or less .
      b. Smoke-Developed Index: 450 or less.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Preinstallation Conference: Conduct conference at Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of operable panel partitions that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Frame: Steel sheet, manufacturer's standard thickness.

B. Steel Face/Liner Sheets: Tension-leveled steel sheet, manufacturer's standard thickness.

2.2 OPERABLE ACOUSTICAL PANELS

A. Operable Acoustical Panels: Operable acoustical panel partition system, including panels, seals, finish facing, suspension system, operators, and accessories.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Skyfold Autolift Wall System as manufactured by Railteck Composites, Inc. or comparable product comply fully with performance criteria specified below.

B. Panel Operation: Electrically operated, vertically folding panels.
   1. Closed Position: Acoustical panels are hard, rigid, flat, plumb walls, made of a grid of rectangular acoustical panels.
   2. Opened Position: The acoustical panels when lifted (opened), fold upward (vertically) without the use of any manual albor, in a manner similar to an accordion, into a pocket in the ceiling.

C. Panel Construction: Provide reinforcement as required to support panel from suspension components and provide reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.
   1. In the down (closed) position, the wall shall be comprised of two vertical plans of acoustical panels separated by an acoustical air space.

D. Dimensions: Fabricate operable acoustical panel partitions to form an assembled system of dimensions indicated and verified by field measurements.

E. STC: Not less than 51.

F. Panel Closure: Manufacturer's standard.

G. Hardware: Manufacturer's standard as required to operate operable panel partition and accessories; with decorative, protective finish.

H. Each acoustical panel shall be individually removable using only a screw driver. No special tools or equipment shall be required. The removal of a single acoustical panel shall not affect, dislocate or cause the removal of any adjacent panels or other acoustical panels.

I. Weight: The operable wall shall not weight more than 8 lbs per square foot (39.1Kg per sq. m.), not including the lifting equipment and the architectural finish on the acoustical panels.

J. Design Life: The operable wall shall be designed to have a design life of at least 10,000 complete closed to opened to closed cycles.

2.3 SEALS

A. General: Provide types of seals indicated that produce operable panel partitions complying with acoustical performance requirements and the following:
   1. Manufacturer's standard seals.
   2. Seals made from materials and in profiles that minimize sound leakage.
   3. Seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between operable panel partition perimeter and adjacent surfaces, when operable panel partition is extended and closed.

B. Horizontal Bottom Seals: PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on floor when extended, ensuring horizontal sealing and resisting panel movement.
   1. Automatically Operated for Acoustical Panels: Extension and retraction of bottom seal automatically operated by movement of partition, with operating range not less than 1-1/2 inches (38 mm) between retracted seal and floor finish.

C. End Wall Seals: PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on walls when extended, ensuring vertical sealing and resisting panel movement.
   1. Automatically Operated for Acoustical Panels: Extension and retraction of end wall seals automatically operated by movement of partition, with operating range not less than 1 inch (25 mm) between retracted seal and wall finish. Seals that rub or brush against the end walls are not acceptable.

D. Top Seals: PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on ceiling when extended, ensuring horizontal sealing and resisting panel movement.
   1. Automatically Operated for Acoustical Panels: Extension and retraction of top seal automatically operated by movement of partition, with operating range not less than 1-3/4 inches (44 mm) between retracted seal and floor finish.

2.4 FINISH FACING

A. General: Provide finish facings for panels that comply with indicated fire-test-response characteristics and that are factory applied to operable panel partitions with appropriate backing, using mildew-resistant nonstaining adhesive as recommended by facing manufacturer's written instructions.

B. Facing Materials: Dry erase wall covering as specified in Division 9 "Wall Coverings".

C. Trimless Edges: Fabricate exposed panel edges so finish facing wraps uninterrupted around panel, covering edge and resulting in an installed partition with facing visible on vertical panel edges, without trim, for minimal sightlines at panel-to-panel joints.

2.5 FOLDING MECHANISM

A. The operable wall shall open and close in a manner similar to an accordion, in that all wall panels fold and unfold at the exact same time, at the exact same rate.
   1. Walls that rely on the sequential folding of acoustical panels, or acoustical panel sets are not acceptable.

B. The hanging, folding and extension mechanism shall be, as much as possible, made from structural grade aluminum extrusions and structural shapes, in order to minimize the weight of the system.

C. All wear surfaces, such as bushings, spacers, pins, discs, bearings, sleeves shall be designed to function quietly and with minimum wear, over the 10,000 cycle design life of the operable wall.

D. The hangers, which fasten the lifting mechanism to the support steel, shall be fabricated from steel and shall be welded or bolted to the support steel supplied by others.

2.6 LIFTING EQUIPMENT

A. The lifting equipment shall be sized properly so that it can open and close the wall effectively over the 10,000 cycle design life of the wall, at the minimum design speed specified.

B. The lifting mechanism shall be designed to function as smoothly, quietly and safely as possible. Wherever possible, ball bearings shall be used instead of bushings and wear surfaces. In no circumstance shall chain or belt drive systems be acceptable.

C. There shall be a wire rope cable for every set of lifting mechanisms. This cable shall be of 6 x 31 construction aircraft cable and shall be made of galvanized steel. The diameter of the cables shall be sized so that they shall be able to hold the entire weight of the wall, with the appropriate safety factor.

D. For the remote drive system, each wire rope cable shall wind and unwind on its own cable drum. The cable drums shall be grooved to accept a single layer of cable and shall have a minimum pitch diameter of 20 times the cable diameter. Length of drums shall be sufficient to accommodate 3 cable safety wraps. Cable drums shall be keyed to the line shaft.

E. The line shaft, sized to deliver the required torque with minimum deflection, shall support and rotate the cable drums.

F. Pillow block bearings (for the remote drive system), of appropriate size, support the line shaft and shall be located immediately on either side of each cable drum.

G. For the remote drive system, the line shaft shall be connected directly to the power drive through properly sized, load rated couplings, keyed to the line shaft.

H. The power drive shall be sized to deliver sufficient amount of torque to safely and effectively raise and lower the operable wall over its design life.

I. The lifting equipment shall use the latest in industry standards in thermal protection, overload protection, quick acting fuses, etc., in order to ensure the safety and reliability of the system.

2.7 SAFETY EQUIPMENT

A. The operable wall shall employ an electromagnetic type of brake which shall activate firmly, without hesitation, when power is lost to the system. This brake shall have a minimum retarding torque rating equal to 200% of the power drive full load torque. A manual break release lever is supplied on the motor.

B. The operable wall shall employ a dynamic brake, distinct and separate from the brake specified in previous paragraph, in order to lower the wall at a controlled speed of no more than approximately 150% of the normal down speed, in the case of a catastrophic failure in the power train. Alternately, the operable wall shall employ a brake, distinct and separate from the brake specified in previous paragraph, in order to completely halt the downward motion of the wall in the case of a catastrophic failure in the power train.

C. The operable wall shall employ electrical or other limit switches in order to stop the wall at its up and down travel limits.

D. The operable wall shall employ an over torque detector in order to sense a jam in the system and to act as an over travel limit in the up direction should the primary limit switch fail to act. This over torque sensor shall be mechanical, using the motor's torque arm in its over torque detection.

E. The entire length of the bottom edge of the operable wall shall be equipped with a continuous pressure sensing strip which shall cut power to the lifting equipment and shall activate the brake outlined in first paragraph of this article, if the sensing edge comes in firm contact with an object, before the wall is in the full down (closed) position. The power shall remain cut to the lifting equipment until the key switch has been released or the direction of the wall has been reversed and the obstruction is removed.

2.8 ELECTRIC OPERATORS

A. General: Provide factory-assembled electric operation system of size and capacity recommended and provided by operable panel partition manufacturer for partition specified; with electric motor and factory-prewired motor controls, speed reducer, chain drive, remote-control stations, control devices, and accessories required for proper operation. Include wiring from motor control to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

B. Comply with NFPA 70.

C. Control Equipment: Complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.

D. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1.

E. Remote Drive System: The motor/shaft/drum assembly shall be off-set from the center line of the operable wall. Provide support steel per manufacturer's requirements.

F. Remote-Control Stations: Two single-key-operated, constant-pressure control stations located on either side of the axis of the wall. Wire in series to require simultaneous activation of both key stations to operate partition. Each three-position control station labeled "Up," "Down," and "Off." Provide two keys per station.
   1. Turning the key from the "off" position shall cause the wall to move in the designated direction "up" or "down".
   2. When hand pressure is removed, the wall shall immediately stop. The operable wall shall stop in a quick and positive fashion without coasting.
   3. As a normal part of the operation, it shall be possible to partially open (or close) the wall, stop it and then reverse the operation.
   4. From a fully open position, the wall shall be able to go through its entire cycle of closing and/or opening without manual intervention.
   5. When the operable wall is being lowered (closed) it shall come automatically to rest once it has reached the fully down (closed) position.
   6. When the operable wall is being lifted (opened) it shall come automatically to rest once it has reached the fully up (opened) position.

G. Operation Speed: The operable wall shall open and close at a constant nominal speed of approximately 5 to 10 vertical feet per minute (1.5 to 3 meters per minute).

2.9 FABRICATION

A. Factory assemble all components, assemblies and systems into the largest possible assemblies in order to minimize the amount of assembly on site.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with ASTM E 557 except as otherwise required by operable panel partition manufacturer's written installation instructions.

B. Install operable panel partitions and accessories after other finishing operations, including painting, have been completed.

C. Install panels from marked packages in numbered sequence indicated on Shop Drawings.

D. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.

E. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted edges is not acceptable.

3.2 ADJUSTING

A. Adjust operable panel partitions to operate smoothly, without warping or binding. Lubricate hardware, electric operator, and other moving parts.

3.3 FIELD QUALITY CONTROL

A. Light-Leakage Test: Illuminate one side of partition installation and observe vertical joints and top and bottom seals for voids; adjust partitions for acceptable fit.

B. NIC Testing: Engage a qualified testing agency to perform tests and inspections.

C. Testing Methodology: Perform testing of installed operable panel partition for noise isolation according to ASTM E 336, determined by ASTM E 413, and rated for not less than NIC indicated. Adjust and fit partitions to comply with NIC test method requirements.

D. Testing Extent: Testing agency shall randomly select one operable panel partition installation(s) for testing.

E. Repair or replace operable panel partitions that do not comply with requirements.

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of repaired, replaced, or additional work with specified requirements.

G. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain operable panel partitions.

END OF SECTION 10651

SECTION 10801 – TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
1. Public-use washroom accessories.
2. Public-use shower room accessories.
3. Childcare accessories.
4. Underlavatory guards.
5. Custodial accessories.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Schedule:
1. Identify locations using room designations indicated on Drawings.
2. Identify products using designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 PUBLIC-USE WASHROOM ACCESSORIES

A. Toilet Tissue (Roll) Dispenser:
1. Description: Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
2. Mounting: Partition mounted serving two adjacent toilet compartments or surface mounted where partition mounted not practical.
3. Operation: Noncontrol delivery with theft-resistant spindle.
4. Capacity: Designed for 4-1/2- or 5-inch- (114- or 127-mm-) diameter tissue rolls.
5. Material and Finish: Stainless steel, No. 4 finish (satin).

B. Combination Towel (Folded) Dispenser/Waste Receptacle:
1. Description: Combination unit for dispensing C-fold or multifold towels, with removable waste receptacle.
2. Mounting: Semirecessed.
a. Designed for nominal 4-inch (100-mm) wall depth.
3. Minimum Towel-Dispenser Capacity: 600 C-fold or 800 multifold paper towels.
4. Minimum Waste-Receptacle Capacity: 12 gal. (45.4 L).
5. Material and Finish: Stainless steel, No. 4 finish (satin).
6. Liner: Reusable, vinyl waste-receptacle liner.
7. Lockset: Tumbler type for towel-dispenser compartment and waste receptacle.

C. Liquid-Soap Dispenser:
1. Description: Designed for dispensing soap in liquid or lotion form.
2. Mounting: Deck mounted on vanity.

D. Grab Bar:
1. Mounting: Flanges with concealed fasteners.
2. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
   a. Finish: Smooth, No. 4, satin finish.
3. Outside Diameter: 1-1/2 inches (38 mm).
4. Configuration and Length: As required to meet ADA requirements.

E. Vendor:
1. Type: Sanitary napkin and tampon.
2. Mounting: Semirecessed.
3. Exposed Material and Finish: Stainless steel, No. 4 finish (satin)
4. Lockset: Tumbler type with separate lock and key for coin box.

F. Sanitary-Napkin Disposal Unit:
1. Mounting: Partition mounted, dual access or surface mounted where partition mounted not practical.
2. Door or Cover: Self-closing disposal-opening cover and hinged face panel with tumbler lockset.
3. Receptacle: Removable.
4. Material and Finish: Stainless steel, No. 4 finish (satin).

G. Seat-Cover Dispenser:
1. Mounting: Recessed.
2. Exposed Material and Finish: Stainless steel, No. 4 finish (satin).
3. Lockset: Tumbler type.

H. Mirror Unit:
1. Refer to Division 8 Section, "Mirrors".
2. Provide mirrors across full length of vanity top, from top of splash to underside of ceiling or soffit

2.2 PUBLIC-USE SHOWER ROOM ACCESSORIES

A. Shower Curtain Rod:
1. Description: 1-1/4-inch (32-mm) OD; fabricated from nominal 0.05-inch- (1.3-mm-) thick stainless steel.
2. Mounting Flanges: Stainless-steel flanges designed for exposed fasteners.
3. Finish: No. 4 (satin).

B. Shower Curtain:
1. Size: Minimum 6 inches (152 mm) wider than opening by 72 inches (1828 mm) high.
2. Material: Nylon-reinforced vinyl, minimum 10-oz. (284-g) or 0.008-inch- (0.2-mm-) thick vinyl, with integral antibacterial agent.
3. Color: White.
4. Grommets: Corrosion resistant at minimum 6 inches (152 mm) o.c. through top hem.
5. Shower Curtain Hooks: Chrome-plated or stainless-steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

C. Folding Shower Seat:
1. Configuration: L-shaped seat, designed for wheelchair access.
2. Seat: Phenolic or polymeric composite of slat-type or one-piece construction.
3. Mounting Mechanism: Stainless steel, No. 4 finish (satin).

D. Grab Bar:
1. Mounting: Flanges with concealed fasteners.
2. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
    1) Finish: Smooth, No. 4, satin finish on ends and slip-resistant texture in grip area.
3. Outside Diameter: 1-1/2 inches (38 mm).
4. Configuration and Length: As required to meet ADA requirements.

E. Soap Dish:
1. Description: With washcloth bar.
2. Mounting: Surface mounted.
3. Material and Finish: Stainless steel, No. 4 finish (satin).

2.3 CHILDCARE ACCESSORIES

A. Diaper-Changing Station:
1. Description: Horizontal or vertical unit that opens by folding down from stored position and with child-protection strap.
    a. Engineered to support a minimum of 300-lb (136-kg) static load when opened.
2. Mounting: Surface mounted, with unit projecting not more than 4 inches (100 mm) from wall when closed.
3. Operation: By pneumatic shock-absorbing mechanism.
4. Material and Finish: High-density polyethylene with plastic laminate insert in color selected by Architect Stainless steel, No. 4 finish (satin), exterior shell with rounded plastic corners; high-density polyethylene interior in manufacturer's standard color.
5. Liner Dispenser: Built in.

2.4 UNDERLAVATORY GUARDS

A. Underlavatory Guard:
1. Description: Insulating pipe covering for supply and drain piping assemblies, that prevent direct contact with and burns from piping, and allow service access without removing coverings.
2. Material and Finish: Antimicrobial, molded-plastic, white.

2.5 CUSTODIAL ACCESSORIES

A. Mop and Broom Holder:
1. Description: Unit with shelf, hooks, and holders.
2. Length: 34 inches (865 mm).
3. Hooks: Four.
4. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
5. Material and Finish: Stainless steel, No. 4 finish (satin).
    a. Shelf: Not less than nominal 0.05-inch- (1.2-mm-) thick stainless steel.

B. Paper Towel (Folded) Dispenser:
1. Mounting: Surface mounted.
2. Minimum Capacity: 400 C-fold or 525 multifold towels.
3. Material and Finish: Stainless steel, No. 4 finish (satin).
4. Lockset: Tumbler type.
5. Refill Indicators: Pierced slots at sides or front.

C. Liquid-Soap Dispenser:
   1. Description: Designed for dispensing soap in liquid or lotion form.
   2. Mounting: Horizontally or vertically oriented, surface mounted.
   3. Lockset: Tumbler type.
   4. Refill Indicator: Window type.

2.6 FABRICATION

A. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

END OF SECTION 10801

SECTION 11132 - PROJECTION SCREENS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes front-projection screens.

B. See Division 16 Sections for electrical service and connections including metal device boxes for switches and conduit, where required, for low-voltage control wiring.

1.2 SUBMITTALS

A. Product Data: For each type of screen indicated.

B. Shop Drawings: Show layouts and types of projection screens. Include the following:
   1. Location of screen centerline relative to ends of screen case.
   2. Location of wiring connections.
   3. Connections to supporting structure recess-mounted screens.
   4. Anchorage details.
   5. Wiring Diagrams: For electrically operated units.

PART 2 - PRODUCTS

2.1 FRONT-PROJECTION SCREENS

A. Electrically Operated Screens, General: Manufacturer's standard units consisting of case, screen, motor, controls, mounting accessories, and other components necessary for a complete installation.
   1. Low-Voltage Control: System consisting of a control unit with 24-V power supply, remote 3-button or 3-position switches, and interconnecting wiring.
      a. Provide key-operated power-supply switch.
      b. Provide infrared remote control consisting of battery-powered transmitter and receiver for use with low-voltage control system.
   2. End-Mounted Motor: Instant-reversing, gear-drive motor with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches, and positive-stop action to prevent coasting.
   3. Tab Tensioning: Units have stainless-steel tensioning cables on both sides of screen connected to edges of screen by tabs to pull screen flat horizontally.

B. Recessed, Electrically Operated Screens with Automatic Ceiling Closure: End-mounted motor units designed and fabricated for recessed installation in ceiling; with bottom of case composed of two panels: one panel designed to open and close automatically, the other removable or openable for access to interior of case.

C. Screen Material and Viewing Surface:

1. Matte-White Viewing Surface: Peak gain of 0.9 to 1.0, and gain of not less than 0.8 at an angle of 60 degrees from the axis of the screen surface, or
2. Seamless Construction: Provide screens, in sizes indicated, without seams.
3. Edge Treatment: Black masking borders.
4. Size of Viewing Surface: 60 by 80 inches (1524 by 2032 mm) .

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.
   1. Install low-voltage controls according to NFPA 70 and manufacturer's written instructions.
      a. Wiring Method: Install wiring in raceway except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
   2. Test electrically operated units to verify that screen controls, limit switches, closure, and other operating components are in optimum functioning condition.

END OF SECTION 11132

SECTION 11160 - LOADING DOCK EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Dock bumpers.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Maintenance data.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

PART 2 - PRODUCTS

2.1 DOCK BUMPERS

A. Molded-Rubber Bumpers: Fabricated from molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Type A Shore durometer hardness of 80, plus or minus 5, when tested according to ASTM D 2240; of size and configuration requiired for application. Fabricate units with not less than two predrilled anchor holes.

B. Anchorage Devices: Hot-dip galvanized.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Dock Bumpers: Attach dock bumpers to face of loading dock in a manner that complies with requirements indicated for spacing, arrangement, and position relative to top of platform and anchorage.
   1. Bolted Attachment: Attach dock bumpers to preset anchor bolts embedded in concrete or to cast-in-place inserts or threaded studs welded to embedded-steel plates or angles. If preset anchor bolts, cast-in-place inserts, or threaded studs welded to embedded-steel plates or angles are not provided, attach dock bumpers by drilling and anchoring with expansion anchors and bolts.

3.2 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain loading dock equipment. Refer to Division 01 Section Demonstration and Training."

3.3 LOADING DOCK EQUIPMENT SCHEDULE

END OF SECTION 11160

SECTION 11458 – DISAPPEARING STAIRWAYS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. One (1) fire-rated disappearing stairway.

1.2 SUBMITTALS

A. Product Data: For each type of product specified.

B. Shop Drawings: Show the following:
   1. Showing fabrication and installation, including fully dimensioned plans, elevations, sections, details of components and attachments to other units of Work.
   2. Show layout, anchorage details, rough-in requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers/Products: Subject to compliance with requirements, manufacturers/ products that may be incorporated in the Work include, but are not limited to, the following:
   1. Precision Stair Corp.; Super Simplex Disappearing Stairway.

2.2 DISAPPEARING STAIRWAY

A. General: Fabricate unit to withstand and support 500 lbs. Construct unit with a minimum 1/8" thick (formed channel) steel box; 6" deep with a one-hour rated fire door.

B. Risers: Maximum 9-1/2-inches (240 mm) height.

C. Treads: Skid serrated (rubber on aluminum).

D. Hardware: Cadmium plated.

E. Size: 30-inches (760 mm) x 54-inches (1370 mm).

F. Fire Door: 1-3/4-inches (32 mm) 'B' label recessed into frame flush with bottom lip.

G. Door Hinge: Steel piano.

H. Side Runner: 5-inches (127 mm) aluminum.

I. Operation: Pole operated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with manufacturer's instructions and recommendations.

B. Anchor units securely to supporting structural substrates, adequate to withstand specified loading.

3.2 CLEANING AND PROTECTION

A. Clean exposed metal and other surfaces according to manufacturer's instructions. Touch-up damaged metal coatings.

END OF SECTION 11458

SECTION 12485 - FOOT GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes recessed foot grilles and frames.

1.2 SUBMITTALS

A. Product Data: For each type of foot grille and frame.

B. Shop Drawings: Show the following:
   1. Items penetrating foot grilles and frames.
   2. Divisions between grille sections.
   3. Perimeter floor moldings.

C. Samples: For each type of product involving color selection.
   1. Foot Grille: 12-inch- (300-mm-) square assembled sections.
   2. Frame Members: 12-inch- (300-mm-) long Sample of each type and color.

D. Maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Basis-of-Design Product: Subject to compliance with requirements, provide C/S Group – "Gridline G6" or a comparable product.

2.2 MATERIALS

A. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304.

B. Stainless-Steel Angles: ASTM A 276 or ASTM A 479/A 479M, corrosion resistant, Type 304.

2.3 FOOT GRILLES

A. Stainless-Steel Foot Grille:
   1. Surface Treads: Wires to be 0.086-by-0.177-inch (2.18-by-2.97-mm) electronically welded and spaced 0.118-inch- (2.99-mm) apart.
   2. Support Rods: Spaced 1 inch (25 mm) o.c., welded to each wire.
   3. Load Capacity: Unit must withstand 500 lb. wheel loads (load applied to a solid 5" x 2" wide polyurethane wheel, 1000 passes without damage).
   4. Pit Grating: 1-1/8 inches (28.5 mm) deep.
   5. Stainless-Steel Finish: Satin finish.

6. Grille Size:
   a. Width: Extend a minimum of 8" pass entrance opening on both sides.
   b. Depth: A minimum of 48 inches (122 cm).

2.4 FRAMES

A. Provide manufacturer's standard frames of size and style for grille type.

2.5 FABRICATION

A. Shop fabricate foot grilles to greatest extent possible in sizes as indicated.

B. Fabricate frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install recessed foot grilles and frames to comply with manufacturer's written instructions at locations indicated and with top of foot grilles and frames in relationship to one another and to adjoining finished flooring as recommended by manufacturer. Set foot-grille tops at height for most effective cleaning action.

3.2 PROTECTION

A. After completing frame installations, provide temporary filler of plywood or fiberboard in foot-grille recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

END OF SECTION 12485

SECTION 12610 - FIXED AUDIENCE SEATING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fixed audience seating with the following:
   1. Beam mounting.
   2. Molded-plastic chairs with upholstered inserts.
   3. Self-rising seat mechanism.
   4. Self-storing tablet arms for each chair[Upholstered] [Molded-plastic].
   5. Each chair equipped with 120 volt, A.C. power.
   6. Each chair provided with capacity for being wired for data transmission; wiring and apparatus provided by Owner.

B. See Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Seating Layout: Show seating layout, aisle widths, row-lettering and chair-numbering scheme, chair widths, and chair spacing in each row.
   2. Accessories: Show accessories, including locations of left- and right-hand tablet arms, electrical devices, accessibility provisions, and attachments to other work.

C. Samples: For each seating component and for each color and texture required.
   1. Two-Seat Unit: Full size with finishes and accessories specified.
      a. Approved Sample may become part of completed Work.
   2. Upholstery Fabric: Full-width Sample, not less than 36 inches long, with fabric treatments applied. Show complete pattern repeat. Mark top and right side.
   3. Molded Plastic: Manufacturer's standard-size unit, not less than 3 inches square.
   4. Exposed Fasteners: Full-size units of each type.

D. Product Certificates: For each type of flame-retardant treatment of fabric, from manufacturer.

E. Maintenance Data.

1.3 QUALITY ASSURANCE

A. Upholstery Fabric Source Limitations: Obtain fabric of a single dye lot for each color and pattern of fabric required.

B. Retain first paragraph below if seating unit components made of wood are required to be certified for

C. Fire-Test-Response Characteristics of Upholstered Chairs: As required by code.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockups for the types of fixed audience seating including fabric, finishes, and accessories:
      a. Size: Two typical seats or a typical two-seat unit.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Preinstallation Conference: Conduct conference at Project site.

1.4 COORDINATION

A. Coordinate layout and installation of electrical wiring and devices with seating layout to ensure that floor junction boxes for electrical devices are accurately located to allow connection without exposed conduit.

1.5 EXTRA MATERIALS

A. Furnish extra materials from the same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Chair Seats and Backs: Furnish a quantity of full-size units equal to 5 percent of amount installed for each type and size of chair seat and back.
   2. Tablet Arms: Furnish a quantity of full-size units equal to 5 percent of amount installed for each type and size of tablet arm.
   3. Armrests: Furnish a quantity of full-size units equal to 5 percent of amount installed for each type of armrest.

PART 2 - PRODUCTS

2.1 MATERIALS AND FINISHES

A. Steel: ASTM A 36/A 36M plates, shapes, and bars; ASTM A 513 mechanical tubing; ASTM A 1008/A 1008M cold-rolled sheet; and ASTM A 1011 hot-rolled sheet and strip.

B. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.

C. Concealed Plywood: HPVA HP-1 hardwood plywood, made with adhesive containing no urea formaldehyde, or DOC PS 1 softwood plywood, as standard with manufacturer.

D. Plastic Laminate: NEMA LD 3, Grade VGS for vertical surfaces and Grade HGS for horizontal surfaces.
   1. Color and Pattern: As selected from manufacturer's full range.

E. Fabric: Manufacturer's standard 100 percent polyolefin with flame-retardant treatment.
   1. Weight: 18 oz./linear yd. (0.56 kg/linear m) .

2. Color and Pattern: As selected from manufacturer's full range.

F. Molded Plastic: High-density polyethylene or polypropylene, blow or injection molded, with smooth or textured surface that is mar and dent resistant.
1. Color and Texture: As selected from manufacturer's full range.

2.2 FIXED AUDIENCE SEATING

A. Fixed Audience Seating: Interior assembly-space seating in permanent arrangement Insert description here as shown on Drawings.

B. Chair Mounting Beam: Steel horizontal beam mounted on riser-attached steel support pedestals.

C. Fabric Upholstered Chairs:
1. Backs:
a. Padding Thickness: 2 inches (51 mm) .
b. Rear Panel: Molded plastic.
c. Top Corners: Rounded.
2. Seats: Two part and as follows:
a. Padding Thickness: Minimum 3 inches (76 mm) at front and rear edge.
b. Seat Underside: Molded-plastic shell.

D. Chair Width: Single width chair in each row, with minimum chair width of 22 inches (559 mm) from center to center of armrests.

E. Back Height: Standard-style backs.

F. Back Pitch: Fixed.

G. Self-Rising Seat Mechanism: Spring-actuated, three-quarter fold .

H. Armrests: Plastic with rounded edges, concealed mounting.

I. Tablet Arms: Manufacturer's oversize, fold away tablet arm with plastic-laminate writing surface over medium-density fiberboard or plywood core and with rounded, matching PVC edges.

J. Accessible Seating:
1. Provide rollaway chairs where wheelchair spaces are required.

2.3 WIRE MANAGEMENT SYSTEM

A. General: A wire management system shall be provided for the seating, allotting each chair with convenient use of the following electrical power and data services:
1. A conveniently located receptacle, 120 volt, A.C., electrical power- minimum of one receptacle per chair.
2. A conveniently located position for an owner-provided telecommunications/data connector – minimum of one receptacle per chair.
3. Power system shall be suitable for connection to the building's power souces; and data services shall be by other trades, utilizing data wiring raceways provided with the chair.

4. All power electrical components shall be Underwriters' Laboratories listed, and all electrical systems shall conform to Article #604 of the National Electric Code.

B. Wire Management Raceways: All chair rows shall be fitted their entire length with formed steel conduit troughs to control power and data wiring, and maintain wiring out of sight beneath the chairs, preventing loose loops of wire which may promote snagging. The raceways shall be sufficiently flexible to allow chairs to be installed on a radius.

C. Power Wiring: A 120 volt, A.C., power shall be provided throughout the system by means of a wire harness running the length of each chair row, with flexible metallic conduit. Power shall be provided to each chair by means of a 3-prong grounded receptacle. Power wiring shall be transmitted along chair rows via 16ga. Formed steel raceways MIG-welded to the rear of chair standards, located to prevent interference with the operation of the self-lifting seats.

D. Power / Data Ports: A120 volt, A.C., 3 prong power receptacle shall be provided for each chair, securely mounted in the standard immediately beneath the armrest to the right hand side of the chair, and shll be provided complete with connection to the 120 volt power source. Accommodation shall be made for a Category 5 data port adjacent to the power receptacle, for provision and connection by the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install seating in locations indicated and fastened securely to substrates according to manufacturer's written installation instructions.
   1. Use installation methods and fasteners that produce fixed audience seating assemblies with individual chairs capable of supporting an evenly distributed 600-lb (272-kg) static load without failure or other conditions that might impair the chair's usefulness.
   2. Install standards and pedestals plumb.

B. Install riser-mounted attachments to maintain uniform chair heights above floor.

C. Install seating so moving components operate smoothly and quietly.

D. Install wiring conductors and cables concealed in components of seating and accessible for servicing.

END OF SECTION 12610

SECTION 13915 - FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following fire-suppression piping inside the building:

1. Automatic wet-type, Class I standpipe systems.
2. Wet-pipe sprinkler systems.

B. See Division 10 Section "Fire-Protection Specialties" for cabinets and fire extinguishers.

C. See Division 13 Section "Fire Alarm" for alarm devices not specified in this Section.

1.2 SYSTEM DESCRIPTIONS

A. Automatic Wet-Type, Class I Standpipe System: Includes NPS 1-1/2 hose stations. Has open water-supply valve with pressure maintained.

B. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device.

1.3 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.

B. Fire-suppression standpipe system design shall be approved by the Engineer.

1. Minimum Residual Pressure at Each Hose-Connection Outlet: No minimum.
2. Maximum Residual Pressure at Required Flow at Each Hose-Connection Outlet: 100 psig.

C. Fire-suppression sprinkler system design shall be hydraulically designed and approved by the Engineer.

1. Margin of Safety for Available Water Pressure: 5 psi or 10 percent, whichever is greater, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications:

   a. Business and Assembly occupancy areas: Light hazard.
   b. Storage and Mechanical Equipment areas: Ordinary hazard Group 2.

3. Minimum Density and Hose Stream Allowance for Automatic-Sprinkler Piping Design:

   a. Light-Hazard Occupancy: 0.10 gpm/sq.ft. over 3000 sq. ft., 250 gpm hose stream allowance.

b. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm/sq. ft. over 3000 sq. ft., 500 gpm hose stream allowance.

4. Maximum Protection Area per Sprinkler:

a. Light hazard areas: 225 sq. ft.
b. Ordinary hazard areas: 130 sq. ft.

D. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13.

1.4 SUBMITTALS

A. Product Data: For each product indicated.

B. Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, including hydraulic calculations.

C. Field test reports and certificates, including certificate that work complies with NFPA 13 and ETL-1110-3-485..

D. Field quality-control test reports.

E. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

1. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a registered professional fire protection engineer or an individual who has obtained NICET Level III certification in Automatic Sprinklers.

2. Licensing and experience: Installer shall be licensed in Louisiana for design and installation of sprinkler systems and shall have at least five years of successful installation experience on projects with fire protection systems work similar to that required for project.

B. Manufacturer Qualifications: Manufacturers shall be regularly engaged in manufacture of fire protection system products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than five years.

C. Codes and Standards: Fire-suppression-system design, equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."
2. NFPA 14, "Installation of Standpipe, Private Hydrant, and Hose Systems."
3. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."
4. DOD Unified Facilities Criteria UFC 3-600-01

5. ETL-1110-3-485

D. UL Labels: Provide fire protection products that have been approved and labeled by Underwriters Laboratories or FM Global.

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends.

1. Cast-Iron Threaded Flanges: ASME B16.1.
2. Malleable-Iron Threaded Fittings: ASME B16.3.
3. Gray-Iron Threaded Fittings: ASME B16.4.
4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
5. Steel Threaded Couplings: ASTM A 865.

B. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed, square-cut- or roll-grooved ends.

1. Grooved-Joint Piping Systems:

a. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
b. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

C. Plain End Type Fittings: Not permitted.

2.2 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.

B. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.

C. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

D. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

2.3 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

B. Butterfly Valves: UL 1091.

1. NPS 2 and Smaller: Bronze body with threaded ends.

2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with grooved ends.

C. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.

D. Gate Valves: UL 262, OS&Y type.

1. NPS 2 and Smaller: Bronze body with threaded ends.

2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.

2.4 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

B. Automatic Sprinklers: Quick response type.

C. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise required by application.

D. Sprinkler Types and Finishes:

1. White finish, pendent or flush type with white ceiling plate, Central Model C-1 or Viking Model M or approved equal, where used in areas with suspended ceilings. Plain upright type Central Model A or Viking Model M or approved equal, in unfinished areas.
2. Dry horizontal type, chrome plated for use beneath outdoor canopies.

E. Sprinkler Escutcheons:

1. Ceiling and sidewall mounting: Chrome-plated steel, one or two piece, flat.

2.5 HOSE CONNECTIONS

A. Description: UL 668, brass or bronze, 300-psig minimum pressure rating, hose valve for connecting fire hose. Female inlet and male 2-1/2 in. hose outlet; and lugged cap, gasket, and chain.

1. Valve Operation: Pressure-regulating type.
2. Finish: Rough.

2.6 FIRE DEPARTMENT CONNECTIONS

A. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Potter-Roemer No. 5348 or approved equal. Provide polished brass and drop clappers.

B. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."

1. Type: Flush, with two inlets and square or rectangular escutcheon plate.
2. Type: Exposed, projecting, with two inlets and round escutcheon plate.
3. Finish: Rough chrome-plated.

2.7 ALARM DEVICES

A. Alarm-device types shall be electric type.

B. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

C. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

2.8 PRESSURE GAGES

1. Description: UL 393, 3-1/2- to 4-1/2-inch diameter, dial pressure gage with range of 0 to 250 psig minimum. Include caption "WATER" or "AIR/WATER" on dial face.

2.9 BACKFLOW PREVENTER

1. UL listed or FMG approved, double check valve backflow preventer.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS, GENERAL

A. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications..

B. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe.

C. Underground Service-Entrance Piping: Ductile-iron, grooved-end pipe and fittings; grooved-end-pipe couplings; and grooved joints.

D. Location of fire department connection shall be approved in writing by Owner and local fire department.

E. Provide pipe markers and valve tags complying with Division 15.

3.2 SPRINKLER AND STANDPIPE SYSTEM PIPING APPLICATIONS

A. NPS 1-1/2 and Smaller: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.

B. NPS 2 and Larger: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.

C. NPS 2 and Larger: Grooved-end, black, standard-weight or schedule 10 (roll groove only) steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

D. NPS 2 and Larger: Schedule 10 pipe with wrought steel butt weld fittings.

3.3 VALVE APPLICATIONS

1. Listed Fire-Protection Valves:

   a. Shutoff Duty: Use UL listed butterfly or gate valves with valve tamper switches.

2. Unlisted General-Duty Valves:

   a. Shutoff Duty: Use gate valves.

3. Check valves:

   a. Use swing check valves.

3.4 JOINT CONSTRUCTION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40.

C. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.

1. Ductile-Iron Pipe: Radius-cut-groove ends of piping. Use grooved-end fittings and grooved-end-pipe couplings.
2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.

3.5 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression piping to water-service piping of size and in location for service entrance to building.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories at connection to water-service piping.

3.6 PIPING INSTALLATION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping installation.

B. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

C. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

D. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

E. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

F. Install sprinkler piping with drains for complete system drainage.

G. Install sprinkler floor control valves, test assemblies, and drain risers adjacent to standpipes.

H. Install drain valves on standpipes.

I. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

J. Install waterflow and valve tamper alarm devices.

K. Hangers and Supports: Comply with NFPA 13 for hanger materials.

1. Install standpipe system piping according to NFPA 14.
2. Install sprinkler system piping according to NFPA 13.
3. Use adjustable steel clevises and adjustable steel band hangers for horizontal piping.
4. Use two bolt riser clamps for vertical piping supports.
5. Use steel turnbuckles and malleable iron sockets for hanger rod attachments. Use concrete inserts, top beam c-clamps, side beam or channel clamps and center beam clamps for building attachments.
6. Piping shall not be suspended from light fixtures, ductwork or ceinling accessories.

L. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.

M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft

metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

N. Install tamper switches on all control valves, and install waterflow switches per the plans.

O. Fill system piping with water.

3.7 VALVE INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 14.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install backflow preventer.

D. Floor Control Valve Assemblies: Install at each floor at each standpipe connection.

3.8 SPRINKLER INSTALLATION

A. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.9 HOSE-CONNECTION INSTALLATION

A. Install hose connections at standpipes.

3.10 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire department connections in vertical wall. Install ¾ in. cast brass ball drip valve at check valve for fire department connection.

3.11 CONNECTIONS

A. Install piping to allow service and maintenance.

B. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping.

C. Install ball drip valves at check valve for fire department connection. Drain to floor drain or outside building.

D. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

3.12 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14.

3.13 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Flush, test, and inspect sprinkler and standpipe systems according to NFPA 13 and NFPA 14.
3. Coordinate with fire alarm tests. Operate as required.
4. Verify that equipment hose threads are same as local fire department equipment.

B. Report test results promptly and in writing to Engineer.

END OF SECTION 13915

SECTION 14210 - ELECTRIC TRACTION ELEVATORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes electric traction passenger elevators.

B. See Division 09 Section "Resilient Flooring" for finish flooring in elevator cars.

1.2 SUBMITTALS

A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information.

B. Shop Drawings: Show plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment and signals. Indicate loads imposed on building structure at points of support, and maximum and average power demands.

C. Samples: For exposed finishes.

D. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.

E. Operation and maintenance data.

F. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with ASME A17.1 and elevator design requirements for earthquake loads in ASCE 7.

B. Accessibility Requirements: Comply with Section 4.10 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."

1.4 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective elevator work within specified warranty period.
   1. Warranty Period: One year from date of Substantial Completion.

1.5 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide one year's full maintenance service by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Otis Elevator Co., Machnie Room-less Gen2™ traction passenger elevator or a comparable product.

2.2 SYSTEMS AND COMPONENTS

A. General: Provide manufacturer's standard elevator systems, including standard components published by manufacturer as included in standard preengineered elevator systems and as required for complete system.

B. Machine: AC gearless machine, with a synchronous permanent-magnet motor, dual solenoid service and emergency disc brakes, mounted at the top of the hoistway.

C. Governor: The governor shall be a tension type governor.

D. Buffers, Car and Counterweight: Compression spring type buffers shall be used.

E. Hoistway Operating Devices
1. Emergency stop switch in the pit.
2. Terminal stopping switches.

F. Positioning System: Consists of an encoder, reader box, and door zone vanes.

G. Guide Rails and Attachments: Guide rails shall be tee-section steel rails with brackets and fasteners. Side counterweight arrangements shall have a dual-purpose bracket that combines both counterweight guide rails, and one of the car guide rails to building fastening.

H. Coated Steel Belts: Polyurethane coated belts with high-tensil-grade, zinc-plated steel cords.

I. Governor Rope: Governor rope shall be steel and shall consist of at least eight strands wound about a sisal core center.

J. Fascia: Galvanized sheet steel shall be provided at the front of the hoistway.

K. Carframe and Safety: A carframe fabricated from formed or structural steel members shall be provided with adequate bracing to support the platform and car enclosures. The car safety shall be integral to the carframe and shall be Type "B", flexible guide clamp type.

L. Emergency Car Lighting: An emergency power unit employing a 6-volt sealed rechargeable battery and totally static circuits shall be provided to illuminate the elevator car and provide current to the alarm bell in the event of building power failure.

M. Emergency Pulsating Sire: Siren mounted on top of the car that is activated when the alarm button in the car operating panel is engaged. Siren shall have a rated sound pressure level of 80 dB(A) at a distance of 3.0 m from the device. Siren shall respond with a delay of not more than 1 second after the switch or push button has been pressed.

N. Fan: A two speed 120 VAC fan shall be mounted to the structural ceiling to facilitate in-car air circulation, meeting A17.1 code requirements. This two-speed fan shall produce airflow rates of 7.2 and 9.2 m^3/min on low and high setting, respectively. The fan shall be rubber mounted to prevent the transmission of structural vibration and shall include a baffle to diffuse audible noise. A swith shall be provided in the car-operating panel to control the fan.

O. Emergency Exit Contact: An electrical contact shall be provded on the car-top exit.

P. Roller Guides: Rubber roller guides shall be mounted on the top and the bottom of the car and counterweight. Car roller guides shall be 6-1/4" (160 mm) at the top and bottom of the car. The counterweight roller guides shall be 3" (76 mm) at the top and the bottom.

Q. Platform: The car platform shall be constructed of 2 layers of plywood and 2 layers of .032-inch (.81 mm) thick aluminum laminate for a total thickness of 1-1/2 inches (38 mm). Load weighing device shall be mouned under the platform.

2.3 OPERATION SYSTEMS

A. General: Provide manufacturer's standard microprocessor operation system as required to provide type of operation system indicated.

B. Controller Location: Controller shall be located adjacent to the hoistway at the top landing in a controller space or a control room.

C. Auxiliary Operations:
1. Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel.
2. Battery-Powered Lowering: If power fails and car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to the next floor below, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.

D. Security Feature: Security feature shall not affect emergency firefighters' service.
1. Card-Reader Operation: System uses card readers at car control stations to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Allow space as indicated for card reader in car.
a. Security access system equipment as required by LARNG.

2.4 DOOR REOPENING DEVICES

A. Infrared Array: Provide door reopening devices with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more of the light beams shall cause doors to stop and reopen.

B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

2.5 FINISH MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.

C. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.

D. Stainless-Steel Bars: ASTM A 276, Type 304.

E. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.

F. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063.

2.6 CAR ENCLOSURES

A. General: Provide steel-framed car enclosures with nonremovable wall panels, with car roof, access doors, power door operators, and ventilation.
   1. Provide standard railings complying with ASME A17.1 on car tops where required by ASME A17.1.
   2. Stainless-Steel Wall Panels: Flush, hollow-metal construction.
   3. Stainless-Steel Doors: Flush, hollow-metal construction.
   4. Sills: Extruded aluminum, with grooved surface, 1/4 inch (6.4 mm) thick.
   5. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.

2.7 HOISTWAY ENTRANCES

A. General: Provide manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories.
   1. Where gypsum board wall construction is indicated, provide self-supporting frames with reinforced head sections.

B. Materials and Fabrication: Provide manufacturer's standards, but not less than the following:
   1. Stainless-Steel Frames: Formed from stainless-steel sheet.
   2. Stainless-Steel Doors: Flush, hollow-metal construction.
   3. Sills: Extruded aluminum, with grooved surface, 1/4 inch (6.4 mm) thick.
   4. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

2.8 SIGNAL EQUIPMENT

A. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements with long-life incandescent lamps and acrylic or other permanent, nonyellowing translucent plastic diffusers or LEDs.

B. Car Control Stations: Provide manufacturer's standard car control stations. Mount in return panel adjacent to car door, unless otherwise indicated.

C. Emergency Communication System: Provide system that complies with ASME A17.1 and the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)." On activation, system dials preprogrammed number of monitoring station and identifies elevator location to monitoring station. System provides two-way voice communication without using a handset and provides visible signals that indicate when system has been activated and when monitoring station has responded. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

D. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Division 28 Section "Fire Detection and Alarm."

E. Car Position Indicator: Provide illuminated, digital-type car position indicator, located above car door or above car control station. Also provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served.
   1. Include travel direction arrows if not provided in car control station.

F. Hall Push-Button Stations: Provide hall push-button stations at each landing as indicated.

G. Hall Lanterns: Units with illuminated arrows.
   1. Units mounted in both jambs of entrance frame.

H. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.

I. Corridor Call Station Pictograph Signs: Provide signs matching hall push-button stations, with text and graphics as required by authorities having jurisdiction.

2.9 ELEVATORS

A. Elevator Description:
   1. Machine Location: Hoistway; no machine room is provided.
   2. Rated Load: 4000 lb (1816 kg).
   3. Freight Loading Class for Service Elevator(s): Class A.
   4. Rated Speed: 200 fpm (1.0 m/s).
   5. Operation System: Selective collective automatic operation.
   6. Auxiliary Operations:
      a. Standby power operation.
      b. Battery-powered lowering.
      c. Automatic dispatching of loaded car.
      d. Nuisance call cancel.
   7. Car Enclosures:

a. Inside Width: 68 inches (1727 mm) from side wall to side wall.
b. Inside Depth: 90 inches (2286 mm) from back wall to front wall (return panels).
c. Inside Height: 94 inches (2388 mm) to underside of ceiling.
d. Front Walls (Return Panels): Satin stainless steel, No. 4 finish.
e. Car Fixtures: Polished stainless steel, No. 8 finish.
f. Side and Rear Wall Panels: Satin stainless steel, No. 4 finish.
g. Door Faces (Interior): Satin stainless steel, No. 4 finish.
h. Handrails: 1-1/2 inches (38 mm) round or 1/2 by 2 inches (13 by 50 mm) rectangular satin stainless steel, No. 4 finish, at sides and rear of car.
i. Floor prepared to receive resilient tile (specified in Division 09 Section "Resilient Flooring").

8. Hoistway Entrances: As follows:
a. Width: 42 inches (1067 mm).
b. Height: 84 inches (2134 mm) .
c. Type: Two-speed center opening.
d. Fire-Protection Rating: 1-1/2 hours.
e. Frames: Satin stainless steel, No. 4 finish.
f. Doors: Satin stainless steel, No. 4 finish.

9. Hall Fixtures: Satin stainless steel, No. 4 finish.

10. Additional Requirements:
a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from polished stainless steel, No. 8 finish.
b. Provide blanket hooks and one complete set(s) of full-height protective blankets.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts designed to minimize transmission of vibrations to structure and thereby minimize structure-borne noise from elevator system.

B. Leveling Tolerance: 1/8 inch (3 mm), up or down, regardless of load and direction of travel.

C. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1 and by governing regulations and agencies.

3.3 PROTECTION

A. Temporary Use: Comply with the following requirements for elevator used for construction purposes:
1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.

2. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
3. Engage elevator Installer to provide full maintenance service.
4. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).

END OF SECTION 14210

SECTION 14245 - HYDRAULIC FREIGHT LIFT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes hydraulic freight lift (elevator).

1.2 SUBMITTALS

A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information.

B. Shop Drawings: Show plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment and signals. Indicate variations from specified requirements, maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.

C. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.

D. Operation and maintenance data.

E. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with ASME A17.1 and elevator design requirements for earthquake loads in ASCE 7.

1.4 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective elevator work within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

1.5 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide one year's full maintenance service by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity.

PART 2 - PRODUCTS

2.1 SYSTEMS AND COMPONENTS

A. General: Provide manufacturer's standard freight elevator systems, including standard components published by manufacturer as included in standard preengineered freight elevator systems and as required for complete system.

B. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations. Provide either of the following:

1. Pump, mounted on oil tank with vibration isolation mounts. Enclose pump in prime-painted steel enclosure lined with 1-inch- (25-mm-) thick, glass-fiber insulation board.
2. Submersible pump, suspended inside oil tank from vibration isolation mounts.
3. Provide motor with wye-delta or solid-state starting.

C. Hydraulic Silencers: Provide hydraulic silencer containing pulsation-absorbing material in a blowout-proof housing at pump unit.

D. Hydraulic Fluid: Nontoxic, readily biodegradable, fire-resistant fluid made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives. Hydraulic fluid is approved by elevator manufacturer for use with elevator equipment.

1. Product: Subject to compliance with requirements, provide "Hydro Safe" by Hydro Safe Oil Division, Inc.

E. Protective Cylinder Casing: PVC or HDPE pipe casing complying with ASME A17.1, of sufficient size to provide not less than 1-inch (25-mm) clearance from cylinder and extending above pit floor. Provide means to monitor casing effectiveness to comply with ASME A17.1.

F. Guides: Provide either roller guides or sliding guides at top and bottom of car and counterweight frames. If sliding guides are used, provide guide-rail lubricators or polymer-coated, nonlubricated guides.

2.2 OPERATION SYSTEMS

A. General: Provide manufacturer's standard microprocessor operation system as required to provide type of operation system indicated.

B. Security Feature: Security feature shall not affect emergency firefighters' service.

1. Card-Reader Operation: System uses card readers at car control stations to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Allow space as indicated for card reader in car.
   a. Security access system equipment is not in the Contract.

2. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at car control stations. Key is removable only in deactivated position.

2.3 DOOR REOPENING DEVICES

A. Infrared Array: Provide door reopening devices with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more of the light beams shall cause doors to stop and reopen.

2.4 FINISH MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, commercial steel, with G60 (Z180) zinc coating (galvanized) or A60 (ZF180) zinc-iron-alloy coating (galvannealed).

D. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.

E. Rolled Steel Floor Plate: ASTM A 786/A 786M.

2.5 CAR ENCLOSURES

A. General: Provide car enclosures as indicated, including ventilation, lighting, finishes, access doors, thresholds, trim, and accessories.

1. Provide power door operators with linkages for hoistway door operation.
2. Provide standard railings complying with ASME A17.1 on car tops where required by ASME A17.1.

B. Materials and Fabrication: Provide manufacturer's standard, flush panel, welded construction made from metal sheet, of metal indicated, not less than 0.067 inch (1.7 mm) and reinforced at 16-inch (406-mm) maximum spacing.

2.6 HOISTWAY ENTRANCES

A. General: Structural-steel frames and sills for hoistway entrances are specified in Division 05 Section " Metal Fabrications." Unless otherwise indicated, provide hoistway entrance doors of type indicated below, with truckable sill bars and resilient safety meeting-rail gaskets.

1. Equip for power operation by means of coordinated linkage with power-operated car door.

B. Metal Door Panels: Constructed of metal sheets, flush on room side, welded and reinforced in steel framing with vertical reinforcing spaced not more than 24 inches (610 mm) o.c. Fabricate panel faces from metal sheet, of metal indicated, not less than 0.097 inch (2.5 mm) thick.

2.7 SIGNAL EQUIPMENT

A. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements of acrylic or other permanent, nonyellowing translucent plastic.

B. Car Control Stations: Provide manufacturer's standard car control station. Mount adjacent to car door, unless otherwise indicated.

C. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet or telephone jack in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Division 28 Section "Fire Detection and Alarm."

D. Hall Push-Button Stations: Provide hall push-button stations at each landing as indicated.

1. Provide single-button stations with "In-Use" indicator.

2.8 FREIGHT LIFT

A. Freight Lift:
1. Type: Holeless, beside-the-car, single-acting, single cylinder, or
2. Type: Holeless, beside-the-car, roped hydraulic, single cylinder.
3. Rated Load: 2500 lb (1135 kg).
4. Freight Loading Class: Class A.
5. Rated Speed (Up): 75 or 80 fpm (0.38 or 0.41 m/s) .
6. Operation System: Single automatic operation.
7. Car Enclosures:

    a. Platform Width: 64 inches (1626 mm).
    b. Platform Depth: 84 inches (2134 mm).
    c. Ceiling Height: 96 inches (2438 mm).
    d. Walls and Ceiling: Satin stainless steel, No. 4 finish.
    e. Car Fixtures: Satin stainless steel, No. 4 finish.
    f. Floor: Rolled steel floor plate.
    g. Car Gate Type: Single-speed or two-speed vertical lift.
    h. Car Gate Operation: Manual.
    i. Car Gate Material: Satin stainless steel, No. 4 finish.
    j. Lighting: Two 48-inch (1219-mm), 2-tube fluorescent light fixture(s).

8. Hoistway Entrances:

    a. Width: 60 inches (1524 mm).
    b. Height: 84 inches (2134 mm) .
    c. Door Type: Single-speed or two-speed vertical lift.
    d. Fire-Protection Rating: 1 hour .
    e. Door Operation: Manual.
    f. Door Material: Satin stainless steel, No. 4 finish.

9. Hall Fixtures: Satin stainless steel, No. 4 finish.
10. Additional Requirements:

    a. Provide door reopening device.

PART 3 - EXECUTION

3.1 INSTALLATION

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting use (either temporary or permanent) of elevators, perform acceptance tests as required and recommended by ASME A17.1 and by governing regulations and agencies.

3.3 PROTECTION

1. Temporary Use: Do not use freight lift for construction purposes.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s). Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 14245

SECTION 15050 – BASIC MECHANICAL MATERIALS & METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. The work to be done under this heading includes the furnishing of labor, materials, equipment, and service necessary for and reasonably incidental to the proper completion of all mechanical work as shown on the drawings and herein specified.

B. Materials and equipment shall be new, except where otherwise indicated, of the best quality, with same brand of manufacturer for all similar material, as defined in Division 1.

C. All work shall be performed in accordance with all codes, standards, and requirements of the industry, as defined in Division 1.

D. Regardless of titles and subdivisions herein employed, consider these specifications as one complete document with General Section applying to all other sections. All bidders are cautioned to read entire specifications and to thoroughly familiarize themselves with all requirements thereof.

E. Protect Owner and his agents including Architect and/or Engineer from any and all damages and expense arising from fulfillment of contract and at completion of work repair all damages done.

F. The word "Provide" as used in these Specifications and on the Drawings shall be as defined in Division 1.

G. Contractor shall include in base bid the connection of all sewer, and water piping to existing mains as shown on the Drawings. Contractor shall include all material and all costs for complete installation.

H. If the Contractor notices during the biding any items of the contract documents which will violate any applicable code, these items shall be brought to the attention of the Architect before the bid date. Failure to bring these items to the attention of the Architect shall be construed as explicit agreement that the Contractor has included in his bid price any and all modifications necessary to complete the project in accordance with all applicable codes.

1.2 REFERENCES

A. The General Provisions of the Contract, including General and Supplementary Conditions and General Requirements apply to the work specified in this Section, as defined in Division 1.

B. Separation of specifications into sections is for convenience only and is not intended to establish limits of work or liability. The following are the Sections titles for this project.

15050 - Basic Mechanical Materials and Methods
15350 - Commissioning
15250 - Piping and Equipment Insulation
15400 - Plumbing
15800 - Heating, Ventilating and Air Conditioning
15840 – Water Treatment Systems
15850 – Testing, adjusting, and Balancing of Air and Hydronic Systems

15900 - Valves, Strainers, Unions and Fittings
15950 - Building Automation & Temperature Control System

1.3 RELATED SECTIONS

A. All exposed piping, ductwork and other equipment requiring painting shall be as specified in PAINTING SECTION. Leave all these surfaces clean of oil, dirt, plaster, etc., ready for painting section's work.

B. Power wiring for all equipment shall be as specified in Division 16 ELECTRICAL .

C. Provide approved power wiring diagrams showing interlocking of all equipment and controls, assisting in all wiring problems affecting equipment, checking and verifying that same is wired correctly as required by Division 16 ELECTRICAL for proper operating of all mechanical items.

D. All heating, air conditioning, ventilating and other mechanical systems controls, starters, firestats, relays, and related equipment shall be as specified in Division 15 MECHANICAL.

E. Opening for all access doors, relief and return air grilles, etc., shall be provided under the respective trade sections.

F. Curbs, flashings, etc., for exhaust fans, vents, etc., shall be provided under the respective sections.

G. All HVAC control wiring shall be as specified in Division 15 MECHANICAL.

1.4 SUBMITTALS

A. Shop Drawings and Submittal Data required:

1. Submit to the Architect for review, within thirty (30) days from award of contract, six (6) copies of complete descriptive information and dimensional data on all items of equipment, materials and accessories, and duct and equipment layout. Piecemeal submissions shall not be approved. Written approval thereof must be obtained before ordering or installation. The following shall be submitted:

Plumbing Fixtures incl. Water Heater	Ductwork Layout Shop Drawings
Insulation	Equipment Layout
VAV Boxes	Diffusers, Grills & Registers
Valves, Strainers, Unions & Fittings	Exhaust Fans
Temperature Controls	Air Conditioning air handling units
Chillers	Pumps
Compression Tanks and hydronic accessories	Heat Recovery Unit
Cooling Towers	Condensing Units
Central Chiller Plant equipment and piping layout	

2. Ductwork shop drawings shall include all piping, electrical feeders and sub-feeders and any special systems raceways larger than 2 inches. Drawings shall be based on measured field conditions and other trade shop drawings and coordination information.

3. Shop drawings and submittal data shall be considered to be instruments of service only and submitted for the sole purpose of convenience to the Contractor to assist him in the performance of the contract. The Architect's review of the shop drawings and submittal data shall not supersede these specifications, the accompanying drawings, or the

contract terms, unless specifically covered by a properly executed change order, and then only to the extent specifically and explicitly stipulated therein.

B. After completion of project Contractor shall turn over to the Architect three (3) bound sets of complete operating and maintenance instructions including listing of supply and repair items and locations of places to purchase same.

C. Substitutions:

1. All material, equipment, methods, and accessories entering into the work under this section of contract are subject to approval or disapproval of the Architect. Approval of any manufacturer, material, or product shall not constitute a waiver of Architect's right to demand full compliance with contract requirements, including shape, size, quality and performance.

2. Equality of materials is that established by opinion of Architect. Decision of Architect is final.

3. Whenever a material or article of equipment is specified by use of a proprietary name, or by naming the manufacturer or vendor, any material or article which will perform adequately the duties imposed by the design will be considered for substitution, providing it is of equal substance, and function, meets specifications, and is esthetically acceptable to the Architect.

4. Literature, technical data, etc., includes complete data and samples if necessary, with submissions for substitutions. Burden of proof that material offered for substitution is equal, or superior, in construction and efficiency to that named, rests on Contractor, and unless proof is satisfactory to Architect, substitution will not be approved.

D. See Division 1 of these Specifications for "Record Drawings" requirements.

1.5 QUALITY ASSURANCE

A. The Contractor bidding on this portion of the work must be fully experienced in installations of equal size, complexity, and quality, and must be licensed to perform such work as required by the Louisiana State Legislature, R.S.37:2152-2163.

B. In bidding he acknowledges that he fully understands the scope of work and design, and has the ability for the contract price to assemble and install the equipment, piping, and ductwork shown or specified, so as to mold same into a satisfactory workable system and arrangement.

C. Contractor shall recognize that a fault or error in his work remains his responsibility regardless of whether such difficulty was discovered after the work had progressed, and shall make corrections at no cost to the Owner.

D. Adequate and competent constant supervision shall be provided by Contractor to assure that work is done in accordance with the drawings and specifications. Contractor shall recognize that amount of information and detail could be provided to contract documents is limitless and could extend into every minute detail and sequence of operations, to a point where only workmen would be required, without drawing on ability, experience and ingenuity of the Contractor.

E. All work shall be installed in strict accordance, with all existing local and state codes and ordinances, and with National Board of Fire Underwriters.

F. This Contractor shall secure all permits and inspections and pay all fees and taxes and shall provide Owner with certificates of approval from agencies having jurisdiction over various phases of the work.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Take necessary precautions to protect all material, equipment, apparatus and work from damage. Failure to do so to the satisfaction of the Architect will be sufficient cause for the rejection of the material, equipment or work in question. Contractor is responsible for the safety and good condition of the materials installed until final acceptance by the Owner.

1.7 PROJECT CONDITIONS

A. Accompanying drawings, including plans, details, diagrams, notes, etc., are shown to limit and explain structural conditions, construction requirements, sizes, capacities and method of installation and erection. Structural and other conditions may require certain modifications and adjustments from conditions shown. Such deviations are permissible; however, specific sizes capacities and requirements affecting the satisfactory performance and operation of the installation shall remain unchanged. Make allowance for normal job conditions and interferences.

B. Whenever it becomes necessary to shift ducts or pipes or to change shape of ducts, such changes shall be referred to Architect for approval.

C. Ask for details whenever uncertain about method of installation. Lack of details not requested shall not excuse improper installation and correction shall be responsibility of Contractor.

D. Furnish detailed duct layout and equipment room shop drawings based on field measurements and actual job conditions.

E. All piping, cleanouts and covers, and other mechanical items in way of construction or remodeling, shall be rerouted, relocated or otherwise adjusted to work out with such construction or changes shown or specified in any or all of various sections of specifications. Unknown piping that is encountered will be referred immediately to Architect for method of disposition before continuation of work.

1.8 GUARANTEE AND SERVICE

A. Guarantee all equipment, materials, and workmanship for a period of one (1) year following date of acceptance.

B. During the period of guarantee any defects in equipment, materials, or workmanship shall be promptly corrected without cost to the Owner.

C. Guarantee includes equipment capacity and performance ratings specified without excessive noise levels. Any deficiencies in equipment capacity specified shall be promptly corrected.

D. Guarantee does not include maintenance items.

PART 2 - PRODUCTS

2.1 ACCESS PANELS

A. Provide all access panels necessary for proper access to valves, traps, fixture connections, control devices or other items installed under this contract.

B. Exact locations for panels to be directed by Architect.

2.2 TOOLS AND SCAFFOLDING

A. Furnish all tools, equipment, scaffolding and other facilities required to properly and expeditiously perform the work.

2.3 SIPHON PREVENTERS

A. Furnish and install on all equipment and fixtures requiring same, backflow preventers or vacuum breakers. Water connections to fixtures and equipment shall be made in such a way as to prevent back siphonage when the water supply is out or the pressure drops. Provide reduced pressure type back flow preventors where indicated on drawings.

2.4 SLEEVES AND THIMBLES

A. Pipe sleeves - wrought iron or cast iron of sufficient size for piping and installation to be installed in floors, walls below grade, and grade beams where piping passes through.

B. Thimbles above grade - heavy galvanized steel of proper size to allow freedom of piping and insulation set in floor or roof slab as work progresses, to be installed in wall and partitions where piping passes through.

C. Thimbles below grade - same as pipe sleeves above.

D. Sleeves through floors extend 1/4" above finished floor. Caulk around and seal all piping in chases and piping passing through floor slab.

E. Provide sleeve seals and shields, as detailed on the drawings for all pipe penetrations of ground floor slab.

2.5 BUCKS, GROUNDS AND CHASES

A. Be responsible for proper location and sizes or for any errors or omission in placing same.

B. Failure to inform the General Contractor promptly of such requirements shall not relieve the Mechanical installer of the responsibility for providing a complete mechanical system.

2.6 HANGERS

A. Horizontal piping above grade without hubs shall be rigidly supported. Distance between pipe supports:

1.	1/2" pipe	6'-0" maximum
2.	3/4" pipe	7'-0" maximum
3.	1" pipe	8'-0" maximum
4.	1 1/4" pipe	9'-0" maximum
5.	1 1/2" pipe and over	10'-0" maximum

B. Above ground hangers shall be similar to "Split Ring" type.

C. Metal strap or wire will not be acceptable.

D. For two or more systems of piping run parallel and with same grade trapeze hangers may be used.

E. Use #22 gauge galvanized sheet steel saddles between the pipe covering and each pipe hanger on all insulated lines. Saddles shall extend along pipe runs and at least half way up piping on each side.

F. All above grade horizontal sewer drain, vent, waste and similar piping shall be hung at every hub using the same type hangers as specified for other piping.

G. All underground piping under the building shall be suspended from the building slab as detailed on the drawings and/or required by Local Code.

PART 3 - EXECUTION

3.1 FLASHING AND COUNTERFLASHING

A. All pipes and ducts that pass through roof and walls shall run so as not to interfere with the structural system and to permit proper application of base and counterflashing. All plumbing vents are to be finished with 2-1/2 pound sheet lead turned down into pipe or at Contractors option flexible type vent thru roof flashing may be substituted. Contractor shall furnish proper flashing and counterflashing materials. Coordinate with the roofing section to verify types or flashing required for compatibility with the roofing system.

3.2 CLEANING, STERILIZING AND PIPING

A. When all work has been finally tested, clean all fixtures, pipes and exposed work.

B. All pipes shall be free from all obstructions.

C. All plated and other finished products shall be thoroughly cleaned and polished.

D. New water piping shall be sterilized.

E. All piping shall be installed so that it may expand and contract freely without damages to equipment, other work, or injury to piping system. All necessary swing joints, expansion joints, or offsets to protect piping, etc., shall be installed whether indicated or not. Piping shall be graded to allow for system drainage.

F. Stainless steel or chromium plated floor, wall and ceiling plates shall be furnished on all exposed piping passing through floor, walls, or ceilings. Plates shall be secured in place with round head screws or toggle bolts of proper size and type for adjacent construction.

G. All piping shall be installed and sized as indicated on the drawings and be of equivalent materials to piping as hereinafter specified.

3.3 TESTING AND INSTRUCTION

A. Piping shall be tested to pressure hereinafter specified. Where pressures are not mentioned, it shall be understood that testing to 1-1/2 times service conditions, before insulation is applied, will be acceptable. All tests shall be held for a minimum of 24 hours before inspection.

B. Furnish all necessary gauges, pumps, test plugs, and temporary connections and shall test sections of the building as work progresses.

C. All new sewerage, vent and waste piping shall be plugged and tested by filling with water from top to bottom of floor prior to being connected to fixtures. Tests shall be held a minimum of 24 hours.

D. All new cold and hot water supply piping shall be tested hydrostatically to 125 pounds per square inch before application of insulation. Test shall be held a minimum of 24 hours.

E. All new gas piping shall be air tested to a pressure of 75 PSIG. During the test all joints shall be painted with a soap solution to test for leaks. The test shall be held a minimum of 24 hours.

F. All tests shall be made in the presence of the Architect or his representative. Where pipes or connections in new piping are found to leak, they shall be made tight and the tests repeated.

G. Make all necessary adjustments to controls, dampers, valves, etc., to obtain best operation first with empty building and later under actual conditions.

H. Thoroughly check the operation of each item of equipment and controls while testing, without waiting first for the Owner or Architect to complain about their operation. Verify that same are wired correctly and completely, notifying the proper parties for necessary corrections. Thoroughly instruct the Owner's representative in the operation and care of controls, individual equipment, and entire system.

I. Provide two (2) copies of balance reports as hereinafter specified.

J. After adjustment period and before acceptance replace all air filters with specified type.

3.4 CUTTING AND PATCHING

A. Cooperate to the fullest extent with all other trades to reduce to a minimum the amount of cutting and patching of other work necessary for this installation. Do not cut or patch the work of other trades but arrange to provide cutting templates in time, or otherwise pay the respective other contractors for changing theirs, to accommodate this work. No cutting into any structural units likely to impair the strength shall be done without the approval of the Architect.

3.5 CLEAN UP

A. Remove debris, surplus and waste materials, oil, grease or stains resulting from the work performed and leave the premises in a broom clean condition AT THE END OF EACH WORKING DAY. All debris, surplus and waste material shall be removed completely from the job site.

3.6 ANTI – TERRORISM PROTECTION FOR MECHANICAL AND PLUMBING SYSTEMS

A. All HVAC and plumbing equipment piping and ductwork shall be installed and separated to meet or exceed the minimum forces of 0.5 times its weight in any direction and 1.5 times its weight in the downward direction.

END OF SECTION 15050

SECTION 15250 - PIPING AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide a complete system of insulation, as herein specified, for both inside and outside of building.

B. The General Provisions of the Contract including General and Supplementary Conditions and General Requirements apply to the work specified in this Section.

C. Refer to Section BASIC MATERIALS AND METHODS, which is applicable to this Section.

D. Insulation shall include insulating materials, their applications, finish, bands, tie wire and weather protection for all piping, fittings, valves, and equipment as indicated and specified herein.

1.2 GENERAL

A. All insulation shall be applied in a workmanlike manner by skilled workmen regularly engaged in this type of work.

B. All pipe insulation shall have COMPOSITE flame and smoke hazard ratings as tested in accordance with standard testing methods (NFPA) 255 and UL 723).

C. Composite ratings shall not exceed: flame spread 25, smoke developed 50.

D. Accessories such as adhesive, mastic, cement, tapes and asbestos cloth shall have the same component ratings as listed above.

E. THE INSULATION CONTRACTOR SHALL CERTIFY IN WRITING, PRIOR TO INSTALLATION, THAT ALL PRODUCTS TO BE USED WILL MEET THE ABOVE CRITERIA.

PART 2 - PRODUCTS

2.1 CHILLED WATER PIPING ABOVE GROUND

A. All chilled water piping and fittings shall be insulated with 100% rigid cellular glass molded pipe insulation. Insulation shall have an average density of 8 lb./cu.ft. and shall have a thermal conductivity of 0.31 BTU-in/hr.sf.degrees F. at 50 degrees F. The insulation shall comply with ASTMC 552, Type II furnished in half sections of 24" long.

B. Insulation shall be installed with all seams and joints sealed with water proof sealant as recommended by the manufacturer. After sealant is applied insulation shall be secured with ½" wide by 0.010" thick stainless steel bands with matching seals. Sealants shall be applied full depth of all joints and shall not be used to fill voids or cracks.

C. Cover all new insulation with an all purpose jacketing of kraft paper/aluminum foil/vinyl coating construction.

D. Insulate fittings, flanges and valves with same material and thickness as adjacent piping. Cover insulation with same jacket as adjacent piping.

E. Chilled water pipe insulation shall have the following thickness:

Pipe Size	Insulation Thickness
Up to 1"	2"
1-1/4" to 4"	2-1/2"
5" to 12"	3"

F. Provide one or two layer expansion/contraction joints in accordance with manufacturer's recommendations.

2.2 ROOF DRAINS

A. Insulate the body of all roof drains and the roof drain piping and fittings from the drain through all horizontal runs to the connection with the vertical leader as specified for domestic cold water pipe, fittings, flanges and valves; thickness to be ½ inch for all pipe sizes. At Contractor's option 1-1/2" thick flexible fiberglass insulation with vapor barrier may be used in lieu of rigid fiberglass. Insulation shall be same type as specified for exterior duct wrap. All joints shall be sealed with pressure sensitive tape.

2.3 PUMPS

A. Insulate chilled water pumps with rigid glass fiberboard insulation having minimum density of 3 PCF with factory applied foil-scrim-kraft (FSK) facing, 1-1/2 inch thick. Form a box to enclose pump and fill void between pump and box with flexible glass fiber insulation. Seal joints with 3-inch wide strips of same facing material adhered with vapor barrier adhesive. Vapor seal and finish with vapor barrier mastic, reinforced with white glass fabric.

2.4 AIR CONDITIONING DRAINS

A. Insulate all air conditioning condensate drains, pipe, fittings, flanges and valves with flexible foamed plastic tubing insulation. Thickness to be 3/4 inch.

B. Insulate all horizontal waste piping (new or existing) above ground that receives A/C condensate from drain to vertical stack. Also insulate the "P" trap of those drains. Insulation shall be same as specified for above ground domestic cold water piping, fitting flanges and valves except thickness shall be 1/2 inch for all pipe sizes.

2.5 DUCT INSULATION

A. DUCT SIZES SHOWN ON DRAWINGS ARE FREE AREA SIZES. See Section 15800 for insulation and duct material and type required for each application. Insulation shall be as per the following:

B. Lined Duct system - All lined ducts shall be lined with fiberglass ductliner. Duct Lining shall be applied in strict accordance with the latest edition of SMACNA's "HVAC Duct Construction Standard Metal & Flexible." Mechanical fasteners shall meet "Standards for Mechanical

Fasteners MF-1-1975." Length of mechanical fasteners shall not compress the insulation more than 1/8" and shall be installed perpendicular to the duct surface. Adhesive shall conform to ASTM C 916 and be applied to the sheet metal with a 90% minimum coverage. All exposed edges of the duct liner material shall be coated with the same adhesive. All rips and tears shall also be repaired using adhesive. All internal duct areas shall be covered with duct liner. Transverse joints shall be firmly butted with no gaps, and coated with adhesive. Longitudinal corner joints shall be overlapped and compressed. For velocities from 4001 to 6000 FPM, metal nosing shall be applied to all upstream transverse edges to additionally secure the insulation." Liner shall be 1" thick, I.5 PCF.

C. Exterior Duct Wrap - Exterior insulation duct wrap shall be 2" thick .75 PCF fiberglass wrap with F.S.K. jacket.

D. All ductwork on the exterior of the building shall be insulated with 2" thick, 6 pcf density, fiberglass rigid board insulation applied to the exterior of the ductwork, and completely covered with a complete covering of Flex Clad 400 stucco embossed flexible aluminum with self adhering adhesive of rubberized asphalt. At contractors option a 2" thick closed cell flexible elastomeric insulation with 13-ply laminate exterior membrane (6 layers of aluminum foil, 4 layers of polyester film around a scrim reinforced core) attached with applied adhesive or pre applied pressure sensitive adhesive, may be used. Seams and joints shall be covered with pressure sensitive Seal Tape. All insulation shall be sloped to prevent water ponding and shall be installed in strict accordance with Manufacturers recommendations.

2.6 DOMESTIC HOT AND COLD WATER PIPING ABOVE GROUND

A. Insulate all new above ground hot & cold water pipe with glass fiber pipe insulation with factory applied white all service jacket, with self-sealing lap (ASJ-SSL) .

B. Insulate fittings, flanges and valves with performed insulation with PVC premolded one-piece fitting covers, with fiberglass inserts, Proto covers, or approved equal. Premolded or shop fabricated Glass Fiber covers may be used in lieu of above at the Contractor's option. Optional covers to be given a smoothing coat of finishing cement, in exposed areas and vapor sealed in all areas with vapor barrier mastic coating, reinforced with white glass fabric.

C. Insulation thickness for all cold water piping to be ½ inch.

D. All new domestic hot water and hot water circulating piping shall be insulated in accordance with the Schedule below.

	PIPE DIAMETER	INSULATION THICKNESS
Runouts to individual fixtures, not exceeding 12 feet in length	up to 2"	½"
All mains, branches and other piping	2" and less	1"
	2-1/2" to 4"	1-1/2"

E. Provide an isolating vapor seal between pipe insulation jacket and pipe at butt joints of insulation at fittings, flanges, valves, hangers and at 21 foot intervals on continuous runs. Using a vapor barrier mastic coating.

F. Adhere longitudinal laps and butt strips of jacket with factory applied pressure sensitive tape system,.

2.7 CHILLED WATER PIPING EXTERIOR INSTALLATION

A. All chilled water piping and fittings installed underground or exposed to the weather shall be insulated with 100% rigid cellular glass molded pipe insulation. Insulation shall have an average density of 7.5 lb/cu.ft. and shall have a thermal conductivity of 0.28 BTU-IN/HR.SF. degrees F at 50 degrees F.

B. Insulation shall be installed with all seams and joints sealed with water proof sealant as recommended by the manufacturer. After sealant is applied insulation shall be secured with ½" wide by 0.010" thick stainless steel bands. Sealants shall be applied full depth of all seams and joints and shall not be used to fill voids or cracks.

C. Cover all insulation with a special bituminous containing laminate water waterproofing membrane. Covering shall be 125 mil, thick. Jacket shall be installed per manufacturer's recommendations. Provide S.S. Bands as required by manufacturer installation details.

D. Insulation thickness shall be 2" thick up to 1" pipe size and 2-1/2" thick up to 4" pipe size, and 3" thick above 4" pipe size.

E. Insulation shall be installed in strict accordance with their recommendations and requirements.

F. At Contractor's option underground chilled water piping may be a pre-insulated piping system as described in section 15800.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND INSTALLATION

A. All insulation shall be applied per manufacturer's specifications and installation requirements.

B. Insulation shall be applied over clean dry surfaces after all test have been performed and approved.

C. Methods of application and other details not specified herein shall be in accordance with manufacturer's recommendations, which shall constitute minimum standards.

D. Sheet Metal Saddles - 10" long shall be provided on all hangers supporting insulated lines. They shall be fabricated to conform with the outside diameter of the pipe covering and shall be fabricated from 22 gauge sheet iron for pipe through 2-1/2" 20 gauge sheet iron for pipes through 8" and 16 gauge for all pipes over 8".

E. A rigid insulation material shall be used at each pipe hanger as an insert and the pipe covering shall pass full thickness through the hangers.

F. On all outdoor piping insulation above ground (including covered parking area), provide aluminum jacket 0.016 inch thick with longitudinal z-joint secured with preformed 2" wide butt strips. Provide preformed aluminum fitting cover on all fittings.

END OF SECTION 15250

SECTION 15350 – COMMISSIONING

PART 1 - GENERAL

1.1 DESCRIPTION

A. The purpose of this section is to specify Division 15 responsibilities in the commissioning process of the Design Build Contractor.

B. The systems to be commissioned are as follows (See system checklists in Part 3):

1. Chilled Water System
2. Condenser Water System
3. Heating System
4. Air Distribution Systems
5. Building Automation System
6. Exhaust Systems
7. Plumbing Systems
8. Domestic Water Heating Systems
9. Piping Systems

C. Commissioning requires the participation of Division 15 to ensure that all systems are operating in a manner consistent with the Contract Documents. Division 15 shall be familiar with all parts of the commissioning plan issued by the Commissioning Agent (CA) and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.2 RESPONSIBILITIES

A. The commissioning responsibilities applicable to each of the mechanical, controls and TAB contractors of Division 15 are as follows (all references apply to commissioned equipment only):

B. Construction and Acceptance Phases
1. Include and itemize the cost of commissioning in the contract price.
2. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
3. Attend a commissioning scoping meeting and other meetings necessary to facilitate the commissioing process.
4. Contractors shall provide the CA with normal cut sheets and shop drawing submittals of commissioned equipment.
5. Provide additional requested documentation, prior to normal O&M manual submittals, to the CA for development of start-up and functional testing procedures.
   a. Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent.
   b. The Commissioning Agent may request further documentation necessary for the commissioning process.
   c. This data request may be made prior to normal submittals.

6. Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the CA for review and approval.
7. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
8. Provide limited assistance to the CA in preparing the specific functional performance test procedures as specified. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
9. Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the prefunctional checklists from the CA for all commissioned equipment. Submit to CA for review and approval prior to startup.
10. During the startup and initial checkout process, execute the mechanical-related portions of the prefunctional checklists for all commissioned equipment.
11. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA.
12. Address current A/E punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.
13. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
14. Provide skilled technicians to perform functional performance testing under the direction of the CA for specified equipment. Assist the CA in interpreting the monitoring data, as necessary.
15. Correct deficiencies (differences between specified and observed performance) as interpreted by the CA, CM and A/E and retest the equipment.
16. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
17. During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing).
18. Provide training of the Owner's operating staff using expert qualified personnel, as specified.
19. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

C. Warranty Period
1. Execute seasonal or deferred functional performance testing, witnessed by the CA, according to the specifications.
2. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

B. The responsibilities of the HVAC Mechanical Contractor, during construction and acceptance phases in addition to those listed in (A) are:

1. Provide startup for all HVAC equipment, except for the building automation control system.
2. Assist and cooperate with the TAB contractor and CA by:
   a. Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
   b. Including cost of sheaves and belts that may be required by TAB.
   c. Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Providing an approved plug.

d. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.

3. Install a P/T plug at each water sensor which is an input point to the control system.
4. List and clearly identify on the as-built drawings the locations of all air-flow stations.
5. Prepare a preliminary schedule for Division 15 pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CA. Update the schedule as appropriate.
6. Notify the CA when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the CA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the CA has the scheduling information needed to efficiently execute the commissioning process.

D. The commissioning responsibilities of the Controls Contractor, during construction and acceptance phases in addition to those listed in (A) are:

1. The Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:
   a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
   b. All interactions and interlocks with other systems.
   c. Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
   d. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).
   e. Start-up sequences.
   f. Warm-up mode sequences.
   g. Normal operating mode sequences.
   h. Unoccupied mode sequences.
   i. Shutdown sequences.
   j. Capacity control sequences and equipment staging.
   k. Temperature and pressure control: setbacks, setups, resets, etc.
   l. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
   m. Effects of power or equipment failure with all standby component functions.
   n. Sequences for all alarms and emergency shut downs.
   o. Seasonal operational differences and recommendations.
   p. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
   q. Schedules, if known.
   r. To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.

2. Control Drawings Submittal
   a. The control drawings shall have a key to all abbreviations.
   b. The control drawings shall contain graphic schematic depictions of the systems and each component.

c. The schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
d. Provide a full points list with at least the following included for each point:
   1) Controlled system
   2) Point abbreviation
   3) Point description
   4) Display unit
   5) Control point or setpoint (Yes / No)
   6) Monitoring point (Yes / No)
   7) Intermediate point (Yes / No)
   8) Calculated point (Yes / No)

   Key:
   Point Description: DB temp, airflow, etc.
   Control or Setpoint: Point that controls equipment and can have its setpoint changed (OSA, SAT, etc.)
   Intermediate Point: Point whose value is used to make a calculation which then controls equipment (space temperatures that are averaged to a virtual point to control reset).
   Monitoring Point: Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.
   Calculated Point: "Virtual" point generated from calculations of other point values.
e. The Controls Contractor shall keep the CA informed of all changes to this list during programming and setup.

3. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.

4. Assist and cooperate with the TAB contractor in the following manner:

   a. Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB. Provide the TAB any needed unique instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.).
   b. For a given area, have all required prefunctional checklists, calibrations, startup and selected functional tests of the system completed and approved by the CA prior to TAB.
   c. Provide a qualified technician to operate the controls to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.

5. Assist and cooperate with the CA in the following manner:

   a. Using a skilled technician who is familiar with this building, execute the functional testing of the controls system as specified. Assist in the functional testing of all equipment specified. Provide two-way radios during the testing.
   b. Execute all control system trend logs specified.

6. The controls contractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to functional performance testing. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:

a. System name.
b. List of devices.
c. Step-by-step procedures for testing each controller after installation, including:
   1) Process of verifying proper hardware and wiring installation.
   2) Process of downloading programs to local controllers and verifying that they are addressed correctly.
   3) Process of performing operational checks of each controlled component.
   4) Plan and process for calibrating valve and damper actuators and all sensors.
   5) A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
d. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.
e. A description of the instrumentation required for testing.
f. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the CA and TAB contractor for this determination.

7. Provide a signed and dated certification to the CA and CM upon completion of the checkout of each controlled device, equipment and system prior to functional testing for each piece of equipment or system, that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.
8. Beyond the control points necessary to execute all documented control sequences, provide monitoring, control and virtual points as specified in Section 15950.
9. List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air, water and building pressure).

E. The duties of the TAB contractor, in addition to those listed in (A) are:

1. Six weeks prior to starting TAB, submit to the CM the qualifications of the site technician for the project, including the name of the contractors and facility managers of recent projects the technician on which was lead. The Owner will approve the site technician's qualifications for this project.
2. Submit the outline of the TAB plan and approach for each system and component to the CA, CM and the controls contractor six weeks prior to starting the TAB. This plan will be developed after the TAB has some familiarity with the control system.
3. The submitted plan will include:
   a. Certification that the TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.
   b. An explanation of the intended use of the building control system. The controls contractor will comment on feasibility of the plan.
   c. All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
   d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
   e. Final test report forms to be used.
   f. Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow straighteners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the water side.

g. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
h. Details of how *total* flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).
i. The identification and types of measurement instruments to be used and their most recent calibration date.
j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.
k. Confirmation that TAB understands the outside air ventilation criteria under all conditions.
l. Details of whether and how minimum outside air cfm will be verified and set, and for what level (total building, zone, etc.).
m. Details of how building static and exhaust fan / relief damper capacity will be checked.
n. Proposed selection points for sound measurements and sound measurement methods.
o. Details of methods for making any specified coil or other system plant capacity measurements.
p. Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later.
q. Details regarding specified deferred or seasonal TAB work.
r. Details of any specified false loading of systems to complete TAB work.
s. Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.
t. Details of any required interstitial cavity differential pressure measurements and calculations.
u. Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
v. Plan for formal progress reports (scope and frequency).
w. Plan for formal deficiency reports (scope, frequency and distribution).

4. A running log of events and issues shall be kept by the TAB field technicians. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CA and CM at least twice a week.
5. Communicate in writing to the controls contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.
6. Provide a draft TAB report within two weeks of completion. A copy will be provided to the CA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standard 111.
7. Provide the CA with any requested data, gathered, but not shown on the draft reports.
8. Provide a final TAB report for the CA with details, as in the draft.
9. Conduct functional performance tests and checks on the original TAB as specified for TAB.

F. The Mechanical designer shall coordinate with requirements of the CA and the Contractor.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Division 15 shall provide all test equipment necessary to fulfill the testing requirements of this Division.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Division 15 shall provide submittal documentation relative to commissioning as required in this Section Part 1.

3.2 STARTUP

A. The HVAC mechanical and controls contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section. Division 15 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning agent or Owner.

B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CA and CM. Beginning system testing before full completion, does not relieve the Contractor from fully completing the system, including all pre-functional checklists as soon as possible.

3.3 TAB

A. Refer to the TAB responsibilities in Part 1.2 above.

3.4 FUNCTIONAL PERFORMANCE TESTS

A. See above for a list of systems to be commissioned and to Part 3.6 for a description of the process.

3.6 OPERATION AND MAINTENANCE (O&M) MANUALS

A. The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications.

B. Division 15 shall compile and prepare documentation for all equipment and systems covered in Division 15 and deliver this documentation to the General Contractor for inclusion in the O&M manuals, according to this section and General Conditions, prior to the training of owner personnel.

C. The CA shall receive a copy of the O&M manuals for review.

D. In addition to documentation that may be specified elsewhere, the controls contractor shall compile and organize at minimum the following data on the control system in labeled 3-ring binders with indexed tabs.

1. Three copies of the controls training manuals in a separate manual from the O&M manuals.
2. Operation and Maintenance Manuals containing:

    a. Specific instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. These instructions shall be step-by-step. Indexes and clear tables of contents shall be included. The detailed technical manual for programming and customizing control loops and algorithms shall be included.
    b. Full as-built set of control drawings (refer to Submittal section above for details).
    c. Full as-built sequence of operations for each piece of equipment.
    d. Full points list. In addition to the updated points list required in the original submittals (Part 1 of this section), a listing of all rooms shall be provided with the following information for each room:
        1) Floor
        2) Room number
        3) Room name
        4) Air handler unit ID
        5) Reference drawing number
        6) Air terminal unit tag ID
        7) Heating and/or cooling valve tag ID
        8) Minimum cfm
        9) Maximum cfm

    e. Full print out of all schedules and set points after testing and acceptance of the system.
    f. Full as-built print out of software program.
    g. Electronic copy on disk of the entire program for this facility.
    h. Marking of all system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.
    i. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
    j. Control equipment component submittals, parts lists, etc.
    k. Warranty requirements.
    l. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).

3. The manual shall be organized and subdivided with permanently labeled tabs for each of the following data in the given order:
    a. Sequences of operation
    b. Control drawings
    c. Points lists
    d. Controller / module data
    e. Thermostats and timers
    f. Sensors and DP switches
    g. Valves and valve actuators
    h. Dampers and damper actuators
    i. Program setups (software program printouts)

4. Field checkout sheets and trend logs should be provided to the CA for inclusion in the Commissioning Record Book.

E. The TAB will compile and submit the following with other documentation that may be specified elsewhere in the Specifications.

1. Final report containing an explanation of the methodology, assumptions, test conditions and the results in a clear format with designations of all uncommon abbreviations and column headings.
2. The TAB shall mark on the drawings where all traverse and other critical measurements were taken and cross reference the location in the TAB report.

F. Review of the commissioning related sections of the O&M manuals shall be made by the A/E and by the CA.

3.7. TRAINING OF OWNER PERSONNEL

A. The General Contractor shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed.

B. The CA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.

C. The Mechanical Contractor shall have the following training responsibilities:

1. Provide the CA with a training plan two weeks before the planned training.
2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment including, but not limited to, pumps, boilers, furnaces, chillers, heat rejection equipment, air conditioning units, air handling units, fans, terminal units, controls and water treatment systems, etc.
3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
6. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
8. Training shall include:

    a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
    b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
    c. Discussion of relevant health and safety issues and concerns.
    d. Discussion of warranties and guarantees.
    e. Common troubleshooting problems and solutions.

f. Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
g. Discussion of any peculiarities of equipment installation or operation.
h. The format and training agenda in *The HVAC Commissioning Process, ASHRAE Guideline 1-1989R*, 1996 is recommended.
i. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.

9. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
10. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
11. Training shall occur after functional testing is complete, unless approved otherwise by the Owner.
12. The Mechanical Contractor shall provide training on each piece of equipment according to the following schedule.

Hours	System
8	Chillers and System
4	Cooling Towers
2	Piping Systems
1	Chemical Treatment
1	Air Compressors and dryers
4	Air Handler Units
2	Variable Speed Drives
2	Air Terminal Units
4	Smoke Control Systems
2	Computer Room AC Units
1	Split System AC or Heat Pumps
1	Unit Heaters
1	Restroom Central Exhaust Fans
2	Service Hot Water Heaters
1	Domestic Water Booster Pump

D. The Controls Contractor shall have the following training responsibilities:

1. Provide the CA with a training plan four weeks before the planned training.
2. The controls contractor shall provide designated Owner personnel training on the control system in this facility. The intent is to clearly and completely instruct the Owner on all the capabilities of the control system.
3. The standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the O&M manuals. In addition, copies of the system technical manual will be demonstrated during training and three copies submitted with the O&M manuals. Manuals shall include detailed description of the subject matter for each session. The manuals will cover all control sequences and have a definitions section that fully describes all relevant words used in the manuals *and* in all software displays. Manuals will be approved by the CA. Copies of audiovisuals shall be delivered to the Owner.
4. The trainings will be tailored to the needs and skill-level of the trainees.
5. The trainers will be knowledgeable on the system and its use in buildings. For the on-site sessions, the most qualified trainers shall be used. The Owner shall approve the instructor prior to scheduling the training.

6. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
7. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
8. There shall be three training sessions:

   a. Training I. Control System. The first training shall consist of 8 hours of actual training. This training may be held on-site or in the supplier's facility. If held off-site, the training may occur prior to final completion of the system installation. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
   b. Training II. Building Systems. The second session shall be held on-site for a period of 12 hours of actual hands-on training after the completion of system commissioning. The session shall include instruction on:
      1) Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including HVAC systems, lighting controls and any interface with security and communication systems.
      2) Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
      3) All trending and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends. Trainees will actually set-up trends in the presence of the trainer.
      4) Every screen shall be completely discussed, allowing time for questions.
      5) Use of keypad or plug-in laptop computer at the zone level.
      6) Use of remote access to the system via phone lines or networks.
      7) Setting up and changing an air terminal unit controller.
      8) Graphics generation
      9) Point database entry and modifications
      10) Understanding DDC field panel operating programming (when applicable)

   c. Training III. The third training will be conducted on-site six months after occupancy and consist of 8 hours of training. The session will be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.

E. The TAB contractor shall have the following training responsibilities:

1. TAB shall meet for 8 hours with facility staff after completion of TAB and instruct them on the following:
   a) Go over the final TAB report, explaining the layout and meanings of each data type.
   b) Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
   c) Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.

d) Discuss any temporary settings and steps to finalize them for any areas that are not finished.
e) Other salient information that may be useful for facility operations, relative to TAB.

3.8 WRITTEN WORK PRODUCTS

A. Written work products of Contractors will consist of the start-up and initial checkout plan and the filled out start-up, initial checkout and pre-functional checklists.

3.9 AIR HANDLER UNITS (AHU) CHECKLISTS

A. Parties Responsible to Execute Functional Test
1. Controls contractor: operate the controls to activate the equipment as needed.
2. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested — Pre-functional Checklist ID
1. AHU and components (fans, coils, valves, ducts, VFD) — PC-_____
2. Heat recovery coil, humidifier or evaporative cooling sections — PC-_____

C. Prerequisites The applicable prerequisite checklist items shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the pre-functional checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements: The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

Function / Mode	Test Method Manual, Monitoring, Either or Both[3]	Required Seasonal Test[1]
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unnoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Mixed & supply air, & reset temperature control functions.	Both	
3. Economizer functions.	Both	Cooling
4. SF, RF and exhaust fan interlocks.	Either	
5. No CCV flow when there is HCV flow.	Both	
6. CCV & HCV modulation & positive shutoff (no leak-thru).	Manual	
7. Duct static pressure (SP) control.	Both	
8. Return or exhaust fan tracking and building SP.	Monitoring	
9. VFD (or inlet vanes) operation on SF and RF: modulation to minimum, control system PID, proportional band of speed vs controlling parameter, constancy of static pressure, verification of program settings, alarms, etc.	Both	[2]

Function / Mode	Test Method Manual, Monitoring, Either or Both[3]	Required Seasonal Test[1]
10. Damper interlocks and correct modulation in all modes, including smoke and fire dampers.	Manual	
11. Temperature difference across HC & CC per specifications.	Manual	
12. Verification of minimum OSA control through varying VAV box positions.	Either	[2]
13. Heating and cooling coils freeze protection.	Manual	[2]
14. Branch duct control damper control.	Manual	
15. Night low limit, morning warmup cycle.	Either	
16. Heat recovery operation.	Monitoring	
17. Verify TAB reported SF cfm with control system reading.	Manual	[2]
18. All alarms (low limits, high static, etc.).	Manual	
19. Heating and cooling coil capacity test, optional.	Manual	Design
20. Sensor and actuator calibration checks: on duct static pressure sensor on SAT, MAT, OSAT, OSA & RA damper and valve positions, SF cfm reading with TAB, and other random checks (EMS readout against hand-held calibrated instrument or observation must be within specified tolerances)	Manual	
21. Verify schedules and setpoints to be reasonable and appropriate		

[1]Cooling season, Heating season or Both. "Design" means within 5°of season design (ASHRAE 2 1/2%), or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.
[2]Seasonal test not required if seasonal conditions can be adequately simulated.
[3]Refer to Special Procedures

E. Special Procedures (other equipment to test with, etc.; reference to function ID)
1. Reduced Testing for Smaller Units. For standard application AHU's less than 15 tons, the following modifications to the testing requirements apply: 1) either Manual or Monitoring will satisfy the verification requirement--where Both is listed, choose one. 2) Testing Modes 6, 8, 11, 13 and 16 is not required.

F. Required Monitoring
1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each AHU being tested:					
RAT	5	5 days incl. weekend	Y	Y	1-3, 5
SAT	5	5 days incl. weekend	Y	Y	1-3, 5
CC LAT (optional)	5	5 days incl. weekend	Y	Y	1-3, 5
HC LAT (optional)	5	5 days incl. weekend	Y	Y	1-3, 5
MAT	5	5 days incl. weekend	Y	Y	1, 3
Indoor WB or enthalpy, if enthalpy economizer	5	5 days incl. weekend	Y	Y	1, 3

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
SF speed, if variable, else status	5	5 days incl. weekend	Y	Y	1, 5-9
RF speed, if variable, else status	5	5 days incl. weekend	Y	Y	1, 5-9
Duct SP	5	5 days incl. weekend	Y	Y	1, 7, 9
Building SP differential	5	5 days incl. weekend	Y	Y	8
OSAT	5	5 days incl. weekend	Y	Y	All
OSA-WB or enthalpy, if enthalpy economizer	5	5 days incl. weekend	Y	Y	1, 3
Indoor dry-bulb ___zones (expected to be most problematic)	5	5 days incl. weekend	Y	Y	All

Remarks:

CCV position (optional)
HCV position (optional)
SF cfm not required if not monitored
RF cfm not required if not monitored

G. Acceptance Criteria (referenced by function or mode ID)
1-21. For the conditions, sequences and modes tested, the AHU, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.
2. AHU with supporting systems shall be able to maintain the SA temperature within 1.0F either side of the deadband of the current setpoint without excessive hunting.
7. AHU and controls shall control the duct static pressure so that it does not drift more than an amount equal to 10% of the setpoint value either side of the deadband without excessive hunting.

H. Sampling Strategy for Identical Units
1. All identical AHU's over 15 tons shall not have any sampling--test all units. However, 25% of the units may have monitoring be the verification method for modes listed with Monitoring or Both as testing methods, with no less than three units being fully tested per the above requirements.
2. All identical AHU's equal to or less than 15 tons shall be sampled:
Randomly test at least 50% of each group of identical equipment (the 1st sample) per the above tests. In no case test less than three units in each group. If 20% of the units in the first sample fail the functional performance tests, test another the remaining 50%, fully at the contractor's expense. This sampling applies to the testing subsections. That is, if calibration is off on more than 10% of the tested piece of equipment, then another sample shall have calibrations checked, but not all other tests need to be done on the second sample.
3. All units not included in the sampling testing and monitoring shall be fully monitored for the monitoring modes listed above in the monitoring section.

3.10. BUILDING AUTOMATION SYSTEM (BAS) CHECKLISTS

A. Parties Responsible to Execute Functional Test
1. Controls contractor: operate the controls to activate the equipment.

2. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested — Pre-functional Checklist ID

1. Building Automation System — PC-_____
2. All pre-functional checklists of controlled equipment — ---

D. Prerequisites The applicable prerequisite checklist items shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the pre-functional checklists previously completed by the installer, before the beginning of functional testing.

E. A significant part of the BAS functional testing requirements is the successful completion of the functional tests of equipment the BAS controls or interlocks with. Uncompleted equipment functional tests or outstanding deficiencies in those tests lend the required BAS functional testing incomplete.

F. Integral or stand-alone controls are functionally tested with the equipment they are attached to, including any interlocks with other equipment or systems and thus are not covered under the BAS testing requirements, except for any integrated functions or interlocks listed below.

G. In addition to the controlled equipment testing, the following tests are required for the BAS, where features have been specified. The following testing requirements are in addition to and do not replace any testing requirements elsewhere in the specifications.

Function / Mode	Test Method Manual (demonstration), Monitoring, Either or Both
MISC. FUNCTIONS	
1. All specified functions and features are set up, debugged and fully operable	Verbal discussion of features
2. Power failure and battery backup and power-up restart functions	Demonstration
3. Specified trending and graphing features demonstration	See equipment trends
4. Global commands features	Demonstration
5. Security and access codes	Demonstration
6. Occupant over-rides (manual, telephone, key, keypad, etc.)	Demonstration
7. O&M schedules and alarms	Demonstration
8. Scheduling features fully functional and setup, including holidays	Observation in terminal screens or printouts
9. Date and time setting in central computer and verify field panels read the same time	Demonstration
10. Included features not specified to be setup are installed (list)	Demonstration
11. Occupancy sensors and controls	Demonstration
12. Demonstrate functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad	Demonstration of 100% of panels and 10% of ports
13. All graphic screens and value readouts completed	Demonstration
14. Setpoint changing features and functions	Done during equipment testing
15. Communications to remote sites	Demonstration
16. Sensor calibrations	Sampled during equipment tests
17. "After hours" use tracking and billing	

Function / Mode	Test Method Manual (demonstration), Monitoring, Either or Both
18. Final as-builts or redlines (per spec) control drawings, final points list, program code, setpoints, schedules, warranties, etc. per specs, submitted for O&Ms.	Observation
19. Verify that points that are monitored only, having no control function, are checked for proper reporting to BAS.	Observation
INTEGRATED TESTS	
20. Fire alarm interlocks and response	Demonstration
21. Duty cycling (if specified)	Monitoring
22. Demand limiting (including over-ride of limiting)	Monitoring
23. Sequential staging ON of equipment	Either
24. Optimum start-stop functions	Monitoring
25. All control strategies and sequences not tested during controlled equipment testing	Either
26. Other integrated tests specified in the contract documents	
27. Security system interlocks	Demonstration
28. Fire protection and suppression systems	Demonstration

H. Special Procedures (other equipment to test with, etc.; reference to function ID)
None

I. Additional Required Monitoring
1. Besides the trending and monitoring required with the functional testing of equipemint, all points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
Misc. equipment current or status for duty cycling and demand limiting	5	5 days incl. weekend	Y	Y	21-22
Equipment or building kW or current for demand limiting	5	5 days incl. weekend	Y	Y	21-22
Optimum start/stop equip.	5	5 days incl. weekend	Y	Y	24

Remarks:

I. Acceptance Criteria (referenced by function or mode ID)
All For the conditions, sequences and modes tested, the BAS, integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

J. Sampling Strategy for Identical Units
1. Sample 10% of the field panels for procedure 9, and 10% of the local ports for procedure 12. If 10% fail, test another 10%. If 10% of those fail, test all remaining units at the contractor's expense.

3.11 CHILLER CHECKLISTS

(Note)The cooling tower can be tested integrally with the chiller testing. The cooling tower test requirements shall be as listed elsewhere.

A. Parties Responsible to Execute Functional Test
1. Controls contractor shall operate the controls as needed.
2. HVAC mechanical contractor or vendor shall assist in testing sequences as needed.
3. CA shall witness, direct and document testing.

B. The applicable prerequisite checklist shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent shall also spot-check misc. items and calibrations on the pre-functional checklists previously completed by the installer, before the beginning of functional testing.

C.

Integral Components or Related Equipment Being Tested	Pre-functional Checklist ID
1. Chiller	PC-_____
2. Primary CHW supply pumps	PC-_____
3. Chilled water piping system	PC-_____
4. Secondary CHW supply pumps	PC-_____
5. VFD on secondary pumps	PC-_____
6. Cooling tower	PC-_____

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements
The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

Function / Mode	Test Method Manual, Monitoring, Either or Both	Required Seasonal Test[1]
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unnoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated. A full cycle from no load to full load and then to no load and compressors off shall be demonstrated.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Primary Side. Lead/lag staging of chillers, optimization, capacity modulation (loading and unloading), heat reclaim, and primary CHW supply pumps, all relating to maintaining CDW and CHW temperatures.	Both	Cooling
3. Secondary Side. Secondary CWH supply pump staging, bypass valve operation, if no VFD and CHWT reset. VFD operation: modulation to minimum, control system PID, proportional band of speed vs controlling parameter, alarms, verification of program settings, etc.	Both	Cooling
4. All alarms: high and low pressure, low oil, etc.	Manual	
5. Test each possible lead chiller as lead chiller, and each pump as lead pump, including standby pumps.	Manual	

Function / Mode	Test Method Manual, Monitoring, Either or Both	Required Seasonal Test[1]
6. kW/ton and APLV efficiency test, optional	Manual	Cooling
7. Capacity test, optional	Manual	Cooling Design
8. Sensor and actuator calibration checks on: ECDWT, CHWST, pressure sensor controlling pump speed, 3-way valve, and other random checks (EMS readout against handheld calibrated instrument must be within 0.5°F for temps. or within a tolerance equal to 10% of the pressure setpoint, with a test gage)	Manual	
9. Verify schedules and setpoints to be reasonable and appropriate		

[1]Cooling season, Heating season or Both. "Design" means within 5°F of season design (ASHRAE 2 1/2%), or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.

E. Special Procedures (other equipment with which to test, etc.; reference to function ID)
1. Test with cooling tower in automatic mode.
2. False load chiller, if necessary.

F. Required Monitoring
1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each chiller and pump:					
Chiller current	5	5 days incl. weekend	Y	Y	1-3
ECDWT	5	5 days incl. weekend	Y	Y	1-3
LCDWT	5	5 days incl. weekend	Y	Y	1-3
CDW pump current or status	5	5 days incl. weekend	Y	Y	1-3
CHWST	5	5 days incl. weekend	Y	Y	1, 3
CHWRT	5	5 days incl. weekend	Y	Y	1, 3
OSAT-DB	5	5 days incl. weekend	Y	Y	1-3
CHWS primary pump current or status	5	5 days incl. weekend	Y	Y	1, 2
CHWS secondary pump speed, if variable	5	5 days incl. weekend	Y	Y	1, 3
CHWS secondary pump flow rate	5	5 days incl. weekend	Y	Y	1, 3
CHWS secondary pump speed controlling parameter value	5	5 days incl. weekend	Y	Y	1, 3

Remarks:

G. Acceptance Criteria (referenced by function or mode ID)

1-9. For the conditions, sequences and modes tested, the chillers, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.
2. Chiller shall maintain the chilled water supply setpoint to within +/- 1.0F of setpoint deadband without excessive hunting.
9. Pumping system and controls shall maintain the current desired pressure setpoint to within an amount equal to 10% of the setpoint value either side of the deadband without excessive hunting.

H. Sampling Strategy for Identical Units
1. No sampling, test all.

3.12 COOLING TOWER CHECKLISTS
(Note)The cooling tower can be tested integrally with the chiller testing.

A. Parties Responsible to Execute Functional Test
1. Controls contractor: operate the controls, as needed.
2. HVAC mechanical contractor or vendor: assist in testing sequences, as needed.
3. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested — Pre-functional Checklist ID
1. Condenser water pump — PC-____
2. Cooling tower and components — PC-____
3. Condenser water piping system — PC-____
4. Fan VFD — PC-____

C. The applicable prerequisite checklist items shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the pre-functional checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements: The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

Function / Mode	Test Method Manual, Monitoring, Either or Both	Required Seasonal Test[1]
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unnoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Cooling season modes of operation.	Both	Cooling
3. Heating season modes of operation.	Both	Heating

Function / Mode	Test Method Manual, Monitoring, Either or Both	Required Seasonal Test[1]
4. Lead/lag staging of towers, including testing each tower as lead tower. Staging of fans, spray pumps, condenser pumps, CDWT reset, time delays.	Both, except[2]	
5. Bypass valve operation and ability of CT to maintain entering CDW temperature.	Either	
6. Sump heater and freeze protection operation.	Either	Heating
7. All alarms: vibration, fan failure, high water, low water.	Manual	
8. Verify approach temperature with manuf. specs, optional.	Either	
9. VFD operation: modulation to low limit, controlling PID, proportional band of speed vs control parameter, verification of program settings, alarms.	Both	
10. Capacity test, optional.	Manual	Clg. Des.
11. Sensor and actuator calibration checks: See Chiller requirements.	Manual	
12. Verify schedules and setpoints to be reasonable and appropriate.		

[1]Cooling season, Heating season or Both. "Design" means within 5°F of season design (ASHRAE 2 1/2%), or 95% of loading design. A blank cell denotes no special seasonal test is required and that testing can be executed during any season, if condition simulation is appropriate.
[2]Monitoring testing each tower as lead tower is not necessary.

E. Special Procedures or Conditions (other equipment to test with, etc.; reference to function ID)
1. Tests to be made with chiller in automatic mode.
2. False load chiller, if necessary.

F. Required Monitoring
1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each CT:					
CDEWT	5	Wed. - Sat	Y	Y	1, 2, 4, 9
CDLWT	5	Wed. - Sat	Y	Y	1, 2, 4, 8, 9
OSAT-DB	5	Wed. - Sat	Y	Y	1, 2, 4, 8,9
OSAT-WB (optional)	5	Wed. - Sat	Y	Y	8
Fan motor speed, stage or current	5	Wed. - Sat	Y	Y	4, 9
CDW pump status or current	5	Wed. - Sat	Y	Y	1, 2, 4, 9
Each chiller status or current	5	Wed. - Sat	Y	Y	1, 2, 4, 9

Remarks:

G. Acceptance Criteria (referenced by function or mode ID)

1-12. For the conditions, sequences and modes tested, the cooling tower(s), integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

5. Cooling tower should be able to maintain the current specified setpoint for entering condenser water to within +/- 2F, when outside conditions do not restrict this thermodynamically.

H. Sampling Strategy for Identical Units
1. No sampling, test all.

3.13 EXHAUST FANS CHECKLISTS

(NOTE)The testing requirements apply to the following fans (check all that apply): __central restroom, __mechanical room, __stairwell pressurization, __elevator pressurization, __kitchen hood, __garage

A. Parties Responsible to Execute Functional Test
1. Controls contractor: operate the controls to activate the equipment, if BAS controlled.
2. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested — Pre-functional Checklist ID
1. Exhaust fans — PC-_____

C. Prerequisites The applicable prerequisite checklist items shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the pre-functional checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements
The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

Function / Mode	Test Method Manual, Monitoring, Either or Both[1]	Required Seasonal Test
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unnoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Verify schedules and setpoints to be reasonable and appropriate		
3. Function at fire alarm (off, depressurization, etc.)	Manual	
4. Interlocks to building pressurization control	Manual	
5. Speed controls	Either	
6. Check TAB report record of sound power level tests and space pressures and compare to specifications	Review	
7. Sensor calibration checks on any controlling temperature or pressure sensor	Manual	

[1]Refer to Special Procedures

E. Special Procedures (other equipment to test with, etc.; reference to function ID)
None

F. Required Monitoring
1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each fan:					
Do be determined					

Remarks:

G. Acceptance Criteria (referenced by function or mode ID)
1-6. For the conditions, sequences and modes tested, the fans, integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

H. Sampling Strategy for Identical Units of the same type and function, but different in size, are considered identical for sampling purposes.
1. Randomly test at least 10% of each group of identical equipment (the 1st sample). In no case test less than three units in each group. If 10% of the units in the first sample fail the functional performance tests, test another 10% of the group (the 2nd sample). If 10% of the units in the 2nd sample fail, test all remaining units in the whole group, fully at the contractor's expense. This sampling applies to the testing subsections. That is, if calibration is off on more than 10% of the tested piece of equipment, then another sample shall have calibrations checked, but not all other tests need to be done on the second sample.

3.14 INDOOR AIR CLIMATE CONTROL--MISC. SYSTEMS CHECKLISTS
(NOTE)At least 10% of all space zones shall be verified to be maintaining proper climate control. Specific test requirements for this may have been identified elsewhere in this specification (e.g., under terminal units). For all areas not specifically specified, otherwise, the following tests shall be conducted.

A. Parties Responsible to Execute Functional Test
1. Controls contractor: operate the controls and provide trend logs
2. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested
1. Cooling plant (entire system)
2. Heating plant (entire system)
3. Air, water or steam distribution system
4. Control system

C. Prerequisites All listed systems in Part B, above, shall have had successful functional tests completed prior to this test.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements

This is a performance test to verify that the HVAC systems can provide and maintain the temperature and relative humidity levels specified, during normal and extreme weather and occupancy conditions. The test consists of monitoring, via trend logs, of various points during the cooling season when temperatures reach to within 5°F of season design (ASHRAE 2 1/2%).

E. Special Procedures (other equipment to test with, etc.; reference to function ID)
1. Building should be normally occupied during the test.

F. Required Monitoring
1. All points listed below which are control system monitored points shall be trended by the controls contractor.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
Space temperature control:					
Space temperature	5	5 days incl. weekend	Y	Y	1-3
OSAT-DB	5	5 days incl. weekend	Y	Y	1-3

Remarks:

G. Acceptance Criteria (referenced by function or mode ID)
1. Space temperature during occupied modes shall average within +/- 1°F of setpoint and always remain within 1°F of the ends of the deadband without excessive hunting of either the applicable damper or coil valve, or complaints of drafts or stuffiness from occupants.

H. Sampling Strategy for Identical Units of the same type and function, but different in size, are considered identical for sampling purposes.
1. Randomly test at least 10% of each group of identical equipment (the 1st sample). In no case test less than three units in each group. If 10% of the units in the first sample fail the functional performance tests, test another 10% of the group (the 2nd sample). If 10% of the units in the 2nd sample fail, test all remaining units in the whole group, fully at the contractor's expense. This sampling applies to the testing subsections. That is, if calibration is off on more than 10% of the tested piece of equipment, then another sample shall have calibrations checked, but not all other tests need to be done on the second sample.

3.15 INDOOR AIR QUALITY CHECK (IAQ) CHECKLISTS

(Note)IAQ checking activities are not technically "functional testing." However, they are included here for consistency. Indoor air quality (IAQ) commissioning does not ensure that indoor air quality will be adequate or without deficiency at building turnover or during occupancy, unless the owner has specifically specified that actual air quality testing be performed. Commissioning for indoor air quality entails performing tasks that minimize the potential for IAQ problems, but it does not eliminate their possibility. .

A. Parties Responsible to Perform IAQ Checks
1. CA: performs and oversees checks, inspections and reviews.
2. TAB contractor: performs checks using test instruments for tasks under Part C

B. Prerequisites CA will perform each check and review as soon as the materials or work is such that IAQ related determinations can be made.

C. Purpose. The purpose of the IAQ check is to minimize the potential for IAQ problems in the facility during occupancy. The CA is not responsible for any IAQ issues during construction, nor for IAQ issues in the occupied part of the facility, if construction is being performed in other parts of the facility.

D. The following tasks will be conducted and documented:

1. Submittal Reviews Compare specified data with submitted data sheets for the following:
   a. Filtration and filter type.
   b. Materials that had specifications for emissions rates as part of the contract documents.
   c. HVAC materials that have a potential for airflow erosion, corrosion and microbial contamination (HVAC insulation materials, etc.).
   d. Manufacturer's safety data sheets (MSDS) for products specified in the contract documents that may be suspected contributors to indoor pollutants (carpets, flooring, fabrics, adhesives, wall coverings, partitions, and ceilings; insulating and fire-proofing materials; sealants on walls and floors; use of preservatives, paints, varnishes, and other finish materials).

2. Static Inspections and Checks
   a. Review the code compliance calculations for accuracy.
   b. Verify that the outdoor air intakes are sized and located according the plans and specifications.
   c. Verify that no outside conditions exist that could compromise the quality of the air entering the outdoor intakes.
   d. Inspect air intakes and exhausts for short-circuiting.
   e. Document any required ductwork cleaning.
   f. Prior to building turnover, verify that final filters are installed and coils, inside of units and ductwork is clean.
   g. Inspect air supply system components to ensure control and minimization of the presence of free and standing water and to minimize microbial contamination (condensate trays, traps, humidifiers, water baffles, mist eliminators and cooling towers).
   h. Verify proper access for cleaning of both sides of coils, condensate pans and/or humidifier reservoirs in all HVAC equipment.
   i. Meet with contractors and review any specified manufacturer's recommended curing, drying and airing procedures (for minimizing emission rates). Document the compliance of the contractors.
   j. When the building is partially occupied during construction, meet with the Contractor and issue a plan in writing for operation of the HVAC system. The plan will describe how the system can be operated at as close to normal operating conditions as possible, to minimize dust and dirt from contaminating the ductwork and coils and polluting the occupied areas, and to prevent damaging moisture migration.
   k. Review TAB reports for consistency with the specifications.
   l. After completion of TAB, review with the TAB contractor, any areas they may consider as being potentially problematic regarding maintaining adequate minimum outdoor air, proper exhaust or room pressure differential.

3. Air Flow and Pressurization Checks
   a. Verify that the specified minimum ventilation rates are maintained during all occupied modes of operation, particularly during VAV terminal box turn-down.
   b. Spot-check TAB supply air flow readings in critical areas.
   c. Spot-check the TAB measurements and setup of the exhaust systems for each area. When purging is specified in the contract documents, develop a plan for, and see that the Contractor purges the building prior to occupancy.
   d. Verify that the total building pressurization criteria is met through varying HVAC loads and economizing conditions.
   e. Verify that room pressure differentials are as specified between critical areas (clean rooms, bio-hazards, film developing rooms, chemical storage areas, etc.).
   f. Verify that the design engineer's specification for interstitial and area pressurization differentials has been met.

4. Verification
   a. Verify that the specified ventilation effectiveness throughout the various areas of the building is being met by: ___smoke tube testing for airflow patterns, ___flow hood readings, ___air contaminant monitoring, ___other_____.
   b. Perform IAQ testing using the following methods (surface cultures for microbial contamination, airborne culture testing, CO_2 monitoring, VOC monitoring, CO monitoring, etc.).

E. Acceptance Criteria Unless noted in the requirements, the commissioning agent in concert with the CM will make determinations and interpretations for when IAQ issues are considered to be in compliance with the contract documents.

3.16 PACKAGED DX AIR CONDITIONING CHECKLISTS

A. Parties Responsible to Execute Functional Test
1. Controls contractor: operate the controls to activate the equipment.
2. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested ID — Pre-functional Checklist
1. Unit (fans, coils, condenser, compressors, ducts, VFD) — PC-_____
2. Heat recovery coil , humidifier or direct / indirect evaporative cooling sections — PC-_____

C. Prerequisites The applicable prerequisite checklist items shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the pre-functional checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

Function / Mode	Test Method Manual, Monitoring, Either or Both[3]	Required Seasonal Test[1]
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unnoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Mixed and supply air, and reset temp. control functions	Both	
3. Economizer functions	Both	Cooling
4. SF, RF and exhaust fan interlocks	Either	
5. Compressor unloading & condenser fan staging for head pressure control	Both	
6. Demand limiting control (if applicable)	Monitoring	Cooling
7. Duct static pressure (SP) control	Both	
8. Return or exhaust fan tracking and building SP	Monitoring	
9. VFD (or inlet vanes) operation on SF and RF: modulation to minimum, control system PID, proportional band of speed vs controlling parameter, constancy of static pressure, verification of program settings, alarms, etc	Both	[2]
10. Damper interlocks and correct modulation in all modes, including fire and smoke dampers	Manual	
11. Temperature difference across heating and cooling coils, if spec'd	Manual	
12. Verification of minimum OSA quantity and control through varying VAV box positions	Either	[2]
13. Branch duct control damper control	Manual	
14. Night low and high limit, morning warmup cycle,	Either	
15. Heat recovery operation	Monitoring	
16. Verify TAB reported SF cfm with control system reading	Manual	[2]
17. All alarms (low limits, high static, freezestat, etc.)	Manual	
18. Unit heating and cooling capacity tests, optional	Manual	Design
19. Heating and cooling EER or COP efficiency tests, optional		Design
20. Change over function from heating to cooling and defrost (heatpumps)	Manual	
21. Sensor and actuator calibration checks on: duct static pressure sensor on units >10 tons, SAT, MAT, OSAT, economizer and RA dampers and other random checks (EMS readout against hand-held calibrated instrument must be within 0.5°F for temps. or within a tolerance equal to 10% of static pressure setpoint, with an inclined manometer)	Manual	
22. Verify control strategies, schedules and setpoints to be reasonable and appropriate		

[1]Cooling season, Heating season or Both. "Design" means within 5°of season design (ASHRAE 2 1/2%), or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.
[2]Seasonal test not required if seasonal conditions can be adequately simulated.
[3]Refer to Special Procedures

E. Special Procedures (other equipment to test with, etc.; reference to function ID)
1. Reduced Testing for Smaller Units. For standard application AHU's less than 15 tons, the following modifications to the testing requirements apply: 1) either Manual or Monitoring will satisfy the verification requirement--where Both is listed, choose one. 2) Testing Modes 6, 8, 11, 13 and 16 is not required.

F. Required Monitoring
1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each Unit being tested:					
RAT	5	5 days incl. weekend	Y	Y	1-3, 5, 19
SAT	5	5 days incl. weekend	Y	Y	1-3, 5
CC LAT	5	5 days incl. weekend	Y	Y	1-3, 5
HC LAT	5	5 days incl. weekend	Y	Y	1-3, 5
MAT	5	5 days incl. weekend	Y	Y	1, 3, 19
Indoor WB or enthalpy	5	5 days incl. weekend	Y	Y	1, 3
SF speed	5	5 days incl. weekend	Y	Y	1, 5-9
RF speed	5	5 days incl. weekend	Y	Y	1, 5-9
Duct SP	5	5 days incl. weekend	Y	Y	1, 7, 9
Building SP differential	5	5 days incl. weekend	Y	Y	8
OSAT	5	5 days incl. weekend	Y	Y	All
OSAT-WB or enthalpy	5	5 days incl. weekend	Y	Y	1, 3
Indoor dry-bulb ___zones	5	5 days incl. weekend	Y	Y	All
Compressor amps or stage	5	5 days incl. weekend	Y	Y	5
Condenser fan amps or stage	5	5 days incl. weekend	Y	Y	5

Remarks:

G. Acceptance Criteria (referenced by function or mode ID)
1-22. For the conditions, sequences and modes tested, the system, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.
2. RTU shall be able to maintain the SA temperature within 1.0F either side of the deadband of the current setpoint without excessive hunting.
7. RTU and controls shall control the duct static pressure so that it does not drift more than an amount equal to 10% of the setpoint value either side of the deadband without excessive hunting.

H. Sampling Strategy for Identical Units
1. All identical AHU's over 15 tons shall not have any sampling--test all units. However, 25% of the units may have monitoring be the verification method for modes listed with Monitoring or Both as testing methods, with no less than three units being fully tested per the above requirements.
2. All identical AHU's equal to or less than 15 tons shall be sampled:
Randomly test at least 50% of each group of identical equipment (the 1st sample) per the above tests. In no case test less than three units in each group. If 20% of the units in the

first sample fail the functional performance tests, test another the remaining 50%, fully at the contractor's expense. This sampling applies to the testing subsections. That is, if calibration is off on more than 10% of the tested piece of equipment, then another sample shall have calibrations checked, but not all other tests need to be done on the second sample.

3. All units not included in the sampling testing and monitoring shall be fully monitored for the monitoring modes listed above in the monitoring section.

3.17 SERVICE HOT WATER SYSTEM CHECKLISTS

A. Parties Responsible to Execute Functional Test
1. CA: perform and document testing.

B. Integral Components or Related Equipment Being Tested — Pre-functional Checklist ID
1. Hot water heaters (heaters, mixing valves) — PC-_____
2. Recirculating pumps — PC-_____

C. Prerequisites The applicable prerequisite checklist items shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the pre-functional checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

Function / Mode	Test Method Manual, Monitoring, Either or Both	Required Seasonal Test
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unnoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Verify schedules and setpoints to be reasonable and appropriate		
3. Unoccupied pump operation	Either	
4. Mixing valve operation and temperature control	Either	
5. Sensor calibration checks on hot water temperature	Manual	

E. Special Procedures (other equipment to test with, etc.; reference to function ID)
None

F. Required Monitoring
None

G. Acceptance Criteria (referenced by function or mode ID)

1-6. For the conditions, sequences and modes tested, the fan's integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

H. Sampling Strategy for Identical Units
1. No sampling. Test all units.

3.18 TERMINAL UNITS CHECKLISTS
(This applies to standard applications, critical applications will have additional tests and a higher fraction tested.)

A. Parties Responsible to Execute Functional Test
1. Controls contractor: operate the controls to activate the equipment.

B. Integral Components or Related Equipment Being Tested — Pre-functional Checklist ID
1. Terminal unit (TU) — PC-_____

C. Prerequisites The applicable prerequisite checklist items shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the pre-functional checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements
The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

Function / Mode	Test Method Manual, Monitoring, Either or Both[3]	Required Seasonal Test[1]
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, warmup, shutdown, unnoccupied & manual modes and power failure and restoration. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with, including all damper, valve and fan functions.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Sensor activator calibration checks on: SAT, MAT, zone air temperature damper position and other random checks (EMS readout against visual or hand-held calibrated instrument must be within 0.5°F for temps. or within a tolerance equal to 10% of static pressure setpoint, with an inclined manometer)	Manual	
3. Device and actuator calibration and stroke checks for heating coil valve and non-DDC dampers	Manual	
4. For the TU's tested, check the prefunctional checklist items.	Observation	
5. Verify control parameters and setpoints to be reasonable and appropriate by reviewing the full program of 5% of all the TU's with each other for consistency. Verify the max. and min. cfm setpoints of all tested TU's against the control drawing and TAB values. Verify other TU programming parameters such as K-factors, deadbands, setpoints, stroke times, etc.	Observation	
6. Verify no CCV flow when there is HCV flow	Either	

Function / Mode	Test Method Manual, Monitoring, Either or Both[3]	Required Seasonal Test[1]
7. Verify no hunting or significant overshoot by damper or valves.	Either	
8. Verify by measurement, CCV & HCV positive shutoff (no leak-thru)	Manual	
9. Verification of minimum OSA control through varying VAV box positions, if applicable	Either	[2]
10. All alarms (fan status, low limits, high static, etc.)	Manual	
11. Verify that TU is maintaining space setpoint temperatures	Monitoring	Both Design
12. Verify airflows and pressures (this random test is part of the TAB test)	--	

NOTES:

[1]Cooling season, Heating season or Both. "Design" means within 5°F of season design (ASHRAE 2 1/2%), or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.
[2]Seasonal test not required if seasonal conditions can be adequately simulated.
[3]Refer to Special Procedures

E. Special Procedures (other equipment to test with, etc.; reference to function ID)
None

F. Required Monitoring
1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each zone thermostat and space sensor and other critical areas, monitor:					
Space temperature	10	3 weekdays, summer design	Y	Y	11
Space temperature	10	3 weekdays, winter design	Y	Y	11
Space temperature	2	8 hours, occupied	Y	Y	7
Heating coil valve	2	8 hours, occupied	Y	Y	7
Damper position or cfm	2	8 hours, occupied	Y	Y	7

Remarks:

G. Acceptance Criteria (referenced by function or mode ID)
1-11. For the conditions, sequences and modes tested, the TU, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.
10. Space temperature during occupied modes shall average within +/- 1°F of setpoint and always remain within 1°F of the ends of the deadband without excessive hunting of either the damper or coil valve, or complaints of drafts or stuffiness from occupants.

H. Sampling Strategy for Identical Units of the same type and function, but different in size, are considered identical for sampling purposes.
1. Testing. Randomly test at least 10% of each group of identical equipment (the 1st sample). In no case test less than three units in each group. If 10% of the units in the

first sample fail the functional performance tests, test another 10% of the group (the 2nd sample). If 10% of the units in the 2nd sample fail, test all remaining units in the whole group, fully at the contractor's expense. This sampling applies to the testing subsections. That is, if calibration is off on more than 10% of the tested piece of equipment, then another sample shall have calibrations checked, but not all other tests need to be done on the second sample.

2. Monitoring. Ten percent of the total number of zones in the building, chosen by the Owner, shall be monitored. Within this 10%, shall be included a distribution of all air handlers, zones expected to have the greatest heating and cooling demand, perimeter and core zones and zones identified from the commissioning process that have exhibited potential problems.

3.19 TEST AND BALANCE WORK (TAB) CHECKLISTS

A. Parties Responsible to Execute Functional Test
1. TAB contractor: perform checks using test instruments.
2. Controls contractor: operate the controls to activate the equipment.
3. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested — Pre-functional Checklist ID
1. TAB water-side — PC-_____
2. TAB air-side — PC-_____

C. Prerequisites The applicable prerequisite checklist items shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the pre-functional checklists previously completed by the installer, before the beginning of functional testing.

D. Purpose. The purpose of this test is to spot check the TAB work to verify that it was done in accordance with the contract documents and acceptable practice and that the TAB report is accurate.

E. The following tests and checks will be conducted. The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

Test or Check	Test Method	Required Seasonal Test[3]

Test or Check	Test Method	Required Seasonal Test[3]
1. A random sample of up to _____ % the TAB report data shall be selected for verification (air velocity, air or water flow rate, pressure differential, electrical or sound measurement, etc.). The original TAB contractor will execute the checks, witnessed by the commissioning authority. The TAB contractor will use the same test instruments as used in the original TAB work. A failure[1] of more than 10% of the selected items of a given system[2] shall result in the failure of acceptance of the system TAB report and the TAB contractor shall be responsible to rebalance the system, provide a new system TAB report and repeat random verifications of the new TAB report. The random testing will include the verification of minimum outdoor air intake flows at minimum, maximum and intermediate total airflow rates for _____% of the air handlers. Other selected data to be verified will be made known upon day of testing.	Demonstration	
2. Verify that final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked by the TAB Contractor.	Demonstration	
3. Verification that the air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity. This shall include a review of TAB methods, control setpoints established by TAB and a physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all TUs taking off downstream of the static pressure sensor, the TU on the critical leg has its damper 90% or more open.	Demonstration	
4. Verification that the water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity. This shall include a review of TAB methods, control setpoints established by TAB and a physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90% or more open.	Demonstration	

[1]Failure of an item is defined as follows:
For air flow of supply and return: a deviation of more than 10% of instrument reading
For minimum outside air flow: 20% of instrument reading (30% for reading at intermediate supply flow for inlet vane or VFD OSA compensation system using linear proportional control)
For temperatures: a deviation of more than 1°F
For air and water pressures: a deviation of more than 10% of full scale of test instrument reading
For sound pressures: a deviation of more than 3 decibels. (Variations in background noise must be considered)

[2]Examples of a "system" are: the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system. Systems can be

defined smaller if inaccuracies in TAB work within the smaller defined system will have little or no impact on connected systems.

[3]Cooling season, Heating season or Both. "Design" means within 5°of season design (ASHRAE 2 1/2%), or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.

F. Special Procedures (other equipment to test with, etc.; reference to function ID)
None

G. Required Monitoring
None

I. Acceptance Criteria (referenced by function or mode ID)
Provided in footnote to test table above.

J. Sampling Strategy for Identical Units
Described in test table above.

END OF SECTION 15050

SECTION 15400 - PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including General and Supplementary Conditions and General Requirements apply to the work specified in this Section.

1.2 DESCRIPTION OF WORK

A. Furnish and install new fixtures, waste, vent, cold water and hot water piping shown on plans.

B. Connections of all equipment and fixtures with accessory fittings, shut-off valves, trimmings, traps, structural supports, insulation, etch., as herein specified and/or as shown on drawings.

C. Refer to SECTION 15050 which is applicable to this Section.

D. Include (but not necessarily limited to) the following items of mechanical equipment, fixtures and materials installed and in a first class operating condition:

1. All labor, materials, equipment, accessories, and miscellaneous items required to provide a complete plumbing system. Provide adequate supervision at all times during the progress of the work.
2. All plumbing piping and hangers for same as specified herein and where shown on the Architectural and/or mechanical drawings.
3. New water service with connections to service mains at 5'-0" outside the building and connection to water distribution.
4. New sewer services, with connections to service mains at 5'-0" outside the building and piping distribution.
5. New Natural gas system with connections to service mains at 5'-0" outside the building and distribution as shown on the drawings
6. Hose bibbs.
7. Floor and miscellaneous drains.
8. All sewer, waste and vent piping and all cleanouts necessary for a complete operation installation as shown on mechanical drawings, or as required by the State and Local Sanitary Codes.
9. Temporary water, sanitary, etc., facilities during construction period.

1.3 QUALITY ASSURANCE

A. Provide plumbing fixtures and accessories for work in this Section produced, meeting the requirements specified.

B. Soldering processes shall conform to ASME B31.3 Process Piping and Copper Development Association recommended practices.

PART 2 - PRODUCTS

2.1 SANITARY SEWER

A. All soil, waste and vent piping 2" in size and larger shall be service weight cast-iron, bell and spigot. All cast-iron lines shall have neoprene gaskets. All waste and vent lines 1-1/2" in size

and smaller shall be galvanized steel cast-iron drainage fittings. Contractor's option piping above ground may be "No-Hub".

B. Cleanouts in sanitary lines, both inside and outside at building, cast-iron body caulking ferrules with brass thread flanged plugs as manufactured by Alabama Pipe Co., or approved equal.

C. Cleanout covers located in floors for sewer lines inside of building, with satin brass scoriated tops and covers.

D. Cleanouts shall be installed in each change of direction of sewer lines where more than a 45 degree angle turn is made. Cleanouts shall be provided within 18" of each sanitary tee.

E. Cleanouts on underground lines shall be brought to a cast-iron cleanout box, with service marking, 1/2" thick flanged type and loose cover. Provide 12" X 4" thick concrete slab around cover and frame.

F. Size and distance between cleanouts shall be required by local authorities and/or as indicated on drawings.

G. All floor drains shall be provided with trap primers and ½" trap primer line.

2.2 DOMESTIC WATER

A. Ball valves shall be provided where indicated on drawings and shall be designed for a minimum water working pressure of not less than one hundred fifty (150) pounds per square inch. Each underground valve shall be protected by a cast-iron valve box with minimum thickness of 3/16 inch. The cover shall have the word "WATER" cast in the metal.

B. Hot and cold water piping inside the building shall be hard drawn seamless copper tubing, type "L", with wrought copper sweat fittings and lead free solder above grade. No joints shall be allowed under building slab, on piping 1" and smaller, larger pipe sizes shall have joints with lead free solder. Water piping underground shall be Type "K". Piping on exterior of building shall be Type "K".

C. All piping, fittings, solder and flux used in conjunction with the potable water systems shall be lead free. The term "lead free" shall be as defined in the Safe Drinking Water Act Amendment of 1986 (P.L. 99-339).

2.3 GAS PIPING

A. All gas piping above ground shall be Schedule 40 black steel and shall be fitted with malleable iron fittings.

B. All new gas piping run above ground shall be exposed or in ventilated spaces.

C. All gas piping underground shall be polyethylene pipe with butt fusion joints and fittings and a minimum 110 PSI design pressure. Pipe transitions to steel shall be made with transition fittings. The underground system shall meet the requirements of ASTM D3261 and ASTM D2513.

D. The project gas distribution system shall be electrically insulated from the utility company's system on the service side of the gas meter with insulated flanges.

E. Provide, where indicated on the drawings, a new gas service connection for the project. Provide a new gas cock to shut off the new building distribution piping.

2.4 STORM DRAIN SYSTEM

A. All storm drain piping inside the building, under slab, out to the connections at the site service main shall be as follows.

1. Above ground standard weight cast iron "No-Hub" as specified for sanitary sewer above ground.
2. Underground shall be standard weight cast-iron bell and spigot as specified for underground sanitary sewer systems.

B. Cleanouts shall be as specified for sanitary sewer, except covers shall have the word "Drain" cast in them.

2.5 FIXTURES

A. Furnish, install and/or connect all plumbing fixtures indicated on drawings or as herein specified. Refer to Mechanical as well as Architectural Drawings for location and number of fixtures required. If any fixtures shown on Architectural Plans but not on Mechanical Plans, or vice versa, these fixtures shall be furnished, installed and connected the same as if indicated on all drawings. See Architectural Drawings for specific fixtures required. Where a specific manufacturer's name and catalog number is used to indicate the type and quality required, it shall be assumed that other manufacturer's products may be used, where they are equal and approved by the Architect as stipulated elsewhere herein.

B. Each plumbing fixture shall be fitted with all necessary and proper fittings, trim and operating devices and shall be left in perfect operating condition. The finish of all traps, wall escutcheons, and exposed metal work in connection with fixtures, trimmings and operating devices shall be chromium plated.

C. Before setting any fixtures or rough-in for fixtures, obtain the exact mounting height, as desired, from the Architect.

D. Equipment shown on drawings to be furnished under other sections shall be roughed-in, installed and connected by this Contractor under this Section. This Contractor shall furnish and install all necessary valves, piping, fittings and waste traps, etc., not provided with said equipment but as required for proper operation and installation. Obtain rough-in dimensions before installing any piping.

E. Plumbing fixtures shall be as follows:

WATER CLOSET (MARK P-1)
Wall hung; china; elongated rim; 2-1/2" trapway; 1-1/2" top back spud; blowout bowl; open front extra heavy solid plastic white seat less cover with check hinge and stainless steel posts; electronic battery operated flush valve with metal cover, over-ride button, screwdriver stop and back flow vacuum breaker; single or double concealed commercial chair carrier with adjustable fixture support as required. Chair carrier bolts and nuts shall be brass material with chrome plated nuts.

WATER CLOSET (MARK P-1A)
Same as Mark P-1 except mount for handicap use, ADA compliant.

LAVATORY (MARK P-2)
Countertop; China; mount for handicap use, ADA compliant; grid strainer with 1-1/2" tailpiece; 1-1/2" c.p. "P" trap with cleanout plug and with offset waste to wall; battery operated electronic faucet with two back checks, solenoid valve, control module; 3/8" flexible metal c.p. risers with wheel handle stops; provide all piping from supplies to fixture; insulate waste and water piping under fixture with closed cell insulation, as manufactured by Truebro or approved equal.

URINAL (MARK P-3)
Wall hung; china; top spud; low consumption; mount for handicap use ADA compliant; blow-out action; concealed chair carrier with hanger plate and bottom bearing plate; battery electronic sensor flush valve with vacuum breaker and screwdriver stop.

SINK (MARK P-4)
Stainless steel; two compartment; countertop; self rimming; 18 ga. type 304 s.s.; 3/8" flexible supplies with wheel handle stops; two stopper strainers; continuous waste; 1-1/2" c.p. "P" trap with waste to wall.

URINAL (MARK P-3)
Wall hung; china; top spud; low consumption; wall hanger; mount for handicap use, ADA compliant; battery electronic sensor flush valve with vacuum breaker and screwdriver stop.

URINAL (MARK P-3A)
Same as Mark P-3 except mount for handicap use, ADA compliant.

SINK (MARK P-4)
Stainless steel; two compartment; countertop; U-channel mounting; self rimming; 18 ga. type 304 s.s.; 3/8" flexible supplies with wheel handle stops; two stopper strainers; continuous waste; 1-1/2" c.p. "P" trap with waste to wall.

SERVICE SINK (MARK P-5)
Terrazzo corner floor mop sink; 12" high sides and 6" drop front; 32" X 32" X 12"; s.s. caps on all curbs; faucet with integral stops; wall brace and vacuum breaker; hose and hose bracket; stainless steel strainer and 3" deep seal "P" trap.

DRINKING FOUNTAIN (MARK P-6)
Wall mounted; dual level; electric fountain; ADA compliant; Lead Free; stainless steel; 120V; 1-1/2" "P" trap; 3/8" c.p. metal supply with wheel handle stop; 8 GPH to 50 degree F at 90 degree F ambient.

SHOWER (MARK P-7)
Field Constructed shower stall, see Architectural details. ADA compliant; pressure balancing mixing valve faucet with 3-way hand held shower/slide bar; wall supply elbow adjustable temperature limit stop: 2" floor drain.

EMERGENCY EYEWASH (MARK P-8)
Wall mounted eye/face wash; 11" stainless steel receptor; aluminum wall bracket; ABS plastic eye/face wash heads; 1½" tailpiece; flow control fitting; inline strainer; thermostatic tempered water mixing valve with adjustable high limit stop and dial thermometer; hot and cold water valve stops;

HOSE BIBB (MARK HB)
3/4" rough brass, loose key sill cock with vacuum breaker, Use for all interior hose bibs.

HOSE BIBB (MARK HB-1)
Wall hydrant cast box with cover, bronze finish, loose key with vacuum breaker. Use for all exterior hose bibs.

FLOOR DRAIN (MARK FD)
Cast-iron - See plans for sizes. Nickel brass square strainers in toilet rooms and finished areas. All floor drains shall have 4" deep seal traps and trap primer connections.

FLOOR DRAIN (MARK FD-1)
Cast iron body and flashing collar with extended rim nikaloy strainer, install with rim flush with floor. All floor drains shall have 4" deep seal traps and trap primer connections.

TRAP PRIMER (MARK TP)
Automatic water metering type, distribution unit to serve drains as shown on drawings. Install per manufacturers recommendations and provide wall access panel for periodic inspection.

ROOF DRAIN (MARK RD)
Cast iron drain with sump, flashing clamp, gravel stop and 16" diameter low profile dome, see drawings for sizes.

2.6 VALVES, STRAINERS, UNIONS AND FITTINGS

A. General - All material shall be new, of the best quality with same brand or manufacturer for all similar installations. SEE SECTION 15900 for type and manufacturer.

2.7 WATER HAMMER ARRESTORS

A. Provide arrestors as marked A.C. (air chambers) where shown on the drawings and/or as necessary to prevent water hammer in the piping based on actual piping arrangement on the job.

B. Install fluid water hammer arrestors in compliance with ASSE Standard 1010.

C. Each unit shall be constructed with a single moving part. The barrel shall be fabricated of Type "K" hard drawn copper, with the cap fabricated from standard wrought copper fittings attached to the barrel with lead free solder. The piston shall be machined from brass and equipped with rubber "O" rings.

2.8 DOMESTIC WATER BOOSTER PUMP

A. Furnish and install a Duplex constant speed, variable flow factory assembled water booster system. The unit shall be rated for a system minimum capacity of 170 GPM, with a minimum system pressure of 70 PSIG, including a minimum suction pressure of 20 PSIG. Maximum suction pressure will be 40 PSIG.

B. The complete Packaged Pumping System, including pumps, motors, control equipment, tank, valves, fittings and manifolds must be UL Listed. In addition to the UL Listing for the complete system the control panel assembly must be separately listed under UL 508A.

C. The booster system shall be factory assembled on a steel skid including pumps, motors, valves, 3" SCH 40 steel hot-dip galvanized after fabrication suction and discharge manifolds, and all interconnecting piping, wiring and controls. Branch piping and tank piping shall be the same

material as the suction and discharge manifolds. Provide isolation valves on the suction and discharge of each pump. The valves shall be non-rising stem gate valves. Provide two 4 1/2" ASME grade A, panel mounted gauges for indicating system suction and system discharge pressure. All skid mounted components shall be factory finished in a high quality enamel paint.

D. Individual pumps, motors and pressure regulating valves shall be serviced with the booster system in operation and all components shall be suitable for the maximum working pressure in the system.

E. System shall include two vertical mounted close-coupled end suction centrifugal pumps with ANSI flanged connections. Pump features to include foot supported casing, back pull out design, top centerline discharge and hydraulically balanced impeller. Pump shall be cast iron bronze fitted construction with a replaceable shaft sleeve and mechanical seal suitable for a working pressure of 175 PSIG. Motor shall be NEMA close-coupled type with a JM shaft.

Pump No. 1 shall be rated 85 GPM at 127 ft head.
Pump No. 2 shall be rated 85 GPM at 127 ft head.

F. Motors shall be 460 volt, 3 phase, 60 Hz totally enclosed fan cooled, vertical mount and manufactured in accordance with NEMA standards. Pump No. 1&2 shall be 5 HP, 3500 RPM . Motors shall be selected so that they do not exceed name plate HP rating throughout the programmed sequence of pump operation.

G. Constant system pressure shall be maintained by a pilot-operated diaphragm type combination pressure regulating and non-slam check valve on each pump. Main valve and cover shall be ductile iron with a fused epoxy coating and stainless steel stem and cover bolts. Construction shall be suitable for the maximum working pressure of the system.

H. Provide a hydro-pneumatic tank with a carbon steel shell and a replaceable F.D.A. approved heavy duty bladder to separate the air and water. No water shall come in contact with the metal walls of the tank. Features shall include an air fill valve and bottom system connection suitable for 100% drawdown. The tank shall be constructed in accordance with Section VIII of the ASME code and be N.B. stamped and shall be rated 132 gallon - 125 PSIG. The tank shall be mounted adjacent to the system requiring one field connection and the tank feed line shall be connected between the lead pump discharge and its PRV to provide maximum tank storage.

I. The lead pump shall run only as necessary to maintain system pressure and shall be controlled automatically by means of a pressure switch and minimum run timer to prevent short cycling. The lag pump shall be sequenced on and off automatically in accordance with the system demand. The lag sequence control shall be pressure switch operated with on delay and minimum run timers to prevent short cycling. Pumps shall be sequenced as follows:

0 GPM to 85 GPM	Pump (1 or 2)
85 GPM to 170 GPM	Pump (1 & 2)

J. Each system shall include a UL listed enclosed industrial control panel in a NEMA 1 enclosure factory mounted and wired on the steel skid. The panel shall be furnished with one main disconnect with six power fuses with through the door handle, magnetic starters with (3) leg overload protection, pump run lights, H-O-A selector switches, 115 volt fused control transformer, necessary relays and timers or a programmable logic controller and pump start, stop and sequence controls. In addition the control panel shall be furnished with the following :

low suction pressure shutdown circuit with auto reset

delay timer and light
automatic alternation

K. After factory assembly, the packaged pumping system shall be hydrostatically tested as well as undergo a complete electric and hydraulic test from 0 to 100% design flow at the factory. All controls, pump sequencing devices, alarms and instrumentation shall be tested and calibrated for proper operation during factory testing.

L. The service of a factory trained representative shall be made available on the jobsite for start-up and instructing operating personnel.

2.9 WATER HEATERS

A. Sizes and requirements of all water heaters shall be as required to meet the design requirements of the project.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. All piping, waste and stacks shall be run concealed underground, in ceiling spaces, walls or in chases provided. The entire installation must present an appearance truly in keeping with the best practice and indicative of skill and neatness. In areas of exposed ceilings piping shall be grouped together and run on common pipe hangers with piping run parallel to building lines.

B. All material shall be installed in a neat and workmanlike manner by competent specialists for each sub-trade. The installation of any materials and equipment not meeting these standards may be condemned by the Architect and shall be removed and re-installed at no additional cost to the Owner. Contractor is responsible for the safety and good condition of the materials installed until final acceptance by the Owner.

3.2 INSTALLATION

A. Pipe shall be laid to the grades and alignment indicated on the drawings. Each pipe shall be laid line to line and grade and in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flow line. The interior of the pipe shall be cleaned of all dirt and superfluous materials of every description. Trenches shall be kept free from water until the pipe joining material has set and pipe shall not be laid when the conditions of the trench or the weather is unsuitable for such work. At times when the work is not in progress, open ends of pipe and fittings shall be securely closed, so that no trench water, earth or other substance will enter the pipe or fittings. Minimum compacted pipe coverage shall be 2'-0", or as indicated on drawings.

B. Where the location of the sewer is not clearly defined by dimensions on the drawings, the sewer shall not be run closer horizontally than 6'-0" to water supply main except that the bottom of the water pipe will be at least twelve (12") inches above the top of the sewer pipe, both pipes may be lain in the same trench. Where sewer mains cross above water services the sewer piping for a distance of ten (10') feet each side of the crossing shall be cast-iron without any joint closer horizontally than three (3') feet to the crossing.

3.3 SANITARY SEWER PIPING

A. New piping shall be a complete system to waste and vent lines from all fixtures.

B. All waste lines shall be installed on a continuous waste and vent system as required by codes and/or regulations.

C. All piping shall be installed straight and true and sized as indicated on drawings.

D. All changes in direction shall be made by the use of 45 degree wyes, double wyes, long sweep quarter bend or 1/8 bends, except that single sanitary tees may be used on vertical stacks. Tees and crosses may be used in vent pipes.

E. Cleanouts easily accessible shall provide at the foot of each vertical waste or soil stack. Cleanouts shall be of nominal size as the pipes up to four (4") inches and not less than four (4") inches for larger pipes. The distance between cleanouts in horizontal lines shall not exceed those distances required by local authorities, whether indicated or not.

F. All cleanouts installed so as to be easily accessible, and all outside cleanouts installed flush with finished grade.

G. Horizontal soil or waste lines shall be run at uniform grade of not less than 1/4" per foot. Horizontal lines shall be supported or anchored at intervals specified in GENERAL MECHANICAL. All stacks shall be supported at their base and every floor to the roof line and pipes shall be rigidly secured.

H. Every fixture trap shall be protected against siphonage and back pressure and air circulation assured by means of a soil or waste stack vent, a continuous waste or soil vent, a loop or circuit vent.

I. No vents shall be less than 2" in diameter and no case shall branch or main vent have a diameter less than half that of the soil or waste pipe served, or as required by local code.

J. Make all arrangements with Local Authority for the inspection of the installation of the new sanitary sewer system, and pay all costs and assessed fees.

3.4 HOT WATER AND COLD WATER SYSTEMS

A. This installation comprises a complete and operating system of hot and cold water distribution and connection to each and every fixture and appliance requiring this service and/or as indicated on drawings.

B. All ends of tubing shall be square cut and burrs removed before assembling. Joints shall be thoroughly cleaned with sandpaper or emery cloth before applying the flux.

C. All water supply piping, fittings, and fixtures shall be protected against water hammer shock, or surge pressure, by adequate air chambers.

D. Each riser battery shall be valved in an accessible location.

E. No hot water piping shall be run closer than six (6") inches from cold water pipes.
F. Distribution and sizes shall be as indicated on drawings.

G. Pitch all piping to low points to allow for system drainage.

H. Make all arrangements with Local Authority for inspection of the new water system and for the building, pay all assessed costs and fees.

3.6 GAS PIPING

A. Gas distribution system shall consist of a distribution system to each service point as indicated on drawings.

B. Provide gas cocks shut-off valve, ball type, and union at each piece of equipment and where indicated on plans.

C. Connections and piping shall be as shown on plans. Provide drip legs at all low points.

D. Provide pipe sleeves at all places piping passes through walls. Sleeves shall be such as to provide not less than 1/3" clearance all around gas pipe.

E. Run all gas lines on the roof or along the outside face of the exterior wall exposed and inside building exposed, or in accessible ventilated spaces. No gas piping shall be run under building slab.

F. Install piping in accordance with NFPA 54 and SBCCI Gas Code latest edition.

G. Make all arrangements and coordination for installation of new gas piping and connection to service to building and pay all assessed costs.

3.7 STORM DRAIN SYSTEM

A. All horizontal storm drain pipe shall be run at uniform grade of not less than 1/4" per foot. If a lesser slope is required because of on job conditions, contractor shall obtain permission before making the change.

B. Horizontal lines inside and under the building shall be supported or anchored at intervals as specified in Section 15050.

C. Connect storm drain piping to site drainage piping, 5'-0" outside building as shown on drawings.

D. Make all arrangements with Local Authority for inspection of storm drain system and pay all assessed costs and fees.

3.8 MISCELLANEOUS ITEMS OF WORK

A. Contractor shall be responsible for securing all information and data for connection to all utilities and pay all costs including meter fees and connection fees.

B. Contractor shall provide temporary water and sewerage on site for use during construction period as required.

C. All valves shall be installed so as to be easily accessible for cleaning, inspection maintenance, and operation.

D. Provide access panels at all concealed valves.

E. All welded piping to be welded by Certified welders skilled in the work to be done.

F. No piping of dissimilar metals placed in contact or in close proximity with each other. Provide bronze valves wherever piping of dissimilar metals is jointed.

G. Provide all necessary steel frames supports, anchor bolts, sleeves, etc., required for safe support of equipment and piping installed under this contract. The Mechanical Contractor shall be completely responsible for the accurate position and dimensions of all foundations and support times.

END OF SECTION 15400

SECTION 15800 – HEATING, VENTILATION AND AIR CONDITIONING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including General and Supplementary Conditions and General Requirements apply to the work specified in this Section.

B. Refer to Basic Mechanical Materials and Methods Section 15050 which shall apply to work in this Section.

1.2 DESCRIPTION OF WORK

A. The work to be done under this Section includes the furnishing of all labor, tools, materials, equipment and services necessary for and reasonable incidental to the installation of complete air conditioning and heating and ventilation equipment as shown on plans and herein specified, excepting only work and/or materials indicated as being done and/or furnished under other sections.

B. Contractor shall refer to other Sections of the Specifications which may be applicable to or associated with this Section.

1.3 RELATED WORK SPECIFIED IN OTHER SECTION

A. Electrical Section will provide all power wiring including furnishing and installing of disconnect switches where specified. Control wiring for air conditioning equipment shall be provided by Building Automation and Temperature Control Contractor.

B. Other Sections will provide and install structural supports for equipment. These supports must be checked and coordinated by this Section so that they suit the equipment which is to be supported.

C. Other Sections will provide all platforms slabs, lintels and curbs, as directed by this Section, to accommodate the mechanical equipment.

D. Mechanical Contractor shall provide starters for motors furnished under this Section.

1.4 QUALITY ASSURANCE

A. These specifications with accompanying drawings, require complete apparatus, fully erected and in successful operating condition. Perform all work in best, most substantial manner.

B. All equipment furnished and installed under this Section shall be U.L. or E.T.L. approved and labeled where applicable.

C. All unfired pressure vessels furnished under this Section shall be ASME and National Board stamped.

D. All manufacturers products shall comply with the requirements of this Section.

E. Employ qualified sheet metal workers in accordance with SMACNA Duct Construction Standards.

F. Qualify welding/brazing process and welder/brazer performance in accordance with AWS B2.2, Standard for Brazing Procedure and Performance Qualification, or ASME Boiler and Pressure Vessel Code, Section IX (See 15050). Provide copy of certification for welding and brazing processes.

G. Soldering processes shall conform to ASME B 31.3, Process Piping and Copper Development Association recommended practices.

1.5 SUBMITTALS

A. Contractor, before beginning work, shall submit dimensional shop drawings (in accordance with requirements of Division 1), for approval, for all duct systems. Contractor is responsible to coordinate all plumbing, piping, sprinkler, ductwork and electrical to avoid all conflicts. Conflicts encountered after work has started will be corrected at Contractor's expense.

B. Where the equipment installed is of a different configuration and/or size than that shown on the drawings, Contractor shall assume all responsibility to conform with the intent of the contract documents. The Architect shall be advised of any changes and deviations for his approval. The same shall be true for any field modification required because of "on job" construction conditions.

PART 2 - PRODUCTS

2.1 HVAC DUCTWORK

A. Provide and install a complete system of ductwork as herein specified to include, but not limit to supply, return, exhaust and fresh air with grilles, registers, diffusers and appurtenance to provide a complete functional and operational system. Duct sizes shown on drawings are free area dimensions. Design shall be as described in the latest edition of SMACNA manuals and as per the following:

1. Galvanized sheet metal shall be lock form quality per ASTM A653 with a G90 zinc coating.

2. Outside air and exhaust air ducts shall be galvanized sheetmetal with air-tight seams and as per applicable sections of SMACNA manuals for low velocity ducts. Insulate outside air and exhaust air ducts with 2" exterior duct wrap as per SECTION 15250.

3. Supply and return ducts for low pressure system and, low velocity systems shall be galvanized sheetmetal with airtight seams and as per applicable section of SMACNA manuals for low velocity ducts. All ducts shall be insulated with 2" exterior wrap as per Section 15250.

4. Rectangular ductwork for medium pressure, high velocity systems shall be galvanized sheetmetal with airtight seams and as per applicable section of SMACNA manuals for high velocity ductwork. Insulate with 2" exterior duct wrap as per Section 15250.

5. Round rigid ductwork shall be all round single wall spiral pipe and fittings, galvanized steel, as per applicable sections of SMACNA manuals for high velocity duct. Insulate with 2"

exterior duct wrap as per Section 15250. Seal all seams, joints and wall penetrations with as herein specified.

6. All ducts shall be sealed per SMACNA Seal Class A. All joints, longitudinal seams and wall penetrations of all supply, return outside air and exhaust ducts shall be sealed with an elastomeric tape which shall consist of a pressure sensitive layer of modified butyl rubber sealer laminated to a foil backing material which shall conform to surface variations and irregular areas and shall not harden crack or peel. The sealant shall be waterproof and shall be a minimum of 15 mils thick. All ductwork shall be cleaned and prepared and sealant shall be applied strickly in accordance with manufacturer's instructions and recommendations. at Contractor's option flanged gasketed duct system may be used for POSITIVE PRESSURE SYSTEM ONLY.

7. Flexible round duct where indicated on plans shall be listed by Underwriters' Laboratories, Inc., under UL-181 standards as Class I flexible Air Duct Material complying with NFPA Standards 90A. Ducts shall be rated on maximum pressure of 6 inches WG positive and 2 inches WG negative. The duct shall be factory fabricated assembly composed of: an inner duct of woven and coated fiberglas providing an air seal and bonded permanently to corrosion resistant coated steel wire helix: a 2" thick fiberglas insulating blanket and low permeably outer vapor barrier of fiberglas reinforced metalized film laminate. Pressure drop not to exceed .15" SP at 500 Fpm through 6" or larger duct. Maximum length of flexible duct shall not exceed 8'-0". Connect flexible round duct with ½" wide nylon positive locking nylon straps on inner duct and outer duct.

8. Splitter dampers shall be installed where branches take off of main trunk ductwork, where ducts divide or where shown on the drawings. Splitters shall be fitted with nickel plated damper regulators in finished areas. Splitters shall be factory fabricated in accordance with SMACNA Duct Construction Standards.

B. Flexible connections shall be provided between each fan unit and ductwork on supply side and also on return side. Material shall be flexible fire-resistive material, minimum 4" wide, UL listed, with no metal to metal contact.

C. Duct supports for rectangular ducts shall be a minimum 1" X 18 gauge galvanized steel bands. Hanger bands shall be bent under lower corners and secured with self-tapping screws at corners and six (6") inch intervals up the sides. Distance between hangers shall be as recommended by SMACNA manual for low and medium ductwork. Ductwork shall be rigidly supported to prevent vibration. Duct attachments to structure, lower hanger attachments, ducts traps and rods and trapeze angles shall be in accordance with SMACNA Low Pressure and High Pressure Duct Standards.

D. Where the ducts pass through walls, draftstops or partitions, the space shall be packed with non-combustible materials, filling all voids around duct.

E. Fire dampers with fusible links shall be installed at all points in ductwork where indicated on drawings, and/or as required by NFPA, 90-A, AND MECHANICAL CODE OF THE IBC.

F. Provide radius elbows unless specifically indicated otherwise or space prohibitive. Rectangular radius elbows shall be factory fabricated with a centerline radius of not less than the width of the duct. Round duct elbows shall have a minimum center line radius of 1-1/2 times the diameter of the duct and shall be smooth where possible. Provide square elbows where indicated or space prohibits the use of radius elbows. Square elbows shall be factory fabricated with double thickness airfoil turning vanes pre-assembled and securely attached to runners.

G. In general, vertical risers and other duct runs, where the method of support specified above is not applicable, or not specifically detailed on drawings, shall be supported by substantial angle brackets designed to meet field conditions, installed to allow for duct expansion and approved by Architect.

H. Provide exposed operators for operation of dampers and splitters in inaccessible ceilings, operators shall be chrome plated.

I. Maximum duct leakage shall be +/- 5%, SMACNA Seal Class A. Ductwork between VAV box and air-handling unit shall be designed for 4.0" static pressure. Ductwork between VAV box and diffuser shall be designed for 2.0" static pressure. Outside air, return air and exhaust air systems shall be designed for 2.0" static pressure. Construct ductwork in accordance with SMACNA Duct Construction Standards for the specified pressure class.

J. Install Automatic dampers, airflow stations and other duct mounted devices required to provide the air distribution of the design build documents.

K. Round and oval rigid duct, where exposed and/or noted on the drawings, shall be double wall and shall be constructed of perforated inner liner, a 1" layer of fiberglass insulation, and an outer pressure shell. Ductwork shall be of spiral lockseam construction fabricated in accordance with ASTM-A527 Standards. Seal all seams, joints, and wall penetrations with elastomeric tape. Ductwork shall be paint grip galvanized steel. Provide welded factory insulated register taps as indicated on the drawings. Minimum steel gauges, hanger spacing, support sizes and attachments, and reinforcement shall be SMACNA Duct Construction Standards. Insulate all register taps.

L. Smoke dampers shall be UL 555S/UL555 combination fire/smoke damper with integral 120V actuator. Dampers shall be automatic reset type. Control and power wiring by Fire Alarm Contractor.

M. Flanged gasketed exhaust and return ductwork will not be accepted.

2.2 DIFFUSERS, GRILLES, REGISTERS AND LOUVERS

A. All sizes shall be as required to meet the design requirements of ASHRAE 62 with respect to indoor air quality. Contractor shall provide calculations as required to verify the air diffusion and minimum flow rates meet those requirements. Space air quantities shown on the drawings are to be considered only as a guide for the design build contractor to use in their finalization of the air distribution design.

B. All outlets shall be balanced to obtain specific air quantities free of all objectional draft and Noises.

C. Diffusers, grilles and registers shall be of normal commercial grade.

D. Insulate the back of all diffusers, grates and registers with ¾ closed cell rubber insulation.

2.3 FIRE DAMPERS

Fire dampers shall be solid sheet curtain type, dynamic closure type corrosion resistant galvanized steel construction. Dampers mounted in the horizontal position shall be closed by a stainless steel negate spring. Damper to be easily reset through standard access panel for required periodic

maintenance. Access panels are required for access to all fire dampers, minimum size 12 X 12 inches. Dampers shall be 100% out of air stream. Provide fusible links rated at 160 degrees F.

2.4 ACCESS DOORS

Access doors shall be installed in ductwork wherever required for ready access to any operating part. Doors shall not be smaller than 12 X 12 inches, with brass hinge and sash type fasteners. Ducts 30" or larger shall be supplied with minimum 18 X 18 inch access doors. Doors shall be double wall insulated type, hinged with sash locks and gaskets.

2.5 PIPING AND FITTINGS (ABOVE GROUND INSIDE BUILDINGS)

A. Furnish and install all piping related to air conditioning systems including make-up water piping, air conditioning condensation drains, and other miscellaneous piping.

B. All piping shall be installed parallel and square with building lines and shall be sloped to permit drainage, with suitable provision for drainage at all low points.

C. Piping shall be arranged to maintain headroom and keep passageways clear and where necessary shall be offset to maintain the required clearance and conform with the structural features of the building. Contractor shall determine in advance of construction locations for all piping sleeves, hangers, etc. No allowance will be made for extra due to inaccurate location of sleeves, piping or equipment.

D. All piping shall have provisions for expansion and contraction with anchorage at each point shown on the plans and/or as required.

E. Full length pipe shall be used where possible, short lengths and couplings will not be permitted. After cutting, all pipes shall be reamed out to full bore and before erection, all cutting and foreign matter shall be removed from the inside of pipes. Screwed joints shall be made tight without caulking or the use of lead or paint and no lubricant shall be used except flake granite and cylinder oil paste, or approved pipe compound applied to make threaded pipe.

F. Pipe sleeves shall be provided for the passage of all pipe through walls, floors and partitions.

G. All condensate drain piping shall be installed using ASTM B88 type "L" hard drawn copper with wrought copper sweat fittings. Changes in direction of piping shall be made with short turn tee pattern or 45 degree wye fittings with brass cleanout plug. Insulate drain piping per Section 15250, minimum drain on fan coil units – 3/4", air handling units – 1-1/4".

H. Make-up water piping shall be installed using copper piping as specified for water piping.

I. Welding fittings shall be Tube Turn, Midwest, or approved equal. Use welding elbows at all turns in welded piping, except where bent runs are indicated and except that turns and off-setting to a maximum of 15 degrees mitered. At branch connections, either use welding tees or weld the branches directly into the mains. Use extra heavy couplings in all cases where female threaded openings are required, in welding piping.

J. Above ground condenser water piping, and chilled water piping, 2-1/2" and larger shall be installed using ASTM A53 Grade B Schedule 40 black steel pipe with malleable iron fittings. At Contractor's option size three (3") inches and larger may be flanged or welded. Welded elbows

shall be factory made long radius. Provide bronze unions at connections to copper coils. Also, at Contractor's option all water piping, above ground, may be installed using grooved mechanical pipe coupling and fittings, with grade "E" gaskets. Piping 2" and smaller shall be ASTM B88 type "L" hard drawn copper with wrought copper sweat fittings.

K. Install control valves, sensor wells, sockets, flow meters and DP sensors required by Section 15950.

L. See Section 15900 for valves, fittings, unions, gaskets, bolts and nuts.

M. See Section 15050 for hangers.

N. Refrigerant piping shall be type "L" hard drawn copper wrought copper sweat type fittings and silfos solder. Provide a catch-all liquid line strainer and a liquid line moisture indicator sight glass in each refrigerant circuit. Strainer shall be installed in a three valve by-pass. Completely evacuate system before providing refrigerant operating charge as recommended by equipment manufacturer. Pipe sizes shall be as recommended by equipment manufacturer for installation shown.

O. Insulate refrigerant suction piping per Section 15250

2.6 UNDERGROUND CHILLED WATER PIPING

A. Furnish a complete HDPE jacketed system of factory preinsulated steel piping for the underground chilled water service.

B. Carrier pipe shall be steel ASTM A-53, Grade B., ERW (Type E) or seamless (Type S), standard weight for sizes 2" and larger, and shall be ASTM A-106/A-53, seamless, standard weight for sizes 1-1/2" and smaller (Std. Wt. is the same as Sch. 40 through 10"). When practical, piping shall be provided in 40-foot double-random lengths. All carbon steel pipe shall have ends cut square and beveled for butt-welding. Straight sections of factory insulated pipe shall have 6" of exposed pipe at each end for field joint fabrication.

C. Insulation shall be polyurethane foam either spray applied or high pressure injected with one shot into the annular space between carrier pipe and jacket. Insulation shall be rigid, 90-95% closed cell polyurethane with a 2.0 to 3.0 pounds per cubic foot density and coefficient of thermal conductivity (K- Factor) of 0.14 and shall conform to ASTM C-591. Maximum operating temperature shall not exceed 250°F. Insulation thickness shall be as listed follows:

Pipe size Inches	Ins. thickness inches
less than 3	1.5
4 to 6	2.0
8 to 12	2.5

D. Jacketing material shall be extruded, black, high density polyethylene (HDPE), manufactured to be compatible with ASTM D-3350 (formerly D-1248) having a minimum wall thickness of 125 mils for jacket sizes less than 12", 150 mils for jacket sizes 12" – 24", and 175 mils for jacket sizes greater than 24". The jacket shall meet the specifications listed below.

Specific Gravity (ASTM D792)	0.941 MIN.
Tensile Strength (ASTM D638)	3100 psi min.

Elongation Ultimate (ASTM D638)	400% min.
Compressive Strength (ASTM D695)	2700 psi min.
Impact Strength (ASTMD256) 2.0 Ft.Lb/in	North Min.
Rockwell Hardness (ASTM D785)	D60 (Shore) min.

E. Moisture barrier end seals shall be factory applied, sealed to the jacket and carrier pipe. End seals shall be certified as having passed a 20-foot head pressure test. End seals shall be high temperature mastic completely sealing the exposed end of the insulation. Field applied end seals shall be installed at any field cut to the piping before continuing with the installation.

F. Straight run joints shall be field-insulated per the manufacturer's instructions, using polyurethane foam poured in an HDPE sleeve and sealed with a pressure sensitive polyethylene backed, rubberized bitumen adhesive tape, 30 mils thick or heat shrink wrap. All joint closures and insulation shall occur at straight sections of pipe.

G. Fittings shall be factory prefabricated and preinsulated fittings with polyurethane foam to the thickness specified and jacketed with a one piece seamless molded HDPE fitting cover, a butt fusion welded, or an extrusion welded and mitered HDPE jacket. Carrier pipe fittings shall be butt-welded, except sizes smaller than 2" shall be socket-welded. Fittings include expansion loops, elbows, tees, reducers and anchors. Elbows, loops, offsets, or any other direction changes shall conform to the standards set by ANSI B31.1, Code for Power Piping.

H. Expansion/contraction compensation shall be accomplished utilizing factory prefabricated and preinsulated expansion elbows, Z-bends, expansion loops and anchors specifically designed for the intended application. External expansion compensation utilizing flexible expansion pads (minimum one inch thickness), extending on either side, both inside and outside the radius of the fittings shall be used with all fittings having expansion in excess of 1/2".

I. Prefabricated systems shall be provided as SC (standard components) fittings and factory insulated straight pipe sections for field engineering per the contract drawings. System can be prefabricated/pre-engineered or field fabricated with fittings insulated with kits provided by the system manufacturer.

J. Underground systems shall be buried in a trench not less than two (2) feet deeper than the top of the pipe and not less than eighteen inches wider than the combined O.D. of all piping systems. A minimum thickness of 24 inches of compacted backfill placed over the top of the pipe will meet H-20 highway loading. Trench bottom shall have a minimum of 6" of sand, pea gravel, or approved backfill material as a cushion for the piping. All field cutting of the pipe shall be performed in accordance with the manufacturer's installation instructions.

K. A hydrostatic pressure test of the carrier pipe shall be performed with a factory recommendation of one and one-half times the normal system operating pressure for not less than two hours. Care shall be taken to insure all trapped air is removed from the system prior to the test.

L. Field Service shall be provided by a certified manufacturer's representative or company field service technician. The technician shall be available at the job a minimum of five days to check unloading, storing, and handling of pipe, pipe installation, pressure testing, field joint insulation and backfilling techniques.

2.7 PIPING AND PIPING IDENTIFICATION

All piping at each piece of equipment shall be stencil to show the service and direction of flow. Stencils shall be black on a white background with letters one (1") inch high spaced at approximately forty-eight (48") inches apart by equipment or 10 foot intervals along piping runs.. Pressure-sensitive pipe markers ANSI Standard A 13.1 may be used in lieu of stenciling.

2.8 EXHAUST FANS AND OUTSIDE AIR INTAKES

A. Size and quantity shall be provided as required to meet the design requirements.

B. All roof exhaust fans and roof outside air intakes shall be provided with factory prefabricated curbs.

2.9 WATER TREATMENT

A. This Contractor shall furnish and install all piping connections, taps and shut off valves to accommodate all the furnished equipment and piping. Contractor shall certify piping is clean and free of air prior to opening to campus piping. This contractor shall coordinate all requirements for the Owner's evaluation. See Section 15840 for system requirements.

B. Contractor shall completely flush piping systems to remove all oil, film and welding slag.

2.10 VAV TERMINAL UNITS

A. Unit performance data must be Rated in Accordance with ARI Standard 880, and must display the ARI Symbol on all standard units. If a manufacturer does not participate in the ARI Certification program, specified equipment must be witnessed by an ARI certified testing laboratory to meet the criteria of the specification, including intended radiated NC, in an equipment mockup. Mockup must be similar to construction and operating conditions of this project. Re-heat terminals shall be U.L. Listed as a room air terminal. All units shall have capacities as required to meet design requirements.

B. Units shall be completely factory assembled, manufactured of corrosion protected welded steel, and fabricated with a minimum of 18-gauge metal on the high pressure (inlet) side of the VAV damper and 22-gauge metal on the low pressure (outlet) side and unit casing.

C. Interior surface of unit casing acoustically and thermally lined with a minimum of 1/2 inch, R-Value 2.1 - 1.9 lb./cu.ft. density glass fiber with foil facing. Insulation shall be UL listed and meet NFPA-90A and UL 181 and Bacteriological Standard ASTM C-665 requirements. The cut edges on the discharge of the unit shall be covered by a metal flange. All exposed edges shall be sealed to prevent fibers in the air stream.

D. Air volume damper, and controls in single cabinet. Air volume control damper shall be factory installed and calibrated consisting of air value with integral actuator. Unit discharge shall have a flange duct connection.

E. Locate air volume damper assembly inside unit casing. Construct from extruded aluminum or a minimum of 20 gauge (0.9 mm) galvanized steel components. Flow sensor must be provided regardless of control chosen. Air volume control damper shall be factory calibrated assembly consisting of air modulation damper and extension for connection to control actuator. All actuator linkage shall be protected by a sheet metal enclosure.

F. Terminals shall include an integral electric heating coil as required to meet design requirements. Coil shall be furnished with all controls necessary for safe and complete operation. Terminal shall have a single point power supply.

G. Controls shall be supplied by the control contractor but mounted on VAV units by equipment manufacturer. Mount electrical components in control box with removable cover. Incorporate single point electrical connection to power source. Provide terminal strip in control box for field wiring of thermostat.

H. Controls shall be as required in Section 15950.

I. Factory set and check all analog electronic controllers to within 5% of scheduled maximum and minimum setting. Base performance on tests conducted in accordance with ARI 880. Maximum Casing Leakage: 1 percent of nominal air flow at 0.5 in wg inlet static pressure. Maximum damper Leakage: 1 percent of design air flow at 4 in wg inlet static pressure.

J. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design air flow to 30 percent nominal air flow. Set units with heating coils for minimum 50 percent full flow.

K. Identify each terminal unit with clearly marked identification label and air flow indicator. Label shall include unit nominal air flow, maximum factory set air flow and minimum factory set air flow.

2.11 AIR HANDLING UNITS

A. Air Handling Units shall be modular, double wall, type as. Units shall have the capacities and requirements as required to meet design requirements. Units shall be tested and rated in accordance with ARI standard 430 and shall be ETL listed. Units shall be Installed in accordance with manufacturer's instructions. Units shall not be operated for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

B. Unit casing shall be fabricated of 16 gauge channel posts and removable panels assembled with mechanical fasteners and a galvanized steel finish. Assemble sections with high compression gasketing between each frame member and unit panel or door to prevent thermal bridging from interior to exterior of unit. Outside casing shall consist of 18 gauge, G90 galvanized steel . Internal lining for all sections shall be constructed of 20 gauge, solid G90 galvanized steel. Insulation shall be foam injected. Fiberglass bat insulation will not be accepted. Entire unit shall have a 6 inch full perimeter base rail for structural rigidity and condensate trapping. The following calculation shall determine the required height of the base rail to allow for adequate drainage. Use the largest pressure to determine base rail height. [(Negative)(Positive) static pressure (in)] (2) + 4" = required baserail height. Should the unit baserail not be factory supplied at this height, the contractor is required to supply a concrete housekeeping pad to make up the difference.

C. Module to module assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor along with meeting indoor air quality standards. Unit casing leak rate shall not exceed 0.5 cfm per square foot of cabinet area at 5" static pressure in order to meet efficiency and indoor air quality standards.

D. Access Doors shall be made of galvanized steel, flush mounted to cabinetry, with minimum of two six inch long stainless steel piano-type hinges, latch and full size handle assembly. Plastic hinges and latches will not be acceptable. Door shall swing outward.

E. Drain pans shall be constructed, from 304 stainless steel, with cross break and double sloping

pitch to drain connection. Provide drain pans under entire cooling coil section. Drain connection centerline shall be a minimum of 3" above the base rail to aid in proper condensate trapping. Drain connections that protrude from the base rail are not acceptable. Drain Pans shall extend a minimum of 12 inches past the cooling coil.

F. Supply fan shall be SWSI plug fan (direct drive when possible) or DWDI class 2 air foil. Fan assemblies including fan, motor and sheaves shall be dynamically balanced by the manufacturer on all three planes and at all bearing supports. Manufacturer shall ensure maximum fan RPM is below the first critical speed. Bearings shall be self-aligning, grease lubricated, ball or roller bearings with extended copper lubrication lines to access side of unit. Grease fittings shall be attached to the fan base assembly near access door. If not supplied at the factory, contractor shall mount copper lube lines in the field. Fan and motor shall be mounted internally on a steel base. Motor shall be mounted on slide base that can be slid out the side of unit. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be mounted on 2" deflection spring vibration type isolators inside cabinetry. Bearings shall be basic load rating computed in accordance with AFBMA - ANSI Standards, L-50 life at 200,000 hours, heavy duty pillow block type, self-aligning, grease-lubricated ball bearings. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable. V-Belt drives shall be cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Variable and adjustable pitch sheaves selected so required RPM is obtained with sheaves set at mid-position and rated based on motor horsepower. Contractor shall furnish fixed sheaves at final RPM as determined by balancing contractor. Minimum of 2 belts shall be provided on all fans with 10 HP motors and above. Motors shall be ODP type with premium efficiency with Electrical characteristics as shown in schedule on drawings.

G. Coils shall have access from connection side of unit for service and cleaning. Coil headers and return bends shall be fully enclosed within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections shall be factory sealed with grommets on interior and exterior and gasket sleeve between outer wall and liner where each pipe extends through the unit casing to minimize air leakage and condensation inside panel assembly. If not factory provided Contractor shall supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit. Certify air coil capacities, pressure drops, and selection procedures in accordance with ARI 410.

H. CFC REFRIGERANTS SHALL NOT BE USED IN THE REFRIGERANT CIRCUITS. Fins shall have a minimum thickness of 0.0075" with full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary-to-secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tube shall not be visible between fins. Refrigerant coils shall be provided with round seamless 5/8" O.D. copper tubes on 1-1/2" centers, staggered in the direction of airflow. All joints shall be brazed. Sweat type copper suction connections shall be located at the bottom of the suction headers for gravity oil drainage. Coils shall be uniformly circuited in a counterflow manner to control capacity reduction. Pressure type liquid distributors used. Coils shall be ARI certified and Underwriters Laboratories, Inc. listed.

I. Water Coils shall have fins with a minimum thickness of .0075" of aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be constructed of 5/8" OD seamless copper mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible

between fins. Water coils shall be provided with round seamless 5/8" OD copper .020" nominal tube wall thickness, expanded into fins with all joints brazed. Water coils shall be provided with headers of seamless copper tubing with intruded tube holes that permit expansion and contraction without creating undue stress or strain. The casing shall be formed channel frame of stainless steel. Coil connections shall be carbon steel with size provided by manufacturer based upon the most efficient coil circuiting. Coil vents and drains shall be provided on the coil connection outside the unit casing. Vent connections shall be provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to insure drainage and prevent freeze-up.

J. Mixing box section shall be provided with or without factory mounted outside air and return air dampers. Dampers shall be low leak rated, and made of galvanized steel in a galvanized frame. Dampers shall have hollow core airfoil blades, fully gasketed and have continuous vinyl seals between the damper blades. Stainless steel jamb seals shall be provided along the end of dampers. Linkage shall be provided when return air and outside air dampers are sized for full airflow. Return air and outside air dampers of different sizes shall not be linked together. The outside air and return air damper leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. The leakage rate shall be tested in accordance with AMCA Standard 500.

K. The filter section shall include filter racks, and hinged and latching access doors on either, or both sides of the section for side loading and removal of filters. Angular filter arrangements shall be provided with 2 inch deep MERV 8 disposable panel filters. Filter media is U.L. Class 2, and tested according to U.L. Standard 900.
with AMCA Standard 500.

2.12 PUMPS (END SUCTION)

A. These pumps shall be horizontal flexible-coupled end suction with capacities as required to meet the design requirements.

B. The pump shall be constructed of the following materials:

Casing.....Cast Iron (ASTM A48)
Impeller.....Bronze (ASTM B584)
Shaft.....Steel (AISI C1045)
Case Wear Ring.....Bronze (ASTM B62)
Shaft Sleeve.....Bronze (ASTM B62)
Base Suction Elbow.....Cast Iron (ASTM A48)

C. The casing shall be of the end suction design with tangential discharge outlet. For suction piping diameters of 2" or less and discharge piping diameters of 1.5" or less, the suction and discharge connections shall be NPT threaded. For suction piping diameters of 2" or greater, the suction inlet shall be a flat-faced flange connection and the discharge outlet shall be a bolt through flange connection. Flange connections shall be ANSI 125 PSI rated. The casing shall have tapped and plugged holes for priming and draining. The casing bore shall be large enough to allow "back pullout" of the impeller without disturbing the casing or suction and discharge piping. The casing shall be supported by the power frame.

D. The impeller shall be of the enclosed type, vacuum cast in one piece. It shall be finished all over, the exterior being turned and the interior being finished smooth and cleaned of all burrs, trimmings, and irregularities. The impeller shall be dynamically balanced. The impeller will be keyed to the shaft, and fastened with a washer, gasket and cap screw.

E. The pump casing shall be fitted with a case wear ring to minimize abrasive and corrosive wear to the casing. The case wear ring shall be of the radial type, press fitted into the casing.

F. The stuffing box shall be integrally cast with a mounting bracket, and shall provide an adequate area for internal recirculation of the pumped fluid around the sealing medium.

G. Shaft sealing shall be accomplished by means of a mechanical seal with a Ni-Resist seat, carbon washer, Buna-N elastomers, and stainless steel metal parts.

H. The impeller shall be direct-coupled to the motor shaft. The motor shaft shall be machined to provide a keyway, and drilled and tapped to accept the impeller fastener. Stub shafts are not acceptable. The outboard shaft extension shall be machined with a keyway to accept a coupling to the driving unit. Water slingers shall be furnished on both the inboard and outboard shaft extensions.

I. The pump shaft shall be fitted with a shaft sleeve to minimize shaft wear. The sleeve shall be sealed to the impeller hub by an 0-ring, and shall be positively driven by a pin to the keyway. The use of adhesive compounds to fasten the sleeve to the shaft shall not be accepted.

J. The power frame shall house a single-row outboard regreaseable thrust bearing. Both bearings shall be selected for a 3 year minimum life at maximum load. The outboard bearing shall be locked in place by a retaining ring. The inboard bearing shall not be locked in order to accommodate thermal expansion of the shaft. Lubrication fittings shall be provided in convenient location. A bearing cartridge end cap shall be provided on the outboard side of the power frame to allow inspection and replacement of the thrust bearing without the need for disassembling the power frame housing.

K. The pump unit shall be supported from beneath the mounting bracket and the power frame by mounting feet.

L. The pump and motor shall be mounted on a groutable formed steel baseplate with integral drip channels incorporated on each side. Each channel shall include an NPT drain connection and plug. The base shall be sufficiently rigid to support the pump and the motor without the use of additional supports or members.

M. A flexible coupling shall be provided to connect the pump shaft to the motor shaft. The coupling shall be of an all metal type with a flexible rubber insert. The entire rotating coupling element shall be enclosed by a coupling guard.

N. The motor shall be a NEMA-JM configuration in accordance with the latest NEMA Standards.

O. Each motor shall have a sufficient horsepower rating to operate the pump at any point on the pump's head-capacity curve without overloading the nameplate horsepower rating of the motor, regardless of service factor. The motor shall have a service factor of at least 1.15. The service factor is reserved for variations in voltage and frequency.

P. The pumping units shall be installed in accordance with the instructions of the manufacturer and as shown on the drawings by the Contractor. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.

Q. All new chilled and heating piping in the building water systems shall be thoroughly cleaned and free of debris, dirt, sand and other impurities. After flushing the system, and after the

completion of the insulation of the pumps, valves, pipe and fittings as specified in Section 15250, start-up of the pumping system can commence. After all adjustments have been completed, the owner and/or his representatives will receive a thorough demonstration of the system operation and will receive training in the operation and adjustment of all components. System manufacturer or his representative shall provide startup, adjustment and training of owner's personnel on the operation and maintenance of the packaged pumping system.

2.13 PUMPS (VERTICLE INLINE)

A. Each pump shall be a centrifugal vertical close-coupled pump, with capacities as required to meet the design requirements.

B. Materials of Construction

Casing.....Cast Iron (ASTM A48)
Impeller.....Bronze (ASTM B584)
Shaft.....Steel (AISI C1045)
Case Wear Ring.....Bronze (ASTM B62)
Shaft Sleeve.....Bronze (ASTM B62)
Base Suction Elbow.....Cast Iron (ASTM A48)

C. The casing will be of the end suction design with tangential discharge outlet. The casing shall have tapped and plugged holes for priming and draining. The casing bore shall be large enough to allow "back pullout" of the impeller without disturbing the casing or suction and discharge piping. The casing shall be supported by the driving unit.

D. The impeller shall be of the enclosed type, vacuum cast in one piece. It shall be finished all over, the exterior being turned and the interior being finished smooth and cleaned of all burrs, trimmings, and irregularities. The impeller shall be dynamically balanced. The impeller will be keyed to the shaft, and fastened with a washer, gasket and capscrew.

E. The pump casing shall be fitted with a case wear ring to minimize abrasive and corrosive wear to the casing. The case wear ring shall be of the radial type, press fitted into the casing.

F. The stuffing box shall be integrally cast with a mounting bracket. Flushing of the seal chamber shall be accomplished by means of an external line with fittings between the stuffing box and pump casing.

G. Shaft sealing shall be accomplished by means of a mechanical seal with a Ni-Resist seat, carbon washer, Buna-N elastomers, and stainless steel metal parts.

H. The impeller shall be direct-coupled to the motor shaft. The motor shaft shall be machined to provide a keyway, and drilled and tapped to accept the impeller fastener. Stub shafts are not acceptable.

I. The pump shaft shall be fitted with a shaft sleeve to minimize shaft wear. The sleeve shall be sealed to the impeller hub by an O-ring, and shall be positively driven by a pin to the keyway. The use of adhesive compounds to fasten the sleeve to the shaft shall not be accepted.

J. The pump and motor unit shall be mounted vertically to a combination base and suction elbow. The base shall be rigid, milled flat and have anchor bolt mounting holes provided. The suction inlet flange and casing mounting flange will be 125# ANSI rated flanges.

K. The motor shall be a NEMA-JM weatherproof TEFC configuration in accordance with the latest NEMA Standards.

L. Motor shall have a sufficient horsepower rating to operate the pump at any point on the pump's head-capacity curve without overloading the nameplate horsepower rating of the motor, regardless of service factor. The motor shall have a service factor of at least 1.15. The service factor is reserved for variations in voltage and frequency.

M. Each centrifugal pump furnished under these specifications shall be tested at the factory to verify individual performance (VIP). Certified copies of all test reports shall be submitted to the Engineer for approval prior to shipment. Each unit shall be hydrostatically tested in accordance with the Hydraulic Institute Standards.

N. The pumping units shall be installed in accordance with the instructions of the manufacturer and as shown on the drawings by the Contractor. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.

2.14 MOTOR STARTERS

A. This Contractor shall provide motor starters for all motors furnished under this section.

B. Starters shall be NEMA ICS 2, AC general-purpose Class A magnetic controllers for induction motors rated in horsepower. Size shall be as for the motors connected. Two-speed starters with time delay relays shall be used for two-speed motors. All motors over 25 HP shall use solid state reduced voltage starters.

C. Coils shall have the operating voltage required for the motors connected. Coils shall be of the encapsulated type with the required poles.

D. Windings shall be straight-through type with all terminals clearly marked.

E. Overload relays shall be NEMA ISC with one piece thermal unit construction, and shall be interchangeable. Overload relay control circuit contacts shall also be replaceable. Thermal units shall be required for starter to operate. Starters shall have phase loss, phase reversal, three phase, under-voltage relay motor protection.

F. Starters shall have HOA, located in the cover. Starters shall also have a 150VA control transformer and auxiliary contacts as required for controls. Coordinate these with the requirements of the building automation system, Section 15950.

G. Starter enclosures shall be ANSI/NEMA ICSG, type 1 or 3R as required to meet conditions of installation.

2.15 VIBRATION ISOLATION SYSTEMS

A. Work shall include furnishing, installing and testing all material required and hereinafter called for complete execution of the vibration isolation system. Isolation materials shall not be limited to compressors, convertors, air units, pumps, piping, duct work, fans, etc. All motor-connected equipment shall be considered a source of vibration and shall be isolated to prevent vibration and sound transmission. Isolation equipment, as manufactured by Kinetics, Mason Industries or prior approval equal, shall be used. Specific reference to isolation under equipment

headings is to provide additional information by which proper selection of the required isolation may be made. Equipment specification data showing physical size, bearing points, weights per point, rotating speeds and sound power levels generated shall be furnished by the respective equipment supplier to the vibration isolation supplier after equipment submittals have been approved.

B. All mechanical and sound isolation materials specified herein or shown on drawings shall be provided by a single manufacturer to assure singular responsibility for proper selection, application, installation and performance. Substitution for isolation material specified incorporating non-permanent materials, such as cork, rubber, wood pulp, or thermal fiberglass will not be acceptable. Should no specific material be called out for particular use, all mechanical vibration isolation shall be based upon Chapter 46, 1999 A.S.H.R.A.E. Guide-Table 45, "Guide for Selection of Vibration Isolators". Bases, mounts and hangers furnished shall have a nominal deflection equal to the minimum deflection as shown in this guide and shall be furnished on all motor driven equipment requiring isolation as well as piping and duct connected to same.

C. To assure stability, the spring element to be a large diameter laterally stable spring with load plate and have a lateral stiffness greater than 0.8 times the rated vertical stiffness and be designed to provide up to 50% overload capacity. Each base mount spring shall have a 1" isolation sound pad of elasomeric material.

D. Isolation shall be stable during starting and stopping of equipment without any transverse or eccentric movement that could damage or adversely affect the equipment or attachments. Isolation systems for floor or ceiling-mounted equipment shall have a maximum lateral motion under start up and shut down of 3/8". Motion in excess shall be corrected by restrained spring-type mounts. Isolators shall be selected for the lowest operating speed of the equipment isolated and shall be located to produce uniform loading and deflection even when equipment weight is not evenly distributed. Static deflection on grade up to 3/8" shall use nominal 1" deflection springs on isolation pads. Static deflection above grade shall use spring isolators with spring deflection based upon 1999 Guide Deflection data. The static deflection of the isolation system shall be selected to avoid being in resonance with the disturbing frequency. All spring isolators shall have neoprene sound damping pads separating isolator from structure.

E. Submittals shall contain a complete schedule of all equipment to be isolated along with the type of isolator, loading per isolator, static deflection, spring diameters and maximum deflection. Should isolation installed fail to perform satisfactorily in preventing the transmission of vibration, the isolation shall be replaced without cost to owner and properly selected isolators shall be installed.

F. Chilled, domestic and condensed water pump bases shall consist of a concrete slab cast into a prefabricated inertia base frame assembly designed and supplied by the isolation materials supplier such as CPF inertia base. Frames shall be welded steel channels with a depth greater than 8% of the longest span between isolators, a minimum of 6" thick or as indicated on the drawings, and shall include 1/2" steel re-enforcing rods on maximum 8" centers each way. Prelocated equipment anchor bolts shall be included. Spring isolator support brackets shall be welded at the corners of the perimeter channel frame with 1/2" reinforcing rods welded 1-1/2" above bottom of bracket running continuously in two directions between all isolator brackets. Inertia bases used to support horizontally split case pumps shall be wide enough to support pipe elbows and may be rectangular or "T" shaped at manufacturers option.

G. Vertically hung air handling units and fans shall be isolated with large diameter laterally stable steel spring in series with a molded neoprene insert, assembled into a stamped or welded hanger bracket with load transfer plates for both the spring and neoprene insert. Hangers to

allow a support rod misalignment thru a 30 degree arc. Mason Model 30N or Kinetics Model SFH.

H. All piping over 1" in diameter and connected to motor-driven equipment shall be spring hung for a minimum of 3 hangers in each direction. The spring deflection for the hanger shall be the same as the spring deflection for the equipment isolated. Mason Model 30N or Kinetics Model SFH.

I. Duct Work - All supply duct work shall be hung on neoprene or spring hangers for a minimum of 3 hangers from air handling unit to prevent the transmission of duct vibration into the structure. Mason Model 30N or Model HD or Kinetics Model SFH or Model RH.

2.16 CHILLERS

A. Provide and install as shown on the plans factory-assembled, factory charged, and factory run-tested water-cooled Centrifugal Liquid Chilling Units. Each unit shall be complete with a single-stage hermetic centrifugal compressor with lubrication and control system, factory mounted starter, evaporator, condenser, refrigerant control device and any other components necessary for a complete and operable chiller package. Each unit shall produce a minimum capacity of 300 tons, cooling 720GPM from 52 °F to 42 °F when supplied with 900 GPM of condenser water at 85 °F. Power input shall not exceed .647 kW/ton with an IPLV (APLV) of .393. The evaporator shall be selected for fouling .00010 factor and a maximum liquid pressure drop of 13.0 ft. Water side shall be designed for 150 PSIG working pressure. The condenser shall be selected for .00025 fouling factor and maximum liquid pressure drop of 9.9 ft. Waterside shall be designed for 150 PSIG working pres sure. Each chiller shall be capable of stable operation to ten percent of full load with standard ARI entering condensing water relief without the use of hot gas bypass. Sound pressure levels for the complete unit shall not exceed the following specified levels. Provide the necessary acoustic treatment to chillers as required. Sound data shall be measured according to ARI Standard 575-87. Data shall be in dB. Data shall be the highest levels recorded at all load points. Test shall be in accordance with ARI Standard 575.

Octave Band

63	125	250	500	1000	2000	4000	8000	dba
69	67	69	70	74	77	77	73	82.5

Chillers shall comply with the following codes and standards

ARI 550/590
ANSI/ASHRAE 15
NEC
OSHA as adopted by the State
ASME Section VIII

B. Compressor:

1. Unit shall have a single-stage hermetic centrifugal compressor. Casing design shall ensure major wearing parts, main bearings, and thrust bearings are accessible for maintenance and replacement. The lubrication system shall protect machine during coast down period resulting from a loss of electrical power.
2. The impeller shall be statically and dynamically balanced. The compressor shall be vibration tested and not exceed a level of 0.14 IPS.
3. Movable inlet guide vanes actuated by an internal oil pressure driven piston shall accomplish unloading. Compressors using an unloading system that requires penetrations

through the compressor housing or linkages are acceptable provided that the Manufacturer provides a Five year extended parts and labor warranty on the entire unit including shaft seals. If the compressor is not equipped with guide vanes for each stage and movable discharge diffusers, then the Manufacturer shall furnish hot gas bypass and the chillers shall be selected at 5% lower kW/ton than specified to compensate for bypass inefficiency at low loads.

4. The compressor shall have an independent lubrication system to provide lubrication to all parts requiring oil. Provide a heater in the oil sump to maintain oil at sufficient temperature to minimize affinity of refrigerant, and a thermostatically controlled water-cooled oil cooler. A positive displacement oil pump shall be powered through the unit control transformer.

C. Refrigerant Evaporator and Condenser:

1. Evaporator and condenser shall be of the shell-and-tube type, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Regardless of the operating pressure, the refrigerant side of each vessel shall bear the ASME stamp indicating compliance with the code and indicating a test pressure of 1.1 times the working pressure, but not less than 100 psig. Provide intermediate tube supports at a maximum of 24 inch spacing.
2. Tubes shall be enhanced for maximum heat transfer, rolled into steel tube sheets and sealed. The tubes shall be individually replaceable.
3. Provide isolation valves and sufficient volume to hold the full refrigerant charge in the condenser or provide a separate pump out system with storage tank..
4. The water sides shall be designed for a minimum of 150 psi or as specified elsewhere. Vents and drains shall be provided.
5. Evaporator minimum refrigerant temperature shall be 33°F.
6. An electronic or thermal refrigerant expansion valve shall control refrigerant flow to the evaporator. Fixed orifice devices or float controls with hot gas bypass are not acceptable. The liquid line shall have a moisture indicating sight glass.
7. The evaporator and condenser shall be separate shells. A single shell containing both vessel functions is not acceptable.
8. Reseating type spring loaded pressure relief valves according to ASHRAE-15 safety code shall be furnished. The evaporator shall be provided with single or multiple valves. The condenser shall be provided with dual relief valves equipped with a transfer valve so one valve can be removed for testing or replacement without loss of refrigerant or removal of refrigerant from the vessel. Rupture disks are not acceptable.
9. The evaporator, suction line, and any other component or part of a component subject to condensing moisture shall be insulated with UL recognized 3/4 inch closed cell insulation. All joints and seams shall be carefully sealed to form a vapor barrier.
10. Provide factory mounted water flow sensors on each vessel to prevent unit operation with no flow.

D. The Prime Mover shall be a squirrel cage induction motor of the hermetic type of sufficient size to efficiently fulfill compressor horsepower requirements. Motor shall be liquid refrigerant cooled with internal thermal overload protection devices embedded in the winding of each phase. Motor shall be compatible with the starting method specified hereinafter. Open drive motors are not acceptable.

F. The chiller shall be equipped with a Variable Frequency Drive (VFD) to automatically regulate compressor speed in response to cooling load and compressor pressure lift. The chiller control shall coordinate compressor speed and guide vane position to optimize chiller efficiency.

1. A digital regulator shall provide V/Hz control.

2. The VFD shall have 110% continuous overload of continuous amp rating with no time limit, PWM (pulse width modulated) output, IGBT (insulated gate bipolar transistors) power technology, full power rating at 2kHz, DC bus inductor (choke), and wireless construction.
3. Units 273 amps and below shall be air-cooled, units above 274 amps shall be water-cooled. All heat producing devices shall be contained in a single heat sink with single inlet and out connections for the connection of chilled water. When factory mounted, on the chiller package, the water connections shall be piped and leak tested at the factory.
4. The following minimum Standard Components shall be provided
    a. Mechanical type solderless connectors to handle wire sizes indicated by the NEC.
    b. Three isolated vertical line contactors.
    c. Three-pole, gang operated non-load break isolating switch.
    d. Three vertically mounted current limiting power fuse blocks (fuses included).
    e. Magnetic three-pole, vacuum break contactor.
    f. Single phase control circuit transformer
    g. Vertically mounted control circuit primary current limiting fuses.
    h. Current transformers
    i. Load terminals
    j. Control circuit terminal blocks and secondary fuses
    k. Phase failure and reversal relay

G. Base unit/compressor control shall be done through a 4-by-20-character display to view system parameters, denote alarms and input setpoints. In conjunction with the standalone base unit controller, the chiller manufacturer shall supply a redundant, state-of-the-art Operator Workstation, complete with super VGA color touchscreen monitor, keyboard and USB port. The operator workstation shall have inherent trend logging capabilities, which are transferable to other PC management systems such as an Excel spreadsheet via a USB port. Active trend logging data shall be available for viewing in 20 minute, 2 hour or 8 hour intervals. A full 24 hours of history shall be downloadable via a USB port. The following trended parameters shall be displayed:

1. Entering and leaving chilled water temps
2. Entering and leaving condenser water temps
3. Evaporator saturated refrigerant pressure
4. Condenser saturated refrigerant pressure
5. Net oil pressure
6. % rated load amps

In addition to the trended items above, other real-time operating parameters shall be also shown on the touch screen. These items shall be displayed in two ways: by chiller graphic showing each component or from a color-coded, bar chart format. At a minimum, the following critical areas must be monitored:

1. Oil sump temperature
2. Oil feed line temperature
3. Evaporator saturated refrigerant temperature
4. Suction temperature
5. Condenser saturated refrigerant temperature
6. Discharge temperature
7. Liquid line temperature

Complete unit operating instructions shall be viewable on the touch screen and shall be downloadable via an onboard USB port. Complete fault history shall be displayed using an easy to decipher, color coded set of messages that are date and time stamped. The last 20

faults shall be downloadable from the USB port. Automatic corrective action to reduce unnecessary cycling shall be accomplished through pre-emptive control of low evaporator or high discharge pressure conditions to keep the unit operating through ancillary transient conditions.

H. Install each chiller in according to manufacturer's requirements, shop drawings, and Contract Documents. Adjust chiller alignment on concrete foundations, sole plates or subbases. Arrange the piping on each vessel to allow for dismantling the pipe to permit head removal and tube cleaning. Furnish and install necessary auxiliary water piping for oil cooler. Coordinate electrical installation with electrical contractor. Coordinate controls with control contractor. Provide all materiel required to ensure a fully operational and functional chiller.

I. Provide Factory Start-Up Services for as long a time as is necessary to ensure proper operation of the unit, but in no case for less than two full working days. During the period of start-up, the Start-up Technician shall instruct the Owner's representative in proper care and operation of the unit.

J. The refrigeration equipment manufacturer's warranty shall be for a period of one year from date of equipment start up. The warranty shall include parts labor and refrigerant costs for the repair or replacement of defects in material or workmanship.

2.17 COOLING TOWERS

A. Furnish and install factory-assembled, induced-draft, crossflow, cooling towers with vertical air discharge. Counterflow design cooling towers are not acceptable.

B. Each cooling tower shall be guaranteed by the manufacturer to cool the quantity of water to meet the chiller design capacities, of water per cell, from 95°F to 85°F at 80°F entering wet bulb temperature. Additionally, the performance shall be certified by the Cooling Technology Institute in accordance with CTI Certification Standard STD-201 or, lacking such certification, a field acceptance test shall be conducted within the warranty period in accordance with CTI Acceptance Test Code ATC-105, by a CTI-accredited independent testing agency.

C. All steel panels and structural members, shall be constructed of type 304 stainless steel. All factory seams in the cold water basin shall be welded, leak tested at the factory to ensure watertight assembly and shall be warranted against leaks for five years. Casing panels and air inlet louvers shall be corrugated fiberglass-reinforced polyester (FRP).

D. All components of units provided, including fan motor, drive system, bearings, structure, fans, fan shafts, bearings, mechanical equipment support, etc., shall be warranted by the manufacturer for a period of not less than five (5) years from the date of start-up/installation.

E. The cold water basin shall be constructed of welded type 304 stainless steel. Basin shall include a depressed center section with drain/clean-out connection. Standard accessories shall include large-area, lift-out steel strainers with perforated openings sized smaller than water distribution nozzle orifices; an integral anti-vortexing hood to prevent air entrainment; and brass makeup valve with large diameter plastic float, arranged for easy adjustment. All factory seams in the cold water basin shall be welded, leak tested at the factory to ensure watertight assembly and shall be warranted against leaks for five years.

F. Each tower cell shall be furnished with a single water inlet connection located in the bottom of the cooling tower complete with the means to balance the flow rate to the hot water distribution

basins. Internal piping shall include an integral pre-strainer assembly such that routine maintenance of the hot water distribution system can be performed from the unit interior. If strainer assembly is not provided integral to the piping system, manufacturer shall provide separate basket strainer for field assembly by mechanical contractor.

G. Air inlet louvers shall be wave formed, fiberglass-reinforced polyester (FRP), spaced to minimize air resistance and prevent water splash-out.

H. Hot water distribution basins shall be the open gravity type and constructed of type 304 stainless steel. Basin weirs and plastic metering orifices shall be provided to assure even distribution of water over the wet deck surface. Thermo-formed, high-density polyethylene (HDPE) basin covers shall be furnished to prevent the formation of algae and the accumulation of debris in the hot water distribution basins.

I. The wet deck surface and integral drift eliminators shall be formed from polyvinyl chloride (PVC), shall be impervious to rot, decay, and fungus or biological attack. The surface shall be manufactured and performance tested by the cooling tower manufacturer to provide single source responsibility and assure control of the final product.

J. Fans shall be heavy duty, axial flow, with aluminum alloy blades. Air shall discharge through a fan cylinder designed for streamlined air entry and minimum fan blade tip clearance for maximum fan efficiency.

K. Fans and shafts shall be supported by heavy-duty, self-aligning, grease-packed ball bearings with moisture-proof seals and integral slinger rings, designed for minimum L10 life of 40,000 hours.

L. Fans shall be driven by an internally mounted gear drive designed specifically for cooling tower service.

M. Fan and motor sheaves shall be fabricated from corrosion-resistant materials, or shall be enclosed and vented to prevent exposure to the saturated discharge air stream.

N. Fan motors shall be totally-enclosed, air-over (TEAO), 1-speed/1-winding, reversible, squirrel cage, ball bearing type, designed specifically for cooling tower service. The motor shall be furnished with special moisture protection on windings, shafts and bearings. Motors shall be inverter duty rated.

O. A hinged access door shall be provided for access to eliminators and fan plenum section. A heavy gauge, hot-dip galvanized wire fan guard shall be provided over each fan cylinder. An external aluminum ladder with safety cage shall be provided for each cell along with galvanized steel handrails to be mounted on the perimeter of the top of each cell. Additionally, an internal service walkway shall be provided along with an internal service platform with ladder to provide a permanent working surface for maintenance personnel to have easy access to moving components needing routine maintenance.

P. The following accessories shall be included as part of the cooling tower installation:

1. Inverter duty fan motors.
2. Stainless steel structure.
3. Stainless steel cold and hot water basins.
4. Bottom inlet and outlet connections.
5. External ladder, safety cage, and handrails.
6. Equalizer connections located in bottom of sump.

7. Bypass connections located in bottom of sump.
8. Electric Pan Heaters
9. Vibration Cut-Out Switches

2.18 ENERGY RECOVERY UNIT

A. The unit shall have the capacities to provide the building with 100% of the outside air requirements utilizing all the building exhaust air for energy recovery, with minimum capacities as scheduled on the drawings. Total outside air shall maintain a building positive pressure of 20% higher than exhaust air, at all times.

B. The structural frame and casing shall be designed and manufactured so as to allow a maximum rotor deflection of 1/32 inch, as measured at the outer radius, during maximum rated airflow condition.

C. All sheet metal shall be reinforced as required to provide a solid mounting surface of the peripheral and radial seals in order to maintain a minimum of ¾ inch fixed distance between the rotor surface and any sheet metal or steel parts. There shall be no special requirement to provide any casing side access for future rotor removal and/or service. All such service work shall be possible to perform from inside the duct at the face of the rotor casing.

D. A purge section shall be provided to eliminate transfer of exhaust air into the supply air, and shall be field adjustable.

E. External tapered roller bearings with double set screw locking collars shall be provided and sized for a minimum L-10 life of 219,000 hours of operation and shall be changeable without a complete disassembly of the rotor. Shaft journals shall be machined to proper tolerance as specified by the bearing manufacturer. Shaft shall be machined as to provide a shoulder against the bearings for a positive locked position to eliminate any lateral movement of the rotor due to axial bearing loads. Grease fittings shall be easily accessible.

F. The spokes shall be made of extruded aluminum with an "I" beam shape to limit deflection of the rotor to 1/32 inch for the maximum rated airflow. Spoke surfaces to be serrated for increased friction and air turbulence across the seals.

G. The rim joint shall connect the spoke ends and the rim ends together in such a way that the heat transfer media can be installed under field conditions without any media deformation or misfits causing future problems. The rim joints shall provide a gradual compression of each section by independently applying increased tension of the rim bolts without the use of any special tools or devices.

H. The rims shall be made of two extruded aluminum sections -- one inner rim and one outer rim with grooves for the twin "V" belts, and guide flanges for securing the media. The two sections shall be welded together to form a tubular structure for improved strength in order to maintain an accurate radius and rotor roundness during the manufacturing process.

I. The rotor media shall be provided in segments to allow for field erection or replacement of one section of media at a time without side access. No external pullers or other special tooling shall be required for field assembly or replacement. The media shall be machined to fit in between a primary and secondary spoke and a guiding flange of the outside rim. Each media segment shall be compressed independently of all other segments during manufacturing without causing any angular deformation and resulting misfits between the spokes and media parts. The

results shall be a wheel with a flatness of +/- 1/32 inch. No adhesive or silicone shall be necessary to secure the media in place.

J. The heat transfer media shall be the industry standard of 200 mm. in depth. Non-standard depths shall be unacceptable. The heat transfer media shall be made out of corrugated aluminum foil with a high surface area per volume and laminar flow to assure that no fouling occurs on the internal heat transfer surface. Dry particles up to 900 microns shall pass freely through the media. This material shall be supplied with a "Balanced Sieve" (4A Molecular Sieve) hygroscopic solid desiccant coating for selective adsorption of water vapor and equal sensible and latent heat transfer. All edges shall have an anti-corrosion epoxy coating.

K. The seals shall be of a maintenance free "non-contact" type with a 4-pass labyrinth "turbine" for optimum performance and designed to eliminate wear and excessive drag. The seals shall be adjustable and set to within 0.05 inch of the rotor surface and must be bolted to the frame with stainless steel hardware to eliminate seal movement. The seal system shall withstand a pressure difference up to 12 in. wc.

L. The drive system shall be gravity tensioned and shall use two standard "B" section V-belts that must ride in a groove in the rotor rim to eliminate any side-to-side movements and slippage. The speed reducer shall be grease lubricated, maintenance free with a flexible Love-Joy input coupling for easy motor separation and for absorption of any shock or vibration. The drive system shall be easily accessible and visible for inspection and maintenance and have a minimum life expectancy of 90,000 hours.

M. The speed control system shall be a variable frequency inverter operating a standard inverter rated AC motor, capable of operating the rotor from 1/4 rpm to 20 rpm or to whatever is required for the type of media used. It shall integrate with the temperature control system to provide the required supply air temperature.

N. The temperature controller shall monitor entering and leaving temperatures for the exhaust and supply air. Adjustable set points shall be for the heating mode discharge temperature, summer/winter change over and for wheel frost control. For multiple rotors in a common air stream each rotor shall provide temperature outputs to the controller in order to get an accurate average discharge temperature.

O. The rotation detector shall be accomplished through the temperature controller. An inductive proximity sensor, shaft target and a relay supplying a dry contract for the controller shall be used to provide RPM readout and wheel stoppage alarm contacts.

P. The entire rotor and wheel assembly shall require only limited maintenance of biannual greasing of the main bearings and inspection of the drive system.

Q. A standard 3-year material and labor warranty shall be provided covering all materials supplied and installed.

2.19 FOURTH FLOOR REDUNDANT CONDENSING UNIT

A. Provide and install as shown on the plans factory-assembled, air-cooled scroll compressor condensing units in the size and quantity scheduled. Each unit shall consist of hermetic tandem or triple scroll compressor sets, air-cooled condenser section, control system and all components necessary for controlled unit operation when field piped and wired to low side equipment specified elsewhere. All units shall have dual compressors on the same refrigerant circuit for capacity reduction. Units shall use 407C refrigerant. Each unit shall be capable of

stable operation to a minimum of 50 percent of full load without hot gas bypass. Performance shall be in accordance with ARI Standard 365-94.

B. The compressors shall be sealed hermetic scroll type with crankcase oil heater and suction strainer. Compressor shall have a forced-feed lubrication system with a reversible oil pump and oil charge. The compressor motor shall be refrigerant gas cooled, high torque, hermetic induction type, two-pole, with inherent thermal protection on all three phases and shall be mounted on RIS vibration isolator pads.

C. The condenser coils shall consist of 3/8 inch seamless copper tubes mechanically bonded into plate-type fins. The fins shall have full drawn collars to completely cover the tubes. A subcooling coil shall be an integral part of the main condenser coil. Condenser fans shall be propeller type arranged for vertical air discharge and individually driven by direct-drive fan motors. They shall be equipped with a heavy-gauge fan guard. Fan motors shall be TEAO, three-phase, direct-drive, 1140 rpm.

D. Capped connections shall be provided for field connection of refrigerant piping. Refrigerant specialties shall be field supplied and installed.

E. Install units in strict accordance with manufacturer's requirements, shop drawings, and contract documents. Adjust and level unit in alignment on supports. Coordinate electrical installation with electrical contractor. Coordinate controls with control contractor. Provide all appurtenances required for a fully operational and functional unit. Install proper charge of refrigerant and oil. Provide testing and starting of machine, and instruct the Owner in its proper operation and maintenance.

2.20 WATER HEATER FLUES

A. Each flue shall be of the double-wall, factory type approved for use with appliances burning natural gas, which produces flue gasses exhausted at temperatures not exceeding 550 deg F.

B. The flue vent shall be constructed of an outer wall of type 304 stainless steel, minimum thickness of .025". The inner wall shall be constructed of type 304 stainless steel, minimum thickness of .035".

C. The vent shall have a minimum integral, annular insulating air space of ½".

D. The edges of the inner and outer walls shall be hemmed prior to final assembly to prevent the piping and fittings from having sharp edges. Walls shall be attached to maintain required spacing and to prevent separation of the inner and outer walls. The vent shall incorporate a push-tab locking system that will prevent disassembly of the vent during and after installation.

E. All fittings, flashings, storm collar, cap and appliance adapter shall be type 304 stainless steel and shall be provided as required to make the installation complete.

F. Vents shall be tested and listed for a minimum clearance to combustibles of 1".

G. Vents shall be installed in accordance with the manufacturer's requirements and recommendations and all State and Local Codes.

2.21 VARIABLE FREQUENCY DRIVES

A. This specification is to cover a complete Adjustable (Variable) Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor. It is required that the drive manufacturer have an existing Sales representative exclusively for HVAC products, with expertise in HVAC systems and controls and an independent service organization. The drive manufacturer shall supply the drive and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of ten years. VFD's that are manufactured by a third party and "brand labeled" shall not be acceptable.

B. The following Referenced Standards shall apply:

1. Institute of Electrical and Electronic Engineers Standard 519-1992, IEEE Guide for Harmonic Content and Control.

2. Underwriters laboratories UL508C.

3. National Electrical Manufacturer's Association (NEMA) ICS 7.0, AC Adjustable Speed Drives.

4. IEC 16800 Parts 1 and 2.

5. VFDs and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. The base VFD shall be UL.

C. Submittals shall include the following information:

1. Outline dimensions, conduit entry locations and weight.

2. Customer connection and power wiring diagrams.

3. Complete technical product description include a complete list of options provided.

4. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD). The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance reactors, no exceptions.

D. The VFD package as specified herein shall be enclosed in a UL Listed Type 12 enclosure, completely assembled and tested by the manufacturer in an ISO9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.

E. The VFD package as specified herein shall operate between 32 to 104°F continuous, and less than 95% humidity, non-condensing. VFD's that can operate at 104° F intermittently (during a 24 hour period) are not acceptable and must be oversized. Enclosure shall be rated UL type 12 and shall be UL listed as a plenum rated VFD. VFD's without these ratings are not acceptable.

F. All VFDs shall have the following standard features:

1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote

mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.

2. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.

3. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.

4. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.

5. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, operating temperature will be monitored and used to cycle the fans on and off as required.

6. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).

7. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.

8. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.

9. The VFD shall have an integral 5% impedance line reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD's with only one DC reactor shall add AC line reactors.

10. The input current rating of the VFD shall be no more than 3% greater than the output current rating. VFD's with higher input current ratings require the upstream wiring, protection devices and source transformers to be oversized per NEC 430-2.

11. The VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.

12. The VFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.

13. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communication bus.

14. The VFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.

G. All VFDs to have the following adjustments:

1. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.

2. Two (2) PID Setpoint controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID setpoint shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer/winter setpoints, etc. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (ie. valves, dampers, etc.). All setpoints, process variables, etc. to be accessible from the serial communication network. The setpoints shall be set in Engineering units and not require a percentage of the transducer input.

3. Two (2) programmable analog inputs shall accept current or voltage signals.

4. Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.

5. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices, typically programmed as here-in-after described. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications) the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to an VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. The keypad shall display "start enable 1 (or 2) missing". The safety status shall also be transmitted over the serial communications bus. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC.

6. Three (3) programmable digital Form-C relay outputs. The relays shall include programmable on and off delay times and adjustable hysteresis. Default settings shall be for run, not faulted (fail safe), and run permissive. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs shall be true form C type contacts; open collector outputs are not acceptable.

7. Seven (7) programmable preset speeds.

8. Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.

9. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.

10. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows the highest carrier frequency without derating the VFD or operating at high carrier frequency only at low speeds.

11. The VFD shall include password protection against parameter changes.

H. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). The keypad shall utilize the following assistants:

1. Start-up assistants.

2. Parameter assistants

3. Maintenance assistant

4. Troubleshooting assistant

I. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):

1. Output Frequency

2. Motor Speed (RPM, %, or Engineering units)

3. Motor Current

4. Calculated Motor Torque

5. Calculated Motor Power (kW)

6. DC Bus Voltage

7. Output Voltage

J. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the VFD shall operate at an adjustable preset speed. The mode shall

override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation.

K. Serial Communications

1. The VFD shall have an RS-485 port as standard. The protocols shall be Modbus, Johnson Controls N2 bus, Siemens Building Technologies FLN, LonWorks, BACnet, Profibus, Ethernet, or DeviceNet. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed. Multiple VFDs sharing one gateway shall not be acceptable.

2. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad "Hand" or "Auto" selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass (if bypass is specified). The DDC system shall also be able to monitor if the motor is running in the VFD mode or bypass mode over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

3. The VFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the DDC system.

4. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value control, etc. Both the VFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFD shall keep the last good set-point command and last good DO & AO commands in memory in the event the serial communications connection is lost.

L. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assemble to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level.

M. All VFD's through 50HP shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad.

N. The following additional features shall be furnished and mounted by the drive manufacturer. All additional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.

1. A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor. Overload protection and shall be provided in both drive and bypass modes.

2. Door interlocked, padlockable circuit breaker that will disconnect all input power from the drive and all internally mounted options.

3. Fused VFD only disconnect (service switch). Fast acting fuses exclusive to the VFD – fast acting fuses allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs, which have no such fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted. Three contactor bypass schemes are not acceptable.

4. The drive / bypass shall provide single-phase motor protection in both the VFD and bypass modes.

5. The following operators shall be provided:

    a. Bypass Hand-Off-Auto
    b. Drive mode selector
    c. Bypass mode selector
    d. Bypass fault reset

6. The following indicating lights (LED type) shall be provided. A test mode or push to test feature shall be provided.

    a. Power-on (Ready)
    b. Run enable (safeties) open
    c. Drive mode select damper opening
    d. Bypass mode selected
    e. Drive running
    f. Bypass running
    g. Drive fault
    h. Bypass fault
    i. Bypass H-O-A mode
    j. Automatic transfer to bypass selected
    k. Safety open
    l. Damper opening
    m. Damper end-switch made

7. The following relay (form C) outputs from the bypass shall be provided:

    a. System started
    b. System running
    c. Bypass override enabled
    d. Drive fault
    e. Bypass fault (motor overload or underload (broken belt))
    f. Bypass H-O-A position

8. The digital inputs for the system shall accept 24V or 115VAC (selectable). The bypass shall incorporate internally sourced power supply and not require an external control power source.

9. Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes (not functional in Fireman's Override 2). The remote start/stop contact shall operate in VFD and bypass modes.

10. Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure for fireman's override. Two modes of operation are required.

    a. One mode forces the motor to bypass operation and overrides both the VFD and bypass H-O-A switches and forces the motor to operate across the line (test mode). The system will only respond to the digital inputs and motor protections.

    b. The second fireman's override mode remains as above, but will also defeat the overload and single-phase protection for bypass and ignore all keypad and digital inputs to the system (run until destruction).

11. The VFD shall include a "run permissive circuit" that will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD system (VFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the VFD system safety interlock (fire detector, freezestat, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.

12. Class 20 or 30 (selectable) electronic motor overload protection shall be included.

13. There shall be an internal switch to select manual or automatic bypass.

14. There shall be an adjustable current sensing circuit for the bypass to provide loss of load indication (broken belt) when in the bypass mode.

O. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual. Power wiring shall be completed by the electrical contractor. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

P. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

Q. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available. A 24/365 technical support line shall be available on a toll-free line. A computer based training CD or 8-hour professionally generated video (VCR format) shall be provided to the owner at the time of project closeout. The training shall include installation, programming and operation of the VFD, bypass and serial communication.

2.22 UVC FIXTURE

A. Lamps and fixtures shall be installed, on all units, in sufficient quantity and in such a manner so as to provide an equal distribution of UVC energy. When installed, the average intensity striking the intended surface shall not be less than 200 microwatts per square centimeter. The

applied energy and its distribution average shall be verified using third party math modeling and that verification shall be included with the submittal.

B. The minimal UVC energy striking a surface shall be sufficient to continuously destroy a mono-layer of mold and bacteria as typically found in HVAC systems in less than six hours. The third party mathematical modeling shall include the destruction time for at least four of the most common HVAC microbes and an energy distribution map.

C. Fixture rows shall be electrically terminated to factory supplied Hard Wire Boxes to meet UL and local electrical codes. Fixtures shall be mounted to irradiate the intended surfaces as well as all of the available line of sight airstream by proper placement and incident angle reflection. Third party irradiation and intensity calculations (modeling) shall determine fixture placement and energy distribution and shall be provided in the submittal.

D. Fixtures shall be track mounted to the appropriate factory supplied hardware to form horizontal rows that provide for the proper fixture support. Fixtures shall be equipped with UL approved fixture-to-fixture mechanical and electrical connections that facilitate proper installation and coupling to A/C power from one end. Fixtures shall be capable of being mounted anywhere in the system and/or as shown on the plans.

E. When used for surface irradiation, the fixture assembly shall be designed and installed such that the sum of the lamp arc lengths in a row shall be equal to a minimum of 90% of the surfaces total width.

F. Fixtures shall meet the "UL" drip proof design and each fixture shall be equipped with an electrical interlock, which will not allow the fixture to energize unless it's properly installed to its factory supplied mounting track.

G. Fixtures shall be constructed of type 304 stainless steel to preclude corrosion.

H. Power supplies shall be of the high efficiency electronic type, matched to the lamp and designed to maximize UVC photon production, radiance and reliability. They shall be UL Listed and labeled for use in air-streams of 55-135° F. They shall be capable of producing the specified output and organism destruction as specified under Irradiation and Intensity at no more than 13 Watts of power consumption for each square foot of treated, cross sectional plane.

I. Each lamp shall contain no more than 8 milligrams of mercury, consistent with current environmental practices, while producing the specified output at 500 fpm in temperatures of 55-135° F. Useful lamp life shall be 9000 hours with no more than a 20% output loss at the end of one year of continuous use. They shall be constructed with UVC proof metal bases and shall not produce ozone.

J. UVC Fixtures shall be stored in a clean, dry place and protect from weather and construction traffic. UVC Fixtures shall be handled carefully to avoid damage to components, enclosures and finish. Factory-shipping covers shall be left in place until installation is complete. Damaged components shall not be installed, instead replace them and return damaged components to equipment manufacturer.

K. Installation of UVC fixtures

1. Coordinate with installation of HVAC equipment and install Fixtures as indicated above after such equipment is properly installed.

2. Comply with manufacturers' installation instructions regarding wiring and testing and to the drawings and/or specification regarding exact fixture placement for proper energy distribution.

3. Provide an interlock switch on all access panels and doors leading to the UVC assembly and/or within view of the fixtures to assure that the UVC assembly will be de-energized when any of these accesses are opened.

4. When specified and/or called out on the drawings, install a relative indicating radiometer and adjust and set in accordance with manufacturer recommendations.

5. Caution Labels shall be installed on all accesses to the Fixtures.

6. Install UVC system on all air handling units.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment and controls shall be installed in accordance with manufacturer's recommendations. Installation, adjustments and starting shall be done under supervision of manufacturer's representative.

B. All ductwork and equipment shall be installed in a neat and workmanlike manner in accordance with the guidelines of NFPA 90-A, SMACNA and the best practice of the trade.

C. Provide manual firestats, set at 125 degrees F, in return inlets of all fans and blowers and all exhaust fans of 600 cfm and over. SEE SECTION 15950 for additional requirements.

D. For requirements of the temperature control system SEE SECTION 15950. This Contractor shall furnish and install any and all mechanical items which are required to complete the temperature controls which are to be provided under other sections of the specifications. Read SECTION 15950 for requirements.

E. All piping as specified under this section shall be tested to the following pressures:

Chilled water	-	100 psi
Condenser water	-	50 psi
Condensate drain	-	10 psi

The method of application of tests and duration shall be as described in SECTION 15050. Maximum of 5% pressure loss during the duration will be acceptable.

F. Upon completion of the installation of all work and equipment the Contractor shall start all equipment and make all necessary tests and adjustments to place entire heating, ventilating and air conditioning systems in a satisfactory condition for continuous safe operation of facilities.

G. All filters shall be replaced with specified type after period of test and adjustment.

END OF SECTION 15800

SECTION 15840 - WATER TREATMENT SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including General and Supplementary Conditions and General Requirements apply to the work specified in this Section.

B. Refer to Basic Materials and Methods Section 15050 which shall apply to work in this Section.

1.2 DESCRIPTION OF WORK

A. Contractor shall perform water analysis and provide all water treatment products, holding reservoirs and labor for testing, cleaning, flushing and dispensing the products to control the water quality for each system as hereinafter specified.

B. Contractor shall provide all chemicals for operating and testing all water treatment systems for a one year period from the date of Substantial Completion. Along with the chemical supplies the Contractor shall provide all the proper operating and maintenance instructions for each water treatment system. Contractor shall also furnish all required water treatment testing equipment for each system, complete with apparatus and reagents necessary for one year of Owner testing.

C. Contractor shall provide the services of a qualified service representative to instruct the Owner's operating personnel in the proper operation and maintenance of the water treatment equipment, systems, and tests required.

1.3 RELATED WORK SPECIFIED IN OTHER SECTION

A. Electrical Section will provide all power wiring including furnishing and installing of disconnect switches where specified. Control wiring for water treatment equipment shall be provided under this section.

B. This Section shall provide and install structural supports for equipment. These supports must be checked and coordinated by this Section so that they suit the equipment which is to be supported.

C. This Section shall provide starters for motors furnished under this Section.

1.4 QUALITY ASSURANCE

A. These specifications with accompanying drawings, require complete apparatus, fully erected and in successful operating condition. Perform all work in best, most substantial manner.

B. All equipment furnished and installed under this Section shall be U.L. or E.T.L. approved and labeled where applicable.

C. All chemical products provided under this Section shall be products that are approved and acceptable under State of Louisiana and Parish of ST Charles Pollution Control and any other governing regulations.

D. All manufacturers' products shall comply with the requirements of this Section.

E. Qualify welding/brazing process and welder/brazier performance in accordance with AWS B2.2, Standard for Brazing Procedure and Performance Qualification, or ASME Boiler and Pressure Vessel Code, Section IX (See 15050). Provide copy of certification for welding and brazing processes.

F. Soldering processes shall conform to ASME B 31.3, Process Piping and Copper Development Association recommended practices.

G. The Contractor performing the work under this Section shall have the following:
1. Research and development facilities.
2. Regional laboratories capable of making water analysis.
3. A Service department and qualified technical service representatives locate within 25 miles of the project site. Service representatives shall be factory certified with not less than 5 years of water treatment experience.

H. All supply water treatment chemicals shall be in metal drums, fiber drums, fiber drums with plastic liners or plastic-lined "liquid-packs" as best suited to the materials. Biocides shall be registered with the USDA or EPA and labeled as required by law.

1.5 SUBMITTALS

A. Contractor shall submit shop drawings for each water treatment system. Drawings shall show all wiring, piping and tubing sizes, fittings, accessories valves and connections.

B. Contractor shall submit all test reports, certified by an officer of the firm, on Company letterheads, of samples of each treated water system specified. Reports shall comply with ASTM D 596 for reporting and shall indicate the ASTM test methods used for each test.

C. Contractor shall submit written guarantee, signed by the Manufacturer and countersigned by the installer and Contractor, agreeing to adjust or replace the system or portions thereof as required to achieve the required performance during the one year warranty period.

PART 2 – PRODUCTS

2.1 GENERAL

A. Contractor shall perform water analysis to determine which chemicals to use from the water samples taken from the building site and shall provide the ingredients necessary to achieve the desired water conditions.

B. Contractor shall ensure that neither products, waste, nor other effluents violate local, State, EPA, or any other Governing Agency regulations in effect in the Project Area...

2.2 CHILLED WATER SYSTEMS

A. Water treatment products shall be provided which shall maintain the pH between 9.0 and 9.5 and which contain inhibitors that perform the following:

1. Form a protective film to prevent corrosion and scale formation on copper, steel, iron, and bronze surfaces.
2. Scavenge oxygen and protect against scale.
3. Remain stable throughout the entire operating range.
4. Are compatible with pump and valve seals and other components of the system.
5. Control the growth of nitrifying bacteria and prevent biological growth.
6. Use a boron-nitrate compound as the primary inhibitor.

B. For each system provide a 5 gallon pot type feeder designed for not less than 300 psig operating pressure. Feeder and chemical storage tank shall be impervious to the chemical products dispensed.

C. Provide a test kit and reagents for determining proper water conditions.

2.3 CONDENSER WATER SYSTEMS

A. Contractor shall provide a complete factory fabricated automatic open loop condenser water treatment system designed to monitor, record and control the following:
1. System alkalinity in a pH range that is non-corrosive (typically 7.87 to 8.8 depending on the chemical used).
2, Total dissolved solids.
3. System blow down.
4. Scaling and corrosion.
5. Eliminate biological growth.

B. Furnish and install the following equipment:
1. Chemical solution reservoirs shipping containers shall have protective linings, which are impervious to the products held and dispersed.
2. Provide a biocide system which shall control micro-organisms and consists of a time switch, a chemical feed pump, control panel, corporation stop, conductivity measuring device, bleed valve and strainer, all as herein after specified.
3. Feed pump shall be a variable output diaphragm type with capacity to inject the quantity of solution required with a minimum discharge pressure of 100 psig. The pump diaphragm shall be tetrafluorethylene with a PVC head block. The check valves shall be PVC with Viton "O" ring seats and ceramic balls. The motor shall be 120V, 1 ph. with a totally enclosed gear train.
4. Provide a Stainless Steel pump for use with organic solvent based biocide ingredients only.

C. Provide one corporation stop and nozzle assembly for each chemical injection location. Each assembly shall be ¾" pipe size with 15" long PVC injection pipe. Nozzle for biocide shall be Stainless Steel.

D. Provide a control panel that shall be weatherproof, wall mounted, 120 V with two sections. One section shall be an electronic control package with solid state plug in circuit boards. The conductivity setpoint dial and status indicator lights shall be visible through a clear plastic cover. The second section shall be a flow through sensor assembly containing the conductivity cell. The sensor shall be wired into the control panel so that an increase in conductivity shall cause the controller to energize the inhibitor feed and bleed off. When the desired solids level has been reached, the chemical feed pump and bleed off circuits shall be de-energized.

E. Bleed valves shall be, normally closed, brass solenoid valve with Buna-N or ethylene propylene rubber seals rated to operate at system pressure and chemical conditions, and Stainless Steel internal wetted parts.

F. Conductivity measurements shall be made with Titanium-palladium alloy electrodes that are temperature compensated for 0-100 deg C and stability thru 0.2% of full scale per day.

G. Provide a cast iron bodied strainer, with Stainless Steel strainer element immediately upstream of the bleed valve rated to operate at system pressure.

PART 3- EXECUTION

3.1 CHEMICALS

A. Provide one year supply of chemicals for all water treatment systems.

3.2 FLUSHING

A. Flush out system and remove pipe scale and oily residue, furnish Pre-Start-Up chemical to be used under direct supervision of chemical company representative. This shall be done after all piping is completed and leak tested and prior to operation and initiation of regular chemical feeding.

3.3 PERSONNEL TRAINING

A. Contractor shall train the Owner's personnel in the use of each treatment system, including preparation of chemical solutions, testing and charging of the chemical solution reservoirs.

END OF SECTION 15840

SECTION 15850 - TESTING AND BALANCING OF AIR AND HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Contractor shall furnish all labor, equipment and services necessary for and incidental to Air and Water Systems Testing and Balancing.

B. The Contractor shall procure the services of an independent testing and balancing agency. The Testing and Balancing Agency (TBA) specializes in testing and balancing of heating, ventilating, air-moving equipment, air-conditioning system and Hydronic systems. The Mechanical Contractor shall award the test and balance contract to the above agency as soon as possible after receipt of contract.

C. Testing and Balancing shall not begin until the systems have been completed and are in full working order.

D. Shop drawings must be provided to the TAB firm no later than 30 days after the final, approved shop drawings have been returned by the Architect to the Contractor.

E. Duct leakage testing shall be the responsibility of the TBA subcontractor.

F. Fire and smoke damper testing shall be done by the contractor and witnessed by the TAB firm.

G. The final and complete Test and Balance Report shall be submitted, for approval, not less than two weeks before a final inspection of the Project is requested by the General Contractor. Failure to provide the Report shall be cause to delay the final inspection until the Report is Approved .

H. Contractor is cautioned that test and Balance Report shall include both Grille counts, and Supply, Return, Outside Air and Exhaust Duct Traverses so that duct leakage can be calculated.

1.2 REFERENCES

A. AABC – National Standards for Total System Balance.

B. NEBB – Procedural Standards for Testing, Adjusting, and Balancing.

1.3 SUBMITTALS

A. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

B. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.

C. Provide reports in soft cover, letter size, binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating, thermostat locations.

1.4 QUALITY ASSURANCE

A. Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance or NEBB Standards – Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems or Testing Adjusting and Balancing Bureau (TABB)-National Standards for Environmental Systems Balance.

1.5 QUALIFICATIONS

A. TBA shall be a Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum three years experience.

PART 2 - PRODUCTS

2.1 ADJUSTMENT DEVICES

A. Replacement of adjustable pulleys, additional balancing dampers, additional fan belts, pressure taps and fitting, hydronic balancing valves and any other devices or equipment required to effect proper testing, adjusting and balancing shall be provided shall be provided by the Contractor at no additional cost to the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

B. Beginning of work means acceptance of existing HVAC conditions.

3.2 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.

B. Air Outlets and Inlets; Adjust total to within plus 5 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 5 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 5 percent of design.

3.3 ADJUSTING – GENERAL

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark setting of valves, dampers, and other adjustment devices allowing setting to be restored. Set and lock memory stops.

C. After adjustment, take measurement to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

E. At the time of final inspection the TAB agency may be required to recheck, in the presence of the Owner's Representative, specific and random selections of data, air quantities, and air motion recorded in the certified report. Points and areas for recheck shall be selected by the Architect. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for recheck, specific plus random, shall not exceed 10% of the total number tabulated in the report.

3.4 AIR SYSTEMS PROCEDURE (MINIMUM REQUIREMENTS)

A. Test and adjust fan RPM to design requirements.

B. Test and record motor full load nameplate rating and actual ampere draw.

C. Test and record system static pressures, fan suction and discharge.

D. Adjust all main supply and return air duct to proper design CFM.

E. Test and adjust each diffuser, grille and register (new and existing as indicated on drawings). Reading and tests of diffusers, grilles and registers shall include design velocity (FPM) and as adjusted velocity, design CFM and adjusted CFM.

F. Test and record outside, mixed air and discharge temperatures (D.B. for heating cycle, D.B. and W.B. for cooling cycle).

G. In coordination with the ATC contractor, set adjustments of automatically operated dampers to operate as specified, indicated and/or noted.

H. Test and adjust air handling and distribution systems to provide required or design supply, return, outside and exhaust air quantities.

I. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

J. Measure air quantities at air inlets and outlets.

K. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

L. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

M. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

N. Provide system schematic with required and actual air quantities recorded at each outlet or inlet

O. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

P. Adjust outside air automatic dampers, outside air, return air and exhaust dampers for design conditions.

Q. Measure temperature conditions across air, return air, and exhaust dampers to check leakage.

R. Where modulating dampers are provided, take measurement and balance at extreme conditions.

S. Measure and record pressure differentials between designated spaces.

3.5 WATER SYSTEM PROCEDURE (MINIMUM REQUIREMENTS)

A. Prepare itemized equipment schedules, listing all cooling elements and equipment in the systems to be balanced. List in order on equipment schedules, by pump or zone according to the design, all cooling elements, all zone balancing valves, circuit pump and ending with the last items of equipment or transfer element in the respective zone or circuit. Include on schedule sheet column titles listing the location, type of element or apparatus, design conditions and measured conditions. Prepare individual pump report sheets for each zone or circuit.

B. Adjust water systems (as indicated on drawings) to provide required or design quantities.

C. Use calibrated Venturi tubes, orifices, or other metered fitting and pressure gages to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

D. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

E. Effect system balance with automatic control valves fully open to heat transfer elements.

F. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

G. Test pumps and adjust flow. Record the following on pumps report sheets: (a) suction and discharge pressure, (b) running amps and brake horsepower of pump motor under full flow and no flow conditions, (c) pressure drop across pump in feet of water and total GMP pump is handling under full flow conditions.

H. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.6 REQUIRED REPORTS TO BE SUBMITTED

A. The following reports shall be submitted, as a minimum, with a complete Title Page, Summary , and Instrument List. All data and nomenclature shall be provided, as required by AABC and/or NEBB Procedure manuals, for each device tested and balanced.

1. Electric Motors.
2. V-Belt Motors.
3. VFD Drives.
4. Pump Data.
5. Heating and Cooling Coils Data.
6. Air Moving Equipment.
7. Return Air/ Outside Air Data.
8. Exhaust Air Data.
9. Duct Traverses.
10. Air Distribution Test Sheets.

3.7 COMMISSIONING

A. Balancing Agency shall coordinate with the Mechanical Contractor the Commissioning requirements as here-in-before specified.

B. Contractor is cautioned that the Owner, thru the Architect, reserves the right to check and verify any and all points and readings of the Test and Balance report. If 15% or more of the points do not agree with the report, then the Contractor shall re-test and re-balance the entire project and submit a complete new Report. If 15% or more of this new Data is independently verified and still does not agree with the Contractor's new Report, then the Owner has the right to hire an Independent Test and Balance Contractor and the Original Contractor shall be held responsible to pay these costs.

C. All TAB deficiencies shall be corrected when found. Any deficiencies that are (for whatever reason) not corrected immediately shall be shown in the TAB report and listed on a summary sheet in the front of the TAB report. The TAB report must be completed and accepted by the Mechanical Engineer before the project is accepted and all items on the summary sheet shall become punch list items with dollar values assigned to them.

END OF SECTION 15850

SECTION 15900 - VALVES, STRAINERS, UNIONS AND FITTINGS

PART 1 – GENERAL

1.1 SUMMARY

A. The work under this heading includes the furnishing and installing of all required appurtenances incidental to the piping systems as indicated on the drawings. Refer to BASIC MATERIALS AND METHODS SECTION which shall apply to all work in this Section.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide factory-fabricated valves for use in service indicted. Provide valves of types and pressure ratings indicated; provide proper selection to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is installer's option. Valves shall be of same make for all these services.

B. Valves shall comply with the following:

Gate - cast iron - MSS SP-70
Gate - bronze - MSS SP-80
Globe - cast iron -MSS SP-85
Globe - bronze - MSS SP-80
Ball - MSS SP-110
Butterfly - MSS SP-67
Check - cast iron - MSS SP-71
Check - bronze - MSS SP-80

C. Gate valves shall be equipped with packing suitable for intended service. (Under no circumstances is asbestos acceptable.) Valves shall be designed so back seating protects packing and stem threads from media when valve is fully opened, and equipped with gland follower. Guides for disc on rising stem valves shall be machined for accurate fit.

D. Globe valves shall be equipped with packing suitable for intended service. (Under no circumstances is asbestos acceptable.) Globe valves shall be designed so back seating protects packing and stem threads from media when valve is fully opened, and equipped with gland follower.

E. Ball valves shall have FULL port opening blow out proof stem: hard chrome plated forged brass ball, rated not less than 600# W.O.G. for sizes 3" or smaller.

F. Provide gear operators on butterfly valves 8" and larger. Valve bodies shall have extended necks to provide for 2-1/4" insulation.

G. Provide valves with features indicated and where not otherwise indicated, provide proper valve features as outlined in this specification. Comply with ANSI B31.1.

H. Valve flanges shall comply to ANSI B16.1 (cast iron), ANSI B16.5(steel), ANSI B16.24 (bronze). Steel flanges shall be Class 150.

I. Threaded valve ends shall comply with ANSI B2.1.

J. Butt-Weld valve ends shall comply with ANSI B16.25.

K. Solder Joint valve ends shall comply with ANSI B16.18.

L. Flangeless valve bodies shall be manufactured to fit between flanges and shall comply with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).

M. Fabricate pressure-containing components of valves, including stems and seats from brass or bronze materials, of standard alloy recognized in valve manufacturing that resist de-zincification.

N. Design seat of valve with removable disc, and assemble valve so disc can be replaced when worn.

O. Butterfly valves shall be designed for flow regulation, and manufactured to be tight in closed position. Test pressures in accordance with MSS SP-67 as follows: Seat 2-12" 220psi. No leakage shall be permitted under test.

2.2 GLOBE VALVES FOR STEEL PIPING (SERVICES UNDER 200 DEGREES F)

A. Threaded Ends 2" and Smaller: Class 125, bronze body, union bonnet, rising stem, Teflon disc.

B. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bolted bonnet, rising stem, OS&Y, renewable seat and disc.

2.3 GATE VALVES FOR STEEL PIPING (SERVICES UNDER 200 DEGREES F)

A. Threaded Ends 2" and Smaller: Class 125, bronze body, union bonnet, rising stem, solid wedge.

B. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge.

2.4 GLOBE VALVES FOR COPPER PIPING (SERVICES UNDER 200 DEGREES F)

A. Soldered Ends 2" and Smaller: Class 125, bronze body, screwed bonnet, rising stem, bronze disc (swivel type.

B. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bolted bonnet, rising stem, OS&Y, renewable seat and disc. Provide dielectric gasket and bolt isolators.

2.5 GATE VALVE FOR COPPER PIPING (SERVICES UNDER 200 DEGREES F)

A. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge. Provide dielectric gasket and bolt isolators.

B. Solder Ends 2" and Smaller: Class 125, bronze body, screwed bonnet, rising stem, solid wedge. (Non-rising stem gate valves may be used where headroom prevents full extension of rising stems.)

2.6 BALL VALVES (SERVICES UNDER 200 DEGREES F)

A. Threaded Ends 3" and Smaller: 600# W.O.G., forged brass two piece body, hard chrome plated forged brass ball, blow-out proof stem.

B. Soldered Ends 2" and Smaller: 600# W.O.G., forged brass two piece body, hard chrome plated forged brass ball, true adjustable packing nut ("O"-ring only type stem seal not acceptable), blow-out proof stem.

C. Flanged Ends 2-1/2" and larger: Class 150, flanged ends, carbon steel body with 316 s.s. trim, uni-body design, full port, blowout proof s.s. stem and ball, telfon seat.

2.7 BUTTERFLY VALVES (SERVICES UNDER 200 DEGREES F)

A. For chilled/hot water system provide lug type with rated working pressure of 200 psi on sizes 2" thru 12". Valve shall be cast iron, drilled and tapped bug body, lever operated, 10 position throttling handle, memory plate, type 410 stainless steel stem with EPDM seat.

2.8 SWING CHECK VALVE IN COPPER PIPING (SERVICES UNDER 200 DEGREES F)

A. Soldered Ends 2" and Smaller: Class 125, bronze body, screwed cap, "Y" pattern swing, bronze disc.

B. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, horizontal swing, cast-iron disc. Provide dielectric gasket with insulated bolts.

2.9 SWING CHECK VALVES IN STEEL PIPING (SERVICES UNDER 200 DEGREES F)

A. Threaded Ends 2" and Smaller: Class 125, bronze body, screwed cap, "Y" pattern swing.

B. Flanged Ends 2-1/2" and Larger: Class 125, iron, bronze mounted, horizontal swing, cast-iron disc.

2.10 UNIONS IN COPPER LINES (SERVICES UNDER 200 DEGREES F)

A. Cast Bronze Unions.

2.11 UNIONS IN BLACK STEEL, WROUGHT IRON OR GALVANIZED STEEL PIPING

A. Ground joint malleable iron galvanized Class 300 for 2" nominal pipe sizes or below. For pipe sizes 2-1/2" and larger use forged steel welding flanges (Galvanized for galvanized piping).

2.12 UNIONS IN CONNECTION BETWEEN COPPER AND STEEL OR IRON PIPING (SERVICES UNDER 200 DEGREES F)

A. Provide bronze valves or dielectric waterways.

2.13 STRAINERS

A. Through 2-1/2" Screwed; mesh monel screen through 2"; .045 stainless steel on 2-1/2"; Strainers on 3" and above flanged, to have .045 mesh, ss screws; 3-1/2" and above .125 mesh, ss screws.

2.14 GAGE COCK

A. All bronze.

2.15 AIR VENT (SERVICES UNDER 200 DEGREES F)

A. Provide automatic air vents where indicated on drawings, with copper discharge line piped to closet floor drain.

2.16 MANUAL AIR VENTS (SERVICES UNDER 200 DEGREES F)

A. Where installed shall be 1/4" tap into line to be vented.

2.17 GAUGES

A. Furnish and install where shown on the plans or where good practice required, pressure gauges with 4-1/2 glass dial face, corrosion resistant stainless steel case and ring, balanced adjustable black pointer guaranteed accurate to 1% of range, easy read dial - white background with bold black numerals and graduations, 270 degree ARG, 1/4" N.P.T. bottom connection.

2.18 THERMOMETERS

A. Shall be Adjustable Angle type with 9" case, lens front reading mercury tube, with angle satin finish aluminum scales, bold black numerals, bold scale graduations, thick glass windows, and die cast aluminum case with baked bronze finish. Thermometer shall rotate 180 degrees and stem swivels 180 degrees in 10 degree increments separable wells to suit insulation. For chilled and condenser water 20 degrees to 120 degrees. For hot water 30 degrees to 240 degrees.

2.19 T.A.P. PLUGS

A. Furnish where shown on plans or where good practice requires 1/2" IPS plug. The Contractor shall leave with the Owner one kit consisting of (1) 1/8" thermometer, (1) pressure gauge and (1) gauge adaptor, 1/8" diameter with stainless steel probe, 1/4" FPT gauge connection.

2.20 BALANCING VALVES

A. Valves ½" to 2" pipe size (NPT or Sweat) to be of dezincification brass or bronze construction.

B. Valves 2-1/2" to 12" pipe size shall be cast iron for flanged models or ductile iron for grooved models. Valves shall be globe type rated 175 psi for iron and 240 psi for brass/bronze at 250 degrees F. Valves to have concealed memory stop feature and visual position readout. Each valve shall have two metering/test ports with internal check valves and protective caps. Valves to be leak-tight at full rated working pressure. All valves to be provided with molded insulation to permit access for balance and read-out.

2.21 GASKETS

A. Material shall be of compressed sheet suitable for the operating conditions. Group 1a or 1b as listed in ASTM B16.5.

2.22 BOLTS AND NUTS

A. Bolts shall conform to ASTM A193/A193M Rev B, Grade B7, nuts shall conform to ASTM A194/A194M Rev A, Grade 2H.

2.23 LUBRICATED PARALLEL PLUG VALVES

A. Lubricated parallel plug valves shall be installed at all locations shown on the drawings for gas valves and shall be the same sizes as the entering pipe. Valves shall have a pressure rating of 125 PSI at 450 degrees F and 200 PSI from –20 degrees F to 150 degrees F.

B. Valves shall be of the lubricated parallel (cylindrical) plug type with clearance between plug and body sealing surfaces equal to, or less than .002 inch. The body, plug and bottom cover shall be cast iron (ASTM A126 C1B).

C. Valves shall be flanged with face to face dimensions in accordance with ANSI B16.10 short pattern.

D. The plug shall have a rectangular port, reduced bore, having a flow area equal to, or greater than, 60% of the same size of the pipe. The body/plug juncture shall have a reinforced TFE thrust washer to minimize operating torque. The valve body shall have a surface penetrating hot phosphate protective treatment.

E. The valve lubricating systems shall have a lubricating screw with buttonhead fitting, and a tight sealing lubricated check valve in the valve stem, and shall be so constructed as to ensure complete lubrication of all sealing surfaces. Lubricant extruding around the valve stem shall indicate that the system is filled to capacity. The sealing compound shall have a temperature ranging from –20 degrees F to 400 degrees F.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND INCIDENTAL ITEMS

A. All valves shall be installed so as to be easily accessible for cleaning, inspection, maintenance, and operation.

B. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward for horizontal plane unless unavoidable. Provide chain operators on all valves over 6' above floor in mechanical rooms.

C. Except as otherwise indicated, install valves with the following ends or types of pipe/tube connections:

Tube Size 2" and smaller - Soldered-joint valves
Pipe Size 2" and smaller - Threaded valves
Pipe Size 2-1/2" and larger - Flanged end valves

D. Install swing check valves in horizontal position, unless otherwise shown on drawings, with hinge pin horizontally perpendicular to centerline of pipe. Install for proper direction of flow.

E. Provide access panels at all concealed valves.

F. Major control and sectionalizing valves throughout building shall be identified by means of a brass valve tag bracketed to valve handle. Contractor shall prepare schedule of such identifying plates and frame under glass for installation in main equipment room.

G. All welded piping to be welded by certified welders skilled in the work to be done.

H. No piping of dissimilar metals placed in contact or in close proximity with each other. Provide bronze valves wherever piping of dissimilar metals is joined.

I. Run all piping concealed unless specifically noted otherwise, making all necessary offsets, turns, etc., necessary to conceal piping from view.

J. Provide all necessary steel frame supports, anchor bolts, sleeves, etc., required for safe support of equipment and piping installed under this contract. The Mechanical Contractor shall be completely responsible for the accurate position and dimensions of all foundations and support items.

END OF SECTION 15900

SECTION 15950 – BUILDING AUTOMATION AND TEMPERATURE CONTROL SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of electronic direct digital control (DDC) temperature control system work is indicated by drawings and schedules, and by requirements of this section.

B. Control sequences are specified in Execution Section of this specification section.

C. Control wiring necessary for temperature control systems is work of this section. All power wiring shall be by others.

D. Furnish all labor, materials, equipment, and service necessary for a complete and operating temperature control system, utilizing a high speed peer to peer network of interoperable Direct Digital Controls (DDC), LonTalk™ I/O point interface to existing TAC VISTA workstations, any additional workstations and associated communication hardware/software, and electronic interfaces and actuation devices, as shown on the drawings and as described herein.

E. The system will consist of an open architecture that utilizes EIA standard 709.1, the LonTalk™ protocol, as the common communication protocol between all controllers. Where necessary or desired, LonTalk™ packets may be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth. Any such encapsulation of the LonTalk™ protocol into IP datagrams shall conform to existing LonMark™ guidelines for such encapsulation and shall be based on industry standard protocols. The products used in constructing the BMS shall be LonMark™ compliant. In those instances in which LonMark™ devices are not available, the BMS contractor shall provide LonWorks™ devices with application source code, device resource files, and external interface definitions.

F. Complete temperature control system to be DDC with electronic sensors and electronic actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein.

1.2 RELATED DOCUMENTS

A. Refer to Division-17 for related work concerning TAC responsibilities for operator workstation graphics and system integration.

B. Drawings and general provisions of Contract apply to work of this section.

C. Refer to Division-15 sections for related work, including Basic Mechanical Materials and Methods, apply to this section.

D. Refer to Division-16 sections for power wiring to line voltage devices; not work of this section.

1.3 QUALITY ASSURANCE

A. Standards

1. Temperature Control System: Direct digital control (DDC)/electronic, which meets in every respect all operational and quality standards specified herein; installed, wired, circuit tested and calibrated by factory employed technicians qualified for this work and in the regular

employment of the temperature control system manufacturer's field office. Supervision, calibration and checkout of the system shall be by the employees of the manufacurer's local temperature control contracting field office. The manufacturer shall be ISO 9001 certified.

2. The temperature control contractor shall be a factory owned single source responsibility control system provider for the product, installation and technical services. Wholesalers and/or distributors in combination with dealer/contractors are not acceptable and will not be approved.

B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of electronic Direct Digital Control (DDC), electric and pneumatic control equipment, of types and sizes required, and whose products have been satisfactory in use in similar service for not less than five years.

1. All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local and state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications. As a minimum, the installation shall comply with current editions in effect 90 days prior to receipt of bids of the following codes. Systems or products not currently offering the following approvals are not acceptable

2. Comply with EIA Standard 709.1 LONTALK® protocol for DDC system control components and shall be so labeled

C. The following work shall be furnished under this section of the work:

1. All control wiring to devices furnished as part of the Temperature Control Contract, including control transformers.

2. All control wiring, including control transformers, for air handling systems.

3. All electrical interlocks incidental to the Temperature Control System.

4. All other wiring, including all power wiring, shall be furnished by the Electrical Contractor.

5. All electrical work shall be carried out in accordance with the requirements of Division 16 of these Specifications.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for each control device furnished, indicated dimensions, capacities, performance and electrical characteristics, and material finishes, also include installation and start-up instructions.

B. Shop Drawings: Submit shop drawings for each DDC control system, containing the following information:

1. Schematic flow diagram of system showing fans, pumps, coils, dampers, valves, and control devices. Show label of each control device with setting or adjustable range of control.

2. Indicate all required electrical wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

3. Provide details of faces of control panels, including controls, instruments and labeling.

4. Include written description of sequence of operation.

1.5 SYSTEM START-UP AND ACCEPTANCE

Upon completion of the installation, the FMCS Contractor shall start-up the system and perform all necessary testing in conformance with the test plan described in this section. An acceptance test is the presence of the Owner's representative, the Architect, and the Engineer shall be performed. Acceptance of the FMCS may be done in phases. Final acceptance, in writing, from the Owner on any given phase will commence the warranty period on that phase.

1.6 OWNER'S INSTRUCTIONS

The FMCS Contractor shall provide two copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the system. The Contractor shall instruct the Owner's designated representatives in these procedures during the start-up and test period. The instructions are to be conducted during normal working hours. The instruction shall consist of both hands-on and classroom training at the job site. Additional training shall be available upon the request of the Owner at a negotiated hourly rate. Provide 8 hours of Owner training and instruction.

1.7 WARRANTY

The system, including all hardware and software components, and labor shall be warranted for a period of five (5) years following the date of acceptance. Any manufacturing defects arising during this warranty period shall be corrected without cost to the Owner.

1.8 OWNERSHIP OF PROPRIETARY MATERIAL

The owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software. All project developed software and documentation shall become the property of the owner. These include, but are not limited to project graphic images, record drawings, project database, project specific application programming code, and all other associated documentation.

1.9 MANUFACTURERS / INSTALLERS

A. Acceptable Manufacturers/Installers:

1. TAC Americas / By TAC Factory Branch
2. Johnson Controls / By JCI Factory Branch
3. Siemens / By Siemens Factory Branch

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT DESCRIPTION

A. The Direct Digital Control System or Facility Management System (FMS) shall be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection.

B. The contractor shall provide an open, interoperable peer-to-peer networked, distributed control system using ANSI/EIA Standard 709.1-A-1999, LONWORKS® technology communication protocols. The system shall consist of LONWORKS®-based microprocessor-based controllers, plus instrumentation, control valves, dampers, operators, control devices, interface equipment, laptop computer, operator workstation(s), LONWORKS® routers, LONWORKS® communication interfaces, and other apparatus required to operate building systems and perform functions specified. The system shall provide total integration of the facility infrastructure systems with user access to all specified system data via existing TAC operator workstations connected to the system network at the Ethernet level using the owners existing Ethernet system.

C. The supplied computer software shall employ object-oriented technology (OOT) for representing all data and control devices within the system. Adherence to industry standards ANSI/EIA Standard 709.1-A-1999, LONWORKS® to assure interoperability between all system components is required.

D. Workstation Client Hardware Stations: The system shall be capable of supporting at least 16 simultaneous users using a standard Webbrowser such as Internet Explorer™ or Netscape Navigator™ operating on any standard computer that supports the current version of Internet Explorer™ or Netscape Navigator™.

E. The FMS shall consist of the following:

1. Programmable Control Units interfaced to primary HVAC systems.
2. Application Specific Control Units interfaced to terminal HVAC equipment.
3. Interface to ALL existing TAC VISTA Operator Workstations
4. Color Graphic Presentation Software and Developed HVAC Graphics
5. Portable Operator's Terminal

F. Workstations: Any temperature control contractor that quotes equipment other than TAC equipment must also provide 4 complete desktop workstations with all workstation software. (two to be installed in South Louisiana and two to be installed in North Louisiana) In addition two complete laptop workstations must also be provided. All six workstations must be provided with all software tools to modify any component of the system, download and modify software and modify graphics on-site. Routers and LAN components must also be provided with each desktop workstation to allow the workstation to connect to the systems from the remote site through the Owner's Ethernet.

G. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

2.3 NETWORK ACCESS

A. Remote Access to Installations on the Owner's Intranet:

1. The owner shall provide the IP address(s) for remote access by the contractor to the control system via the Internet.
2. The FMS contractor shall provide bridges, routers and hubs required for interface to the owners Intranet and access to the IP address via the Internet.

2.4 PROGRAMMABLE NODES (CONTROLLERS)

A. Control Units General: Provide an adequate number of control units to achieve monitoring and control of all data points specified and necessary to satisfy the sequence of operation for all mechanical systems shown on the plans. Provide a minimum of one separate controller for

each AHU or other HVAC system. Multiple DDC controllers may control one system provided that all points associated with individual control loops are assigned to the same DDC controller. Points used for control loop reset such as outside air or space temperature are exempt from this requirement. Each of the following panel types shall meet the following requirements. Controllers shall be suitable for the anticipated ambient conditions.

1. Memory: The Control Units shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
2. Diagnostics: The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall assume a predetermined failure mode and generate an alarm notification.

B. Universal Network Controllers (UNC)

1. The Universal Network Controllers (UNC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the UNC. It shall be capable of executing application control programs to provide:
   a. Calendar functions
   b. Scheduling
   c. Trending
   d. Alarm monitoring and routing
   e. Time synchronization by means of an Atomic Clock Internet site including automatic synchronization
   f. Integration of LonWorks controller data
   g. Network Management functions for all LonWorks based devices
2. The Universal Network Controllers must provide the following hardware features as a minimum:
   a. One Ethernet Port – 10/100 Mbps
   b. One RS-232 port
   c. One LonWorks Interface Port – 78KB FTT-10A
   d. Battery Backup
   e. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
3. The UNC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the UNC shall be an ODBC compliant database or must provide an ODBC data access mechanism to read and write data stored within it.
4. The UNC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.
5. Event Alarm Notification and actions
   a. The UNC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
   b. The UNC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
   c. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
      1) To alarm
      2) Return to normal
      3) To fault

d. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
e. Provide timed (schedule) routing of alarms by class, object, group, or node.

6. Data Collection and Storage

a. The UNC shall have the ability to collect data for any property of any object and store this data for future use.
b. The data collection shall be performed by log objects, resident in the UNC that shall have, at a minimum, the following configurable properties:

1) Designating the log as interval or deviation.
2) For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
3) For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
4) For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
5) Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

7. All log data shall be stored in a relational database in the UNC and the data shall be accessed from a server or a standard Web Browser.
8. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
9. All log data shall be available to the user in the following data formats:
   a. HTML
   b. XML
   c. Plain Text
   d. Comma or tab separated values
10. The UNC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other UNC on the network. Provide the ability to configure the following archiving properties, at a minimum:
    a. Archive on time of day
    b. Archive on user-defined number of data stores in the log (buffer size)
    c. Archive when log has reached it's user-defined capacity of data stores
    d. Provide ability to clear logs once archived
11. DATABASE BACKUP AND STORAGE
    a. The UNC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.
    b. Copies of the current database and, at the most recently saved database shall be stored in the UNC. The age of the most recently saved database is dependent on the user-defined database save interval.
    c. The UNC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

C. Custom Application Control Units:

Modular, comprising processor board with programmable, nonvolatile, RAM/EEPROM memory for custom control applications. CAC's shall be provided for Roof Top Units, Boiler Plant, Chiller Plant and other applications as shown on drawings and shall have published LonWorks™ application source code, device resource files and external interface definitions

1. Stand-alone mode control functions operate regardless of network status. Functions include the following:
   a. Peer to peer primary network level communications supporting at least 200 LonMark™ Standard Network Variables (SNVTs) per CAC utilizing at least 100 different SNVT types as documented by the LonMark™ Interoperability Association to assure present and future compatibility with third party LonMark™ devices. The 200 LonMark™ SNVTs, minimum, must be configurable in any combination – all inputs or all outputs or any combination of input/outputs in any combination of the 100 different, minimum, SNVT types. The XIF SNVT order shall be definable, rather than random, to provide logical and effective LonMark™ network management. With the submittal package, contractor shall provide CAC performance data that specifies the exact maximum number of SNVTs available in any combination and a list of all available SNVT types including the LonMark™ Interoperability Association SNVT number.
   b. Automatic communications loss detection to maintain normal control functionality regardless of available network communications.
   c. Discrete/digital, analog, and pulse input/outputs.
   d. Monitoring, controlling, or addressing data points.
   e. Local energy management control strategies
   f. Incorporate internal customizable safeties and limits to prevent third party LonMark™ tools from providing improper and unrealistic inputs to CAC 's.
2. Local operator interface port provides for download from and connection to portable workstation.
3. Communication: The Custom Application Controller shall communicate via the Primary Controller Network between BMS Controllers and other LonWorks™ devices. CAC's shall communicate with the Building Controller and ASC's at a baud rate of not less than 78.8K baud using LonTalk™ communications protocol (EIA 709.1).

2.5 PORTABLE OPERATOR'S TERMINAL

A. Provide a local operator interface device with touch screen display and keypad that resides on the DDC controller LAN and operates "on-line" and interactive with all DDC system points on a real-time basis.

B. Operator interface shall use self-prompting menus and smart function keys to provide viewing of all points' current status and alarms, adjusting and changing of all DDC system setpoints, override of time schedules, historical data reports, and editing of all DDC controller programs.

C. Unit shall be housed in an impact resistant enclosure with all power and communication's connections via plug-in connections to LPN or LSPN controllers and the display and keypad exposed.

2.6 ALL APPLICATION SPECIFIC CONTROL UNITS

A. Single board construction comprising processor board with programmable, nonvolatile, RAM/EEPROM memory for custom control and unitary applications. ASCs shall be provided for Unit Ventilators, Fan Coils, Heat Pumps, VAV Terminal Boxes, Rooftop Units and other applications as shown on the drawings. To assure complete interoperability, all ASCs firmware shall support all mandatory and all optional LonMark™ Standard Network Variables (SNVTs) for their LonMark™ profile as documented by the LonMark™ Interoperability Association. Bidder shall provide proof of ASC compliance for all the mandatory and all optional LonMark™ SNVTs.

ASCs shall be based on the Echelon Neuron 3150 microprocessor working with the ASCs stand alone control program.

1. Units monitor or control each input/output point; process information; and download from the operator station.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    a. Peer to peer primary network level communications with automatic communications loss detection to maintain normal control functionality regardless of available network communications.
    b. Discrete/digital, analog, and pulse input/output.
    c. Monitoring, controlling, or addressing data points.
    d. Appropriate LonMark™ profiles for specific unitary applications.
    e. Support for all mandatory and optional LonMark™ Standard Network Variable Types (SNVTs) for their LonMark™ profile as documented by the LonMark™ Interoperability Association
    f. Internal customizable safeties and limits to prevent third party LonMark™ tools from providing improper and unrealistic inputs to ASC's.
3. Local operator interface port located on ASC and ASC sensor provides for download from or upload to portable workstation. All Lon bus devices shall be accessible from either port.
4. Communication: ASC's shall communicate with the Building Controller and CAC's at a baud rate of not less than 78.8K baud using LonTalk™ communications protocol (EIA 709.1).

B. ASC – VAV Controller Functionality: Controls shall be microprocessor based Pressure Independent Variable Air Volume Digital Controllers, as shown in the drawings. The VAV ASC shall be a single integrated package consisting of a microprocessor, power supply, damper actuator, differential pressure transducer, field terminations, and application software. An alternate model shall be offered that allows for direct connectivity to an external actuator for those applications that employ a non-butterfly style damper configuration. All input/output signals shall be directly hardwired to the VAV ASC controller. The internal actuator shall employ a manual override that allows for powered or non-powered adjustment of the damper position. In all cases, the controller shall automatically resume proper operation following the return of power to, or control by the ASC. Programming, configuring and/or troubleshooting of input/output signals shall be easily executed through the ASC sensor or GP tool connected at the wall sensor location.

1. LonMark™ VAV profiles for including support for all mandatory and optional LonMark™ Standard Network Variable Types (SNVTs) as documented by the LonMark™ Interoperability Association
2. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ASC or shall be available as I/O points for other controllers throughout the network.
3. The FMCS contractor shall provide VAV ASC to the VAV box manufacturer, for factory mounting. The VAV terminal unit supplier shall include in its price all costs for mounting of VAV ASC controller, connection of actuator to damper shaft, wiring of device power, wiring of VAV ASC to fan (fan powered terminal) and wiring to electric reheat coils or reheat valve actuator as specified on drawing.
4. The VAV terminal manufacturer shall provide a multi-point, averaging, differential pressure sensor mounted on the inlet to each VAV box. The VAV terminal unit manufacturer shall supply a line to low voltage transformer, of sufficient capacity, to power the VAV ASC plus all reheat valves and/or contactors and fan circuits associated with the VAV terminal and actuator assemblies. The FMCS contractor shall provide all reheat control valves to the mechanical contractor for mounting and piping. The FMCS contractor shall provide and install all wiring between the valve and VAV ASC controller and between the room sensor and the VAV ASC controller.

C. ASC VAV - Air Balancing. Through the portable Graphical Programming Tool, the VAV ASC shall support a fully prompted Air Balance sequence. The Graphical Programming Tool shall, when connected through the wall sensor, access the connected VAV ASC unit. The air balance sequence shall step the balancing contractor through the checkout and calibration of the VAV ASC. Upon completion of the balancing sequence, the flow values presented by the VAV ASC shall match those observed by the balancing contractor's measurement equipment. Additionally, upon completion of the air balance, the balance settings shall be archived for future use if the controller were to require replacement. Systems not able to provide a formatted air balance Graphical Programming Tool shall provide an individual full time during the Air-balancing process to assure full balance compliance.

2.7 SYSTEM SOFTWARE FEATURES

A. General

1. All necessary software to form a complete operating system, as described in this specification, shall be provided.

2. The software programs specified in this section shall be provided as an integral part of the Digital Panel, and shall not be dependent upon any higher level computer for execution.

3. This Contractor shall provide all software required for efficient operation of the automatic system functions required by this specification. Software shall be modular in design for flexibility in expansion or revision of the system. It is the intent of this specification to require provisions of a system which can be fully utilized by individuals with no, or limited, previous exposure to PC's and programming techniques and languages. If the system to be provided requires the use of any modified BASIC, "C", PASCAL, or DRUM Language program, or writing "line" programming statements to modify operation or strategy in the system, the vendor shall provide unlimited, no charge, software modification and support for a period of five (5) years after the completion of the project in addition to the warranty period specified elsewhere. Systems which are factory programmed are unacceptable.

4. The software in the system shall consist of both "firmware" resident in the direct digital controllers and "software" resident in the operator workstations. The architecture of the system, and the application software/firmware shall be distributed with no single system component responsible for a control function for the entire Primary LAN. Each Direct Digital Control unit shall contain the necessary firmware and I/O capability to function independently in case of a network failure. No active energy management or environmental control sequences shall be resident in the PC workstations. All PC workstations shall be removable from the system without loss of control function - only alarm monitoring, long-term history collection, and operator monitor/command/edit functions would be lost.

B. GUI Server Application Software: Capability from all TAC VISTA operator stations for monitoring and controlling all of the points listed in the input/output point list must be provided through the LonTalk™ interface. The operator shall be able to monitor and access all points by means of clear concise English names without having to understand or reference hardware point locations or controller programs. It is the intent of this specification that the owner's daily tasks to operate and monitor all systems statewide occur from the existing TAC workstations. Workstations described below are to be provided as system maintenance and repair tools. In addition to routing points listed in the I/O points list to the TAC VISTA workstations, any FMCS Contractor other than TAC must provide 4 desktop workstations and two laptop workstations. FMCS

Contractor must also provide all routers and devices necessary to provide access from each workstation to the systems. Each workstation must meet the following requirements.

1. Operating System: The GUI shall run on Microsoft Windows NT Workstation 4.0, Service Pack 4, Windows 2000, or later.

2. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

3. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:
   a) Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
   b) Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
   c) Graphics shall support layering and each graphic object shall be configurable for assignment to one a layer. A minimum of six layers shall be supported.
   d) Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
      1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
      2) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

4. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:

   a.) Create, delete or modify control strategies.
   b.) Add/delete objects to the system.
   c.) Tune control loops through the adjustment of control loop parameters.
   d.) Enable or disable control strategies.
   e.) Generate hard copy records or control strategies on a printer.
   f.) Select points to be alarmable and define the alarm state.
   g.) Select points to be trended over a period of time and initiate the recording of values automatically.

5. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.

6. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor,

and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

7. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

C. Web Browser Clients

1. The system shall be capable of supporting at least 12 clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, are only acceptable if 64 licensed copies of the client machine software are provided, installed, and tested.
2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, shall only be acceptable if 12 workstation or workstation hardware upgrades are provided.
3. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
4. The Web browser client shall support at a minimum, the following functions:

   a. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
   b. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
   b. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
   c. Storage of the graphical screens shall be in the Building Control Units (BC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
   d. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
   e. User's shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
      1) Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
      2) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
      3) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
      4) Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
      5) View logs and charts
      6) View and acknowledge alarms

g. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
h. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.10 ELECTRIC CONTROL WIRING

A. Provide control wiring without splices between terminal points, color-coded. All wiring shall be in accordance with ANSI/NFPA 70, "National Electrical Code."

B. Provide circuits over 25-volt with color-coded No. 12 THHN wire in electric metallic tubing.

C. Provide circuits under 25-volt with color-coded No. 18 THHN wire and 0.031" high temperature plastic insulation on each conductor and plastic sheath overall.

D. Provide electronic circuits with color-coded twisted pair No. 18 wire with 0.023" polyethylene insulation on each conductor with plastic jacketed copper shield overall. Shield shall be grounded at a point separate from other voltages.

E. Provide all circuits in return air plenums and in exposed locations in electric metallic tubing. At Contractor's option, under 25 volt in return air plenums may be run with plenum cable in accordance with NEC 725.2 (b) and UL 910 latest edition.

2.11 CARBON DIOXIDE SENSORS

CO_2 level tracer gas sensing shall be accomplished with a common detector employing duct air CO_2 concentration level detection and sampling techniques for OA, RA, and SA. The sensing technique shall provide consistent operating data, which for accuracy requirements is updated at least once per minute. The data gathering and dissemination technique shall also be arranged so as to maintain accurate detection and associated air flow control with a minimal need for calibration (through deployment of common sensing, without added maintenance costs attributable to other forms of multi-device/multi-location techniques). CO_2 sensing techniques shall be accurate to $\pm$ 100 ppm per year and be suitable for use with typical HVAC system air flow stations(s) etc., described elsewhere in this specification.

2.12 DAMPERS

A. Damper Construction: incorporate blades equipped with steel shafts and operating in bearings in damper frame, arranged so that all linkages are encased in side channels of frame to decrease friction and eliminate air noise.

1. Frames: 16 gauge (minimum) galvanized steel.

2. Blades: not exceed 6" in width; be double thickness 22 gauge (minimum) or single thickness 16 gauge (minimum) galvanized steel.

3. Bearings: nylon, equipped with oil impregnated sintered iron bushings.

4. Seals: installed on all blade edges and frame top and bottom, synthetic elastomer; installed for blade ends, stainless steel.

B. Damper Design: provide for tight shut-off, arranged so that leakage does not exceed 1% at a 4" w.g. pressure differential when delivering scheduled system volume.

C. All Dampers for Modulating Control: proportioning type with adjacent blades rotating in opposites directions.

D. All Dampers for Two Position Action: have blades arranged for parallel rotation.

2.13 DAMPER AND VALVE ACTUATORS

A. Actuators shall be direct coupled, brushless DC motor type which require no crank arm and linkage. The actuator shall provide 0 - 10 VDC, 0 - 2 V phased cut or 4 - 20 mA proportional control or two position control or pulse width modulation or Tri-State control as dictated by HVAC application and sequences of operation. Actuators shall be designed for either clockwise or counterclockwise fail-safe operation, have a manual positioning mechanism and control direction of rotation switch. Run time shall be constant and independent of torque. A 2 to 10 VDC feedback signal shall be provided for position feedback or master-slave applications.

B. Actuators shall be UL listed and CSA certified, protected from overload at all angles of rotation and manufactured under ISO 9001 quality control standards.

C. All actuators on fresh air, return air and face and bypass dampers and valves shall be spring return to their normally open or closed position in the event of power failure.

D. Damper Actuators: minimum 50% oversized for long life and increased reliability; to be mounted outside the airstream.

E. All actuators shall be electric or electronic and designed to interface with the Direct Digital Control System.

PART 3 - CONTROL SEQUENCES OF OPERATION

3.1 WORK INCLUDED

A. The sequence described herein shall be strictly adhered to as to the scope of the operation. All required devices to accomplish these sequences shall be furnished whether specified or not. All devices not furnished by equipment manufacturers shall be supplied by the Temperature Control Contractor.

B. Systems include:

1. Air Handling Units (VAV and Constant Volume)
2. VAV Terminal Units with Electric Heating
3. Exhaust Fans
4. Electric Unit Heaters
5. Start-up/Testing
6. Training

3.2 SYSTEM DESIGN & ARCHITECTURE

A. Furnish and install a temperature control and facilities automation system consisting of direct digital control of primary mechanical equipment and terminal equipment, operator interface equipment.

B. For other than TAC systems provide specified color graphic PC workstations to allow access to each Digital Control Unit and Application Specific Controller and each controller's digital program and software; a portable operator's terminal for local operator system interface.

C. Provide necessary hardware and software for the owner or his representative to communicate with this building from a remote location via the Internet and the owner's Ethernet as described elsewhere in this specification.

D. Install a communications network to link the Digital Control Units, Application Specific Controllers, and other associated terminal controllers to the TAC VISTA workstations. Provide all programming necessary to serve all points listed in the I/O table to the TAC supplied, 527 LonTalk router in standard LonMark protocols as described elsewhere in this specification.

E. Furnish the input/output points, for each of the systems described below or in the plans, to the TAC VISTA workstations. The I/O table shall represent the minimum points to be viewable at the TAC VISTA workstations. Additional points that the owner may require shall be provided as needed to achieve the owner's monitoring and control requirements and shall be supplied by the FMCS Contractor for no additional charge.

3.3 CONSTANT VOLUME AHU

A. Unit fan shall be started and stopped through the Hand-Off-Auto switch on the cover of the magnetic motor starter based on a time schedule from the DDC/FMS Once the unit fan is energized the automatic temperature control system shall be placed in operation and the outside air damper shall open.

B. Duct smoke detectors located in the supply air stream and the return air stream shall signal the Fire Alarm System to de-energize the unit fan should particles of combustion are sensed. Duct detectors are furnished and installed by Fire Alarm Contractor.

C. A space sensor shall modulate the chilled water valve and energize the stages of electric heat as required to maintain a setpoint of 74 degrees F (adj).

D. A manual reset, low limit thermostat, shall de-energize the unit fan and close the outside damper if the mixed air temperature falls below 35 degrees F.

E. An indoor air quality sensor/transmitter mounted in the space shall override the minimum position of the outside air damper and modulate the damper as required to maintain a space setpoint of + 800 ppm for CO2 and a setpoint of + 20 ppm for CO. Should either of these limits be exceeded, an audio/visual alarm shall be sounded at the EMC panel and/or a location determined by the owner.

F. When the AHU is off and the space temperature falls to 60 degrees F(adj), the unit fan shall be energized, the outside air damper shall remain closed, and the space thermostat shall energize the electric reheat coil to maintain a night setback temperature of 60 degrees F (adj). When the AHU is off and the space temperature rises to 85 degrees F(adj), the unit fan shall be energized, the outside air damper shall remain closed, and the space thermostat shall modulate the chilled water valve to maintain a night setup temperature of 85 degrees F (adj).

G. Should the space humidity rise above 60%(adj) during unoccupied hours, the unit fan shall be energized to maintain an acceptable space humidity of 60 % RH (adj). When the unoccupied setpoint of 60 % is reached, the AHU shall be de-energized.

H. AHU shall be overridden on during normal unoccupied hours from override timer on the face of the panel. Outside air damper shall remain closed during override conditions.

I. Install and wire the UVC lights along with the necessary safety switches.

3.4 VARIABLE AIR VOLUME AHU

A. Unit fan shall be started and stopped through the Hand-Off-Auto switch on the cover of the Variable Frequency Drive. Upon a signal from the DDC/FMS to energize the unit fan, the outside air damper shall open to its minimum position, and the automatic temperature control system shall be placed in operation.

B. Duct smoke detectors located in the supply air stream and the return air stream shall signal the Fire Alarm System to de-energize the unit fan should particles of combustion are sensed. Duct detectors shall be furnished and installed by Fire Alarm Contractor.

C. A discharge air sensor shall modulate the 2-way chilled water control valve to maintain a discharge air temperature setpoint of 55 degrees F (adj).

D. A static pressure sensor located 2/3 down the supply air duct shall modulate the VFD to maintain a setpoint of 1.5" wg (adj.).

E. A manual reset, low limit thermostat shall deenergize the unit fan and close the outside damper if the mixed air temperature falls below 35 degrees F.

F. A manual reset, high limit static pressure safety switch shall deenergize the unit fan should its setpoint of 3.5 " wg (adj) be reached.

G. An indoor air quality sensor/transmitter mounted in the space shall override the minimum position of the outside air damper and modulate the damper as required to maintain a space setpoint of + 800 ppm for CO2 and a setpoint of + 20 ppm for CO. Should either of these limits be exceeded, an audio/visual alarm shall be sounded at the SSCC panel and/or a location determined by the owner.

H. Individual DDC room thermostats shall maintain the room temperature setpoint of 74 degrees F (adj) cooling and 72 degrees F (adj) heating by modulating the VAV box DDC damper actuator and the electric reheat coil.

I. When the AHU is off and the space temperature falls to 60 degrees F, the unit fan shall be energized, the outside air damper shall remain closed, and the VAV boxes thermostats shall energize their respective electric reheat coils to maintain a night setback temperature of 60 degrees F (adj). When the AHU is off and the space temperature rises to 80 degrees F(adj), the unit fan shall be energized, the outside air damper shall remain closed, and the VAV boxes thermostats shall modulate their respective actuators to maintain a night setup temperature of 80 degrees F (adj).

J. Should the space humidity rise above 60% during unoccupied hours, the unit fan shall be energized and the outside air damper shall open to its minimum position. The VAV thermostats shall modulate the VAV boxes and/or reheat valves to maintain a humidity setpoint of 60%. When setpoint is reached, unit fan shall be deenergized.

K. Install and wire the UVC lights along with the necessary safety switches.

3.5 VARIABLE AIR VOLUME AHU WITH BACKUP DX COIL AND CONDENSING UNIT

A. Unit fan shall be started and stopped through the Hand-Off-Auto switch on the cover of the Variable Frequency Drive. Upon a signal from the DDC/FMS to energize the unit fan, the smoke dampers in the supply and return ducts shall open. Once the smoke dampers are open as determined by the respective end switches, the unit fan shall be energized, the outside air damper shall open to its minimum position, and the automatic temperature control system shall be placed in operation.

B. Duct smoke detectors located in the supply air stream and the return air stream shall signal the Fire Alarm System to de-energize the unit fan should particles of combustion are sensed. Duct detectors shall be furnished and installed by Fire Alarm Contractor.

C. A discharge air sensor shall modulate the 2-way chilled water control valve to maintain a discharge air temperature setpoint of 55 degrees F (adj).

D. A static pressure sensor located 2/3 down the supply air duct shall modulate the VFD to maintain a setpoint of 1.5" wg (adj.).

E. A manual reset, low limit thermostat shall deenergize the unit fan and close the outside damper if the mixed air temperature falls below 35 degrees F.

F. A manual reset, high limit static pressure safety switch shall deenergize the unit fan should its setpoint of 3.5 " wg (adj) be reached.

G. A CO2 sensor/transmitter mounted in the return air shall override the minimum position of the outside air damper and modulate the damper as required to maintain a return air setpoint of $\pm$ 900 ppm.

H. Individual DDC room thermostats shall maintain the room temperature setpoint of 74 degrees F (adj) cooling and 72 degrees F (adj) heating by modulating the VAV box DDC damper actuator and the electric reheat coil.

I. When the AHU is off and the space temperature falls to 60 degrees F, the unit fan shall be energized, the outside air damper shall remain closed, and the VAV boxes thermostats shall energize their respective electric reheat coils to maintain a night setback temperature of 60 degrees F (adj). When the AHU is off and the space temperature rises to 80 degrees F(adj), the unit fan shall be energized, the outside air damper shall remain closed, and the VAV boxes thermostats shall modulate their respective actuators to maintain a night setup temperature of 80 degrees F (adj).

J. Should the space humidity rise above 60% during unoccupied hours, the unit fan shall be energized and the outside air damper shall open to its minimum position. The VAV thermostats shall modulate the VAV boxes and/or reheat valves to maintain a humidity setpoint of 60%. When setpoint is reached, unit fan shall be deenergized.

K. Upon a loss of power to the central plant, the emergency DX coil and its respective condensing unit shall be energized to maintain a discharge air temperature setpoint of 55 degrees F (adj).

L. Install and wire the UVC lights along with the necessary safety switches.

3.6 DDC VARIABLE AIR VOLUME BOXES

A. Each VAV box shall be controlled by its own terminal equipment controller. The terminal equipment controller shall modulate the supply air damper or electric reheat coil as required to maintain temperature setpoint. The supply air volume will be limited by the minimum and maximum air volume settings.

B. During the Unoccupied Mode, the terminal equipment controller shall be reset to Occupied Mode for an operator determined time period. This reset shall be activated by a signal from a local override switch on each room temperature sensor or by command from the operator's terminal. If each room sensor does not include this override switch capacity, an override switch shall be provided and installed at each room sensor location. At the end of the operator determined time period, the terminal equipment controller shall return to the Unoccupied Mode.

C. All parameters (minimum/maximum velocity setpoint, space temperature) shall be obtainable and updated from the operator's terminal by plugging into the local thermostat.

3.7 OUTSIDE AIR UNIT

A. Unit fans shall be started and stopped through the Hand-Off-Auto switch on the cover of the magnetic motor starter based on a time schedule from the DDC/FMS Panel. Once the unit fan is energized the automatic temperature control system shall be placed in operation, the outside air damper shall open and the Heat Wheel shall be energized any time the AHU is energized.

B. The chilled water control valve, the electric preheat coil and the electric reheat coil shall be modulated to maintain a discharge setpoint of 55 degrees F to the outside air intake of the AHU's when the outside air temperature is above 60 degrees F. When the outside air temperature is below 60 degrees F, the discharge air setpoint shall be 70 degrees F.

C. A manual reset, low limit thermostat, shall deenergize the unit fan and close the outside damper if the discharge air temperature falls below 35 degrees F.

D. Space humidity sensors shall override the space temperature sensors and modulate the chilled water valve as require to maintain space humidity setpoint of 55% RH (adj.). The controlling setpoint shall be an average between the sensors.

E. Space mounted temperature sensors shall modulate the chilled water valve and the reheat coil as required, to maintain space setpoint of 72 degrees F(adj.). The controlling setpoint shall be an average between the two sensors.

F. A duct mounted smoke detector located in the pure supply air stream shall de-energize the unit fan when particles of combustion are sensed. The detector shall also send a signal to the fire alarm system to annunciate that system.

G. When the unit fan is de-energized, the automatic control system shall be inoperable.

H. Install and wire the UVC lights along with the necessary safety switches.

3.8 CHILLED WATER SYSTEM

A. A start signal is given from the DDC/FMS to the Lead Chilled Water Pump and the lead condenser water pump. When flow is proven through differential pressure switchs, the Lead

Chiller shall be energized. The chiller shall then cycle around its internal controls to maintain a primary loop chilled water supply setpoint of 45 degrees F (adj). Should the primary chilled water loop temperature rise to 48 degrees F (adj), the second Chilled Water Pump and condenser water pump shall be energized. When flow is proven through its differential pressure switchs, the second Chiller shall be energized. The chiller shall then cycle around its internal controls to maintain a primary chilled water loop supply setpoint of 45 degrees F (adj). Should the primary chilled water loop temperature rise to 51 degrees F (adj), the third Chilled Water Pumpand condenser water pump shall be energized. When flow is proven through its differential pressure switchs, the third Chiller shall be energized. The chiller shall then cycle around its internal controls to maintain a primary chilled water loop supply setpoint of 45 degrees F (adj). The reverse sequence shall occur upon a drop in primary loop temperature.

B. A differential pressure transmitter shall modulate the Secondary Chilled Water Pump VFD to maintain a differential pressure setpoint in the chilled water secondary building loop. Upon a demand for more chilled water to the buildings, the VFD shall ramp up. Upon a decrease in demand for chilled water to the building, the VFD shall ramp down. The balancing contractor shall determine the location of the differential pressure sensing points and the setpoint.

C. A differential pressure transmitter in each respective tertiary chilled water loop shall modulate its respective Tertiary Chilled Water Pump VFD to maintain a differential pressure setpoint in the chilled water tertiary building loop. Upon a demand for more chilled water to the building, the VFD shall ramp up. Upon a decrease in demand for chilled water to the building, the VFD shall ramp down. The balancing contractor shall determine the location of the differential pressure sensing points and the setpoint.

3.9 CONDENSER WATER SYSTEM

A start signal shall be given from the DDC/FMS to the Lead Cooling Tower Fan-1 VFD which shall ramp as required to maintain a condenser water return temperature of 85 degrees F (adj.). Should the condenser water return temperature rise above 84 degrees F (adj.), CTF-2 VFD shall be energized. CTF-1 shall run at 100% and CTF-2 shall ramp as required maintain condenser water return temperature of 85 degrees F. Should the condenser water return temperature continue to rise above 84 degrees F (adj.), CTF-3 VFD shall be energized, CTF-1 and CTF-2 shall run at 100% and CTF-3 shall ramp as required maintain condenser water return temperature of 85 degrees. When condenser water return falls to 84 degrees F (adj.), the reverse shall occur to maintain condenser water temperature. CTF-1 CTF 2 and CTF-3 shall rotate in a lead position application every month so as to try and equalize runtime on all three fans. A Cooling tower bypass valve shall also be installed and shall modulate to maintain condenser water setpoint 85 degrees F (adj.).

3.10 ATRIUM SMOKE CONTROL SYSTEM.

A. The smoke control fans shall be energized on a signal from the Fire Alarm system.

B. Upon activation of the Smoke control Fans all air handling Unit Fans and the Outside Air Heat Recovery unit fan shall be energized.

3.11 ELECTRIC UNIT HEATER CONTROL

Integral space thermostat shall cycle unit fan and stage electric heating coil to maintain space temperature setpoint.

3.12 FAN COIL UNITS

A. Unit shall be energized be the space thermostat.

B. If space temperature is above set point the chilled water valve shall open to reach set point.

C. If space temperature is below set point the electric heating coil shall be energized to reach set point.

D. The unit fan shall cycle around the thermostat setting.

3.13 INFRA-RED HEATING UNITS

The space thermostat shall open the gas valve when the space is below set point, and close the valve when set point is reached.

END OF SECTION 15950

LOCATION / SYSTEM:	HARDWARE																								
	I/O TYPE					INPUT DEVICE												OUTPUT DEVICE						
Jackson Barracks AREA C	Analog Input	Binary Input	Analog Output	Binary Output		Dry Contact	Limit Switch	Temperature	CO2 Sensor	Current Senso	Pressure	Humidity	Flow	VFD	Freezestat	Miscellaneous	Relay	El./Pneu. Valve	Pneu. Xducer	Existing Devic	Actuator	VFD	0-10/4-20ma
Louisiana National Guard																								
Building / System:																								
Chiller Plant (typical)																								
Chiller start/stop				X													X						
Chiller run indication		X								X													
Chiller run load amps/run indication	X									X													
Chiller general alarm		X				X																	
Chiller Supply Temperature	X							X															
Chiller Return Temperature	X							X															
Chiller Pump start/stop				X													X						
Chiller Pump run indication		X								X													
Chiller Pump general alarm		X				X																	
Secondary CHW Pump start/stop				X																		X	
Secondary CHW Pump run indication		X												X									
Secondary CHW Pump speed			X																			X	
Secondary CHW Pump feedback	X													X									
Secondary CHW Supply Temperature	X							X															
Secondary CHW Return Temperature																							
Secondary CHW general alarm		X				X								X									
CHW Differential Pressure Transmitter	X										X												
CHW Return Flow (for primary/secondary systems)	X												X										
Condenser Water Pump start/stop				X													X						
Condenser Water Pump run indication		X								X													
Condenser Water Supply Temperature	X							X															
Condenser Water Return Temperature	X							X															
Cooling Tower Fan start/stop				X																		X	
Cooling Tower Fan run indication		X												X									
Cooling Tower Fan speed			X																			X	
Cooling Tower Fan feedback	X													X									
Cooling Tower Fan alarm		X												X									
Summer/Winter Changeover				X													X	X					
Chiller isolation valves	X															X							
Cooling Tower by-pass valve	X							X															
Cooling Tower by-pass valve setpoint	X							X															
Cooling Tower by-pass valve setpoint adjust			X																	X			
Outside Air Heat Recovery Unit																							
Supply Fan Start/Stop				X													X						
Supply Fan Status		X								X													
Suppply Fan Speed			X																			X	
Suppply Fan Speed Feedback	X													X									
Suppply Fan Alarm		X												X									
Outside Air Fan Start/Stop				X													X						
Outside Air Fan Status		X								X													
Exhaust Air Fan Start/Stop				X													X						
Exhaust Air Fan Status		X															X						
Supply Duct Static Pressure	X										X												
Supply Duct Static set point	X										X												
Supply Duct Static set point adjust			X																	X			
Unit Leaving Air Temperature	X							X															
Unit Leaving Air Temperature set point	X							X															
Unit Leaving Air Temperature set point adjust				X																X			
Preheat Coil Temperature	X							X															
Preheat Coil Temperature set point	X							X															
Preheat Coil Temperature set point adjust			X																	X			
Reheat Coil Temperature	X							X															
Reheat Coil Temperature set point	X							X															
Reheat Coil Temperature set point adjust			X																	X			
Cooling Coil Control Valve	X							X															
Cooling Coil Control Valve set point	X							X															
Cooling Coil Control Valve set point adjust			X																	X			
Space Relative Humidity																							
Space Relative Humidity set point																							
Space Relative Humidity set point adjust																							

LOCATION / SYSTEM:	HARDWARE																								
	I/O TYPE					INPUT DEVICE												OUTPUT DEVICE						
Jackson Barracks AREA C	Analog Input	Binary Input	Analog Output	Binary Output		Dry Contact	Limit Switch	Temperature	CO2 Sensor	Current Senso	Pressure	Humidity	Flow	VFD	Freezestat	Miscellaneous	Relay	El./Pneu. Valve	Pneu. Xducer	Existing Devic	Actuator	VFD	0-10/4-20ma
Heat Wheel Start/Stop				X													X						
Heat Wheel Status		X								X													
Heat Wheel Alarm		X												X									
Constant Volume Air Handling Units (Typical)																							
Supply fan start/stop				X													X						
Supply fan status		X								X													
Room (space) temperature for each zone	X							X															
Room (space) temperature set point for each zone	X							X															
Room (space) temperature set point adjust for each zone			X																	X			
Space zone damper control			X																		X		
Mixed air temperature	X							X															
Mixed air temperature set point	X							X															
Mixed air temperature set point adjust			X																	X			
Hot deck air temperature	X							X															
Hot deck air temperature set point	X							X															
Hot deck air temperature set point adjust			X																	X			
Cold deck air temperature	X							X															
Cold deck air temperature set point	X							X															
Cold deck air temperature set point adjust			X																	X			
CO2 level reading	X								X														
CO2 level setpoint	X															X							
CO2 level setpoint adjust			X																	X			
Heating Coil control			X																		X		
Heating Coil control set point	X															X							
Heating Coil control set point adjust			X																	X			
Cooling control valve			X																		X		
Cooling Coil control set point	X															X							
Cooling valve control set point adjust			X																	X			
Space Relative Humidity	X											X											
Space Relative Humidity Set point			X																	X			
Push button override		X				X																	
Push button override time setting			X													X							
Override status		X														X							
Filter status		X				X																	
Package DX AC/Heating Units (Typical)																							
Supply fan start/stop				X													X						
Supply fan status		X								X													
Room (space) temperature for each zone	X							X															
Room (space) temperature set point for each zone	X							X															
Room (space) temperature set point adjust for each zone			X																	X			
Mixed air temperature	X							X															
Mixed air temperature set point	X							X															
Mixed air temperature set point adjust			X																	X			
Discharge air temperature	X							X															
Discharge air temperature set point	X							X															
Discharge air temperature set point adjust			X																	X			
CO2 level reading	X								X														
CO2 level setpoint	X															X							
CO2 level setpoint adjust			X																	X			
Heating stage control				X													X						
Cooling stage control				X																			
Space Relative Humidity	X											X											
Space Relative Humidity Set point			X																	X			
Space Relative Humidity Set point			X																	X			
Push button override		X				X																	
Push button override time setting			X													X							
Override status		X														X							
Filter status		X				X																	
Variable Air Volume Air Handling Units (Typical)																							
Supply fan start/stop				X													X						
Supply fan status		X								X													
Supply Fan speed			X																			X	

LOCATION / SYSTEM:	HARDWARE																								
	I/O TYPE					INPUT DEVICE												OUTPUT DEVICE							
Jackson Barracks AREA C	Analog Input	Binary Input	Analog Output	Binary Output		Dry Contact	Limit Switch	Temperature	CO2 Sensor	Current Senso	Pressure	Humidity	Flow	VFD	Freezestat	Miscellaneous		Relay	El./Pneu. Valve	Pneu. Xducer	Existing Devici	Actuator	VFD	0-10/4-20ma	
Supply Fan speed feedback	X													X											
Supply Fan alarm		X												X											
Duct Static Pressure	X							X																	
Duct Static Pressure setpoint	X										X														
Duct Static Pressure setpoint adjust			X																		X				
Mixed air temperature	X							X																	
Mixed air temperature set point	X							X																	
Mixed air temperature set point adjust			X																		X				
Discharge air temperature	X							X																	
Discharge air temperature set point	X							X																	
Discharge air temperature set point adjust			X																		X				
CO2 level reading	X								X																
CO2 level setpoint	X															X									
CO2 level setpoint adjust			X																		X				
Cooling control valve			X																			X			
Cooling valve control set point	X															X									
Cooling valve control set point adjust			X																		X				
Filter status		X				X																			
Variable Air Volume Boxes (Typical)																									
Room (space) temperature for each zone	X							X																	
Room (space) temperature set point for each zone	X							X																	
Room (space) temperature set point adjust for each zone			X																		X				
Space box damper control output			X																			X			
Space box damper control position	X													X											
Space box airflow feedback	X													X											
Space box airflow minimum set point	X															X									
Space box airflow minimum set point adjust			X																		X				
Space box airflow maximum set point	X															X									
Space box airflow maximum set point adjust			X																		X				
Space box heating stage control output			X															X							
Space box heating Stage control set point	X															X									
Space box heating Stagecontrol set point adjust			X																		X				
Push button override		X				X																			
Push button override time setting			X													X									
Override status		X														X									
Fan Coil Units (Typical)																									
Room (space) temperature for each zone	X							X																	
Room (space) temperature set point for each zone	X							X																	
Room (space) temperature set point adjust for each zone			X																		X				
Fan coil heating valve control output			X																			X			
Fan coil heating valve control set point	X															X									
Fan coil heating valve control set point adjust			X																		X				
Fan coil cooling valve control output			X																			X			
Fan coil cooling valve control set point	X															X									
Fan coil cooling valve control set point adjust			X																		X				
Fan coil fan start/stop				X															X						
Fan coil fan start/stop override				X																	X				
Fan Coil outside air damper control set point			X																			X			
Fan Coil outside air damper control output	X													X											
Push button override		X				X																			
Push button override time setting			X													X									
Override status		X														X									
Filter status		X				X																			
Infra-Red Heating Units (Typical)																									
Room (space) temperature for each zone	X							X																	
Heater enable/disable				X															X						
Heater enable/disable override				X																	X				
Push button override			X			X																			
Push button override time setting				X												X									
Override status			X													X									

LOCATION / SYSTEM:	HARDWARE																						
	I/O TYPE					INPUT DEVICE												OUTPUT DEVICE						
Jackson Barracks AREA C	Analog Input	Binary Input	Analog Output	Binary Output		Dry Contact	Limit Switch	Temperature	CO2 Sensor	Current Senso	Pressure	Humidity	Flow	VFD	Freezestat	Miscellaneous		Relay	El./Pneu. Valve	Pneu. Xducer	Existing Devic	Actuator	VFD	0-10/4-20ma
Unit heaters (Typical)																								
Room (space) temperature for each zone	X							X																
Unit heaters start/stop				X														X						
Unit heaters space temperature	X							X																
Unit heaters space setpoint	X							X																
Unit heaters space setpoint adjust			X																		X			
Push button override		X				X																		
Push button override time setting			X													X								
Override status		X														X								
Digital Energy Monitoring																								
KW Demand	X									X														
KWH totalization	X									X														
KVA	X									X														
KVAR	X									X														
Voltage on each leg of incoming power	X									X														
Amperage on each leg of incoming power	X									X														
Voltage on each leg of incoming power to neutral	X									X														
Emergency power status		X				X																		
Work Bays / Vehicle Maintenance Areas Exhaust																								
Maintenance area Exhaust fans start/stop		X																X						
Overhead door position switch		X				X																		
Exhaust louver interlock position		X				X																		
Maintenance area CO2 levels	X								X															
Maintenance area CO2 exhaust setpoint	X															X								
Maintenance area CO2 exhaust setpoint adjustment			X													X								
Miscellaneous Systems/Points																								
Exhaust fans start/stop		X																X						
After Hours setback set point for every part of bui	X															X								
After Hours setback set point for every part of building a			X													X								
After Hours setup set point for every part of build	X															X								
After Hours setup set point for every part of building adju			X													X								
Atrium Smoke Control status		X								X														
Atrium Smoke Control start/stop		X																X						

NOTES

1) Points list above are minimum and must be included in the BASE-BID.
2) Each output point and set point must have the capability of override and adjust from the TAC LON operator workstation whether
3) Points listed are typical for given types of equipment, point types must be provided for each piece of equipment as listed.
4) Temperature control contractor is responsible for reading the requirements of the Division 17000 graphics and providing points r developing the specified graphics pages even if the points are not listed here.
5) Temperature control contractor is responsible for creating time schedules for each piece of equipment and making those schedu at the TAC LON operator workstation.
6) The input and output values of each DDC module in the system programming must be made available for use in developing graph TAC LON workstation as specified in Division 17000.
7) Special devices such as air-flow monitoring, water flow meters, ect. Must have points provided to accurately represent systems, s programming logic graphically at the TAC LON workstation per Division 17000 specifications.
8) Special systems such as emergency back-up power or sequences such as building purge cycles must have points provided to accu the system, sequences and DDC programming logic graphically at the TAC LON workstation per Division 17000 specifications.
9) Division 15 Temperature control contractor must communicate quantities of points to be integrated to the Division 17000 contrac to ensure proper coordination exists between Division 15 and Division 17 contractors if they are different.

END OF SECTION 15950

SECTION 16010 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE

A. This specification is for electrical and related work particular to the Jackson Barracks 141st Readiness Center, Central Chiller Plant, and renovations to Building OMS 12. Coordinate with other plans and specifications sections.

1.2 RELATED DOCUMENTS

A. The general provisions of the Contract, including Contract Requirements, and other Division 1 Specification sections, apply to this Section. Sections included in DIVISION 16 of the Project Manual are as follows:

SECTION 16010 - ELECTRICAL GENERAL PROVISIONS
SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS
SECTION 16051 - ELECTRICAL RELATED WORK
SECTION 16055 - OVERCURRENT PROTECTIVE DEVICE COORDINATION
SECTION 16060 - GROUNDING AND BONDING
SECTION 16075 - ELECTRICAL IDENTIFICATION
SECTION 16080 - ELECTRICAL TESTING
SECTION 16120 - CONDUCTORS AND CABLES
SECTION 16124 - MEDIUM VOLTAGE CABLES
SECTION 16130 - RACEWAYS AND BOXES
SECTION 16139 - CABLE TRAYS
SECTION 16140 - WIRING DEVICES
SECTION 16145 - LIGHTING CONTROL DEVICES
SECTION 16146 – LIGHTING CONTROLS
SECTION 16215 - ELECTRICAL POWER MONITORING AND CONTROL
SECTION 16231 - PACKAGED ENGINE GENERATORS
SECTION 16271 - MEDIUM VOLTAGE TRANSFORMERS
SECTION 16289 - TRANSIENT VOLTAGE SUPPRESSION
SECTION 16410 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS
SECTION 16415 - TRANSFER SWITCHES
SECTION 16441 - SWITCHBOARDS
SECTION 16442 - PANELBOARDS
SECTION 16461 - DRY-TYPE TRANSFORMERS (600V AND LESS)
SECTION 16511 - INTERIOR LIGHTING
SECTION 16521 - EXTERIOR LIGHTING
SECTION 16570 - DIMMING CONTROLS
SECTION 16721 - FIRE ALARM
SECTION 16726 - PUBLIC ADDRESS AND MUSIC EQUIPMENT
SECTION 16750 - VOICE AND DATA COMMUNICATION CABLING
SECTION 16950 - LIGHTNING PROTECTION

1.3 DESCRIPTION OF WORK

A. This Section specifies several categories of provisions for electrical work, including: (1) Certain adaptive expansions of requirements specified in DIVISION 1, (2) General performance

requirements within the electrical systems as a whole, and (3) General work to be performed as electrical work because of its close association.

B. This Project Manual and accompanying Drawings are intended to describe complete workable systems of the various types. Items of materials, work, or equipment not mentioned but normally necessary for the proper execution of this work, shall be provided as if specifically called for, at no additional cost to the Owner.

1.4 SUMMARY OF ELECTRICAL WORK

A. Drawings:

1. Refer to the Electrical Drawings for graphic representations, schedules and notations showing electrical work.
2. The Drawings show approximate locations only of feeders, branch circuits, outlets, etc., except where specific routing or dimensions are indicated. The Architect reserves the right to make reasonable changes in locations indicated before roughing-in without additional cost to the Owner.
3. Because of the small scale of the Drawings, it is not possible to indicate all of the offsets, fittings, and accessories required. The Contractor shall investigate the structural and finish conditions affecting his work and shall arrange such work accordingly, furnishing fittings, bends, junction boxes, pull boxes, access panels, and accessories required to meet such conditions.

B. Project Manual:

1. Refer to the DIVISION 16 Sections for the primary technical Sections of electrical work.
2. General Outline: This section of the Project Manual covers furnishing materials, equipment, constant competent supervision, special tools, test equipment, technicians, and labor necessary for installation of a complete working electrical system, all as indicated on the plans of in this Project Manual.

C. Scope:

1. The work shall include but not necessarily be limited to the following:
   a. Medium voltage (13.8 KV) duct banks, manholes, cables, vaults, etc.
   b. Power distribution systems - feeder & branch circuits, panels, wiring, transformers, devices, etc.
   c. Power wiring and connections of mechanical equipment.
   d. Service systems.
   e. Grounding systems.
   f. Raceway systems.
   g. Lighting systems-fixtures/lamps/auxiliaries wiring/connections/etc.
   h. Lightning protection systems.
   i. Emergency power and lighting systems.
   j. Telephone and data system raceways.
   k. Public address system.
   l. Fire alarm system.
   m. Lighting control systems.
   n. Dimming Control Systems

o. All required sleeves, thimbles, anchors, hangers, bolts, miscellaneous structural steel, cutting, etc., for the complete installation of the electrical systems serving the building.
p. Temporary electrical services for construction.

1.5 COORDINATION OF ELECTRICAL WORK

A. General: Refer to the DIVISION 1 sections for general coordination requirements applicable to the entire work. It is recognized that the contract documents are diagrammatic in showing certain physical relationships which must be established within the electrical work, and in its interface with other work including utilities and mechanical work, and that such establishment is the exclusive responsibility of the Contractor.

B. Arrange electrical work in a neat, well organized manner with exposed conduit and similar services running parallel with primary lines of the building construction, and with a minimum of 8'-0" overhead clearance or as directed by the Architect.

C. Advise other trades of openings required in their work for the subsequent move-in of large units of electrical work (equipment).

D. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

E. Refer to equipment Sections in Divisions 2 through 15 for rough-in requirements.

F. Verify all dimensions by field measurements.

G. Arrange for chases, slots, and openings in other building components to allow for electrical installations.

H. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

I. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

J. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.

K. Where mounting heights are not detailed or dimensioned, install electrical services and overhead equipment to provide the maximum headroom possible.

L. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

M. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.

N. Coordinate connection of electrical systems with exterior underground utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

1.6 ELECTRICAL COORDINATION DRAWINGS:

A. Prepare and submit a set of coordination drawings showing major elements, components, and systems of electrical equipment and materials in relationship with other building components. Prepare drawings to an accurate scale of 1/4" = 1'-0" or larger. Indicate the locations of all equipment and materials, including clearances for servicing and maintaining equipment. Indicate movement and positioning of large equipment into the building during construction.

B. Prepare floor plans, elevations, sections, and details to conclusively coordinate and integrate installations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the work, including (but not necessarily limited to) the following:

1. Substations;
2. Main switchgear rooms;
3. Motor control centers;
4. Generator set and automatic transfer switches;
5. Electrical rooms;
6. Underground conduit routing;
7. Distribution panels;
8. Routing of 13.8 KV conduit feeders, noting pull box locations.

1.7 TEMPORARY ELECTRICITY

A. Furnish and install all necessary temporary power, metering, lighting or wiring that is required to insure quality workmanship everywhere.

B. Furnish and install area distribution boxes with ground fault protection so located that the individual trades may use their own construction-type extension cords to obtain proper power and artificial lighting at all points where required by inspectors and for safety.

1.8 DEMOLITION:

A. Refer to Architectural plans and specifications to determine the areas to be demolished and the extent of this demolition. Cooperate fully with the Architect.

B. Remove all branch circuit conductors and conduit, which serve areas to be demolished. Back to the electrical panelboards.

C. Remove boxes, light fixtures, and wiring devices in areas to be demolished.

D. Remove communication equipment and cable.

E. Cooperate fully with the Owner when removing communications equipment and cable.

F. Extend conduits and conductors to maintain electrical continuity of electrical equipment serving areas not demolished as required. This applies to both power and communications circuits.

G. Panelboards, power distribution feeders and communications equipment shall remain in good working order unless otherwise noted, specified or direct by the Architect.

H. Branch circuitry serving communications equipment shall remain in good working order unless otherwise indicated.

1.9 QUALITY ASSURANCE, STANDARDS

A. General: In addition to standards specified in individual work sections, the following standards are imposed, as applicable to the work in each instance:

1. NFPA 70, National Electrical Code
   The electrical installation shall conform to the requirements of the latest edition of the National Electrical Code (NEC-NFPA 70).
2. NEMA/ANSI/ASTM
   Electrical material shall be built and tested in accordance with the applicable standards of the National Electrical Manufacturer's Association (NEMA); the American National Standards Institute (ANSI); and the American Society of Testing and Materials (ASTM).
3. Underwriters' Laboratories (UL)
   Electrical materials shall be new and unused and shall be listed, inspected, approved and labeled by Underwriters' Laboratories, Inc., where such labeling service is available.
4. NFPA-101, Life Safety Code
   OSHA Code of Federal Regulations (for construction practices)Applicable state and local codes/ordinances.
5. NFPA 99, Health Care Facilities

1.10 ELECTRICAL SUBMITTALS:

A. Refer to the Division 1 Section 01630 for submittal definitions, requirements, and procedures.

B. Submittal of shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Data submitted from subcontractors and material suppliers directly to the Architect will not be processed.

1.11 SUBSTITUTIONS/PRIOR APPROVALS

A. Substitutions/Prior Approvals shall be submitted in accordance with Section 01630 and provisions thereof.

B. Only firms regularly engaged in manufacture of electrical products of types required, whose products have been in satisfactory use in similar service for not less than 3 years, shall be utilized.

C. Any item not specified herein but submitted for approval as a substitute for the specified item shall be accompanied by manufacturer's documentation stating/illustrating the following applicable information in addition to the specific information requested in other sections:

1. Dimensions/weight.

2. Electrical ratings-voltage, amperage, short circuit capability, etc.
3. Construction - gauge of steel/aluminum, paint finish/application method, color, NEMA type, etc.
4. Warranty.
5. Local manufacturer's representative or nearest stocking distributor.
6. Length of time the product has been available to the public.

D. Shop Drawings: Submit completion descriptive and dimensional data on the following materials which Contractor proposes to use:

1. Panelboards
2. Lighting Fixtures
3. Fuses
4. Transformers
5. Poles
6. Lamps
7. Lightning Protection Equipment
8. Safety Switches
9. Circuit Breakers
10. Generator
11. Wiring Devices
12. Motor Controls
13. Lighting Controls
14. Transfer Switches
15. Switchgear
16. Conductors
17. Nurse Call System
18. Fire Alarm System
19. Public Address System
20. Fire Stop Materials
21. Electrical Coordination Drawing (See 16010-4)

E. Corrections or comments made on shop drawings during the review do not relieve the Contractor from compliance with requirements of the Contract Documents, Plans and Project Manual. Shop Drawings will be checked for general conformance with the design concept of the project and general compliance with information given in the contract documents. Review of Shop Drawings shall not relieve the Contractor from responsibility for confirming and correlating all quantities and dimensions, coordinating work with that of all other trades, and performing work in a safe and satisfactory manner. Review of shop drawings shall not permit any deviation from Plans and Project Manual. Shop Drawings must be accompanied by signed statement from contractor, stating that he has reviewed the submittal and checked it for compliance.

F. See Section 01330, for number of copies of shop drawings and product data to be submitted.

1.12 DELIVERY, STORAGE AND HANDLING:

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications, adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

C. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion.

1.13 RECORD DOCUMENTS:

A. Refer to the Division 1 Section 01781 for requirements.

1.14 OPERATION AND MAINTENANCE DATA:

A. Refer to the Division 1 Section 01782 for procedures and requirements for preparation and submittal of maintenance manuals.

1.15 WARRANTIES:

A. Refer to the Division 1 Section 01770 for procedures and submittal requirements for warranties. Refer to individual equipment Sections for warranty requirements.

1.16 CLEANING

A. Refer to the Division 1 Section 01770 for general requirements for final cleaning.

B. Clean and restore to original finish all equipment prior to final acceptance.

1.17 GUARANTEE:

A. The work installed shall be kept in perfect working order for one year from date of substantial completion Guarantee shall be based upon defective materials and/or workmanship. Furnish free of cost to the Owner materials and labor necessary to comply with this guarantee.

1.18 WIRING FOR EQUIPMENT BY OTHERS:

A. Electrical service for all equipment furnished under this Project manual shall be roughed-in and connected under this Section. It is the responsibility of the Contractor to obtain correct roughing-in dimensions and requirements for this equipment.

B. Under other DIVISIONS, unless otherwise noted, equipment will be furnished such as: motors and magnetic motor starters (except when part of motor control centers). Connection/interconnection of that equipment shall be part of DIVISION 16000 and shall comply with other DIVISION 16000 Basic Material and Methods Sections.

C. Apparatus required for controls and firestats will be furnished as specified under DIVISION 15 - Mechanical Work. Control wiring shall be furnished and installed as work under DIVISION 15 - Mechanical.

1.19 TESTS AND BALANCING

A. The contractor shall conduct operating tests to demonstrate that the electrical systems are installed and will operate properly and in accordance with the requirements of this Project Manual. Tests shall be performed in the presence of the Architect's representative. The Contractor shall furnish instruments and personnel required for such tests.

B. Contractor shall perform tests in the presence of the Architect to show that the power and lighting loads are equally divided among phases of feeders serving each piece of equipment and each panelboard.

C. Any work and materials tested and found varying from the requirements of the Drawings and Project Manual shall be replaced by the Contractor without additional cost to the Owner.

D. This requirement is in addition to specific tests such as high-potential tests, meggar test, phasing tests, generator testing, etc. which may be called for in other sections.

1.20 WORKMANSHIP

A. Install all materials and electrical components of the work in accordance with instructions of manufacturer following the best modern construction practices and conforming with the Contract Documents. Workmanship shall be first class, in both function and appearance, whether finally concealed or exposed and shall be performed by experienced workmen skilled in the type of work. As practicable, the lines of all components of the system shall be perpendicular or parallel. In general, workmanship shall conform to guidelines set forth in N.E.C.A. manuals.

1.21 MOUNTING HEIGHTS:

A. Unless otherwise noted on the Drawings or required by the Architect, the following mounting heights shall apply.

B. Upon approval of the Architect, mounting heights may be adjusted.

C. Heights of Outlets - all heights measured from finish floor to bottom of device.

1.	Wall Switches	44"
2.	Receptacle Outlet (General)	16"
3.	Special Purpose Outlet	within 12" (12 inches) of intended use
4.	Telephone Outlet	16"
5.	Clock Outlet	7'-0" when possible Allow space below ceiling to service or replace. Above doors, center between door trim and ceiling.
6.	Bells, Buzzers, Chimes	7'-0"
7.	Fire Alarm Station	44"
8.	Fire Alarm Annunciator (Gongs, Strobe, Horns)	80"(per ADA Requirements) Allow sufficient space below ceiling to service or replace.
9.	Wall Mounted PIR Occupancy Sensors	44"

D. Heights of Disconnect Switches, Protective Devices, Controllers, etc.

E. The mounting height of disconnect switches, circuit breakers, motor controllers, push button stations, and other similar devices and equipment will vary depending upon location and whether individually or group mounted. For convenience and safety operating levers, handles or buttons shall be mounted no more than 80 inches above the finish floor line.

F. Panelboards shall be located so that the highest overcurrent protective device is a maximum of 72" above the floor.

1.22 SAFETY

A. It shall be the Contractor's responsibility to do all things necessary in the pursuit of the installation or testing to provide safe conditions in which to work.

1.23 FIRESTOPPING

A. Firestopping of all openings in fire-rated floors, walls, and ceilings accommodating penetrating items such as cables, bus ducts, wireways, conduits, etc. shall be required as part of DIVISION 16000 work. Provide Firestop installation as required to meet ratings equal to the floor or wall being penetrated. See Section 07270

B. Fire stop materials shall be manufactured for that purpose and shall be installed in accordance with the manufacturer's recommendation in order to provide a U.L. listed fire stop at all openings equal to or exceeding the rated floor, wall or ceiling.

C. Plastic sleeves/pipe shall not be used within the building when penetrating a fire-resistant-rated wall, ceiling, partition, or floor.

END OF SECTION 16010

SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Electrical equipment coordination and installation.
2. Common electrical installation requirements.

1.3 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 QUALITY ASSURANCE

A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

1.6 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."

D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Through-Penetration Firestop Systems."

3.3 FIELD QUALITY CONTROL

A. Inspect installed sleeve and sleeve-seal installations and associated firestopping for damage and faulty work.

END OF SECTION 16050

SECTION 16051 - ELECTRICAL RELATED WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications sections, apply to work of this section.

B. This section is a Division 16 Basic Materials and Methods section, and is part of each Division 16 section making reference to electrical related work specified herein.

1.2 DESCRIPTION OF WORK

A. Extent of electrical related work required by this section is indicated on drawings and/or specified in other Division 16 sections.

B. Types of electrical related work specified in this section include the following:

1. Excavating, Trenching and Backfill for Electrical Work.
2. Concrete for Electrical Work:
   a. Electrical equipment foundations and mounting pads.
   b. Foundations for light poles.

1.3 PROJECT CONDITIONS

A. Existing Utilities: Locate and protect existing utilities and other underground work in a manner which will ensure that no damage to personnel or property or service interruption will result from excavating and backfilling.

B. Protect property from damage which might result from excavating and backfilling.

C. Protect persons from injury at excavations by barricades, warnings and illumination.

D. Coordinate excavations with weather conditions, to minimize possibility of washouts, settlements and other damages and hazards.

PART 2 - PRODUCTS

2.1 EXCAVATING FOR ELECTRICAL WORK

A. Backfill Materials:

B. Subbase Material: A graded mixture of gravel, sand, crushed stone or crushed slag.

C. Backfill Material: Soil material suitable for compacting to required densities, and complying with AASHTO Designation M 145. Group A-1, A-2-4, A-2-5, or A-3.

D. Drainage Fill Material: Washed and uniformly graded gravel, crushed stone or crushed slab, with 100% passing a 1-1/2" sieve and not more than 5% passing a No. 4 sieve.

2.2 MATERIALS OF CONCRETE WORK

A. Encasement of conduits, ductbanks, etc. shall utilize 2500 PSI class mix. Light pole foundations and equipment pads shall utilize 3000 PSI class mix. Red dye shall be mixed with concrete when encasing conduits utilizing conductors with voltage over 150 volts to ground unless the encasement is poured as part of a foundation slab or under a slab. (The dye shall be incorporated as an additive to the mix and shall be utilized for the entire encasement.)

PART 3 - EXECUTION

3.1 EXCAVATION, TRENCHING AND BACKFILLING

A. Perform all excavation of every description and of whatever substances encountered to the depths indicated on the Drawings or as otherwise specified. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or not suitable for backfill shall be removed and wasted or removed from jobsite as indicated on the drawings or as directed by Architect, at no additional cost to Owner.

B. Sheeting and shoring shall be done as necessary for the protection of the work and for the safety of personnel. Provide necessary pumping at all times to maintain a dry working condition in all trenches. Unless otherwise indicated, excavations shall be by open cut except that short sections of a trench may be tunnelled if, in the opinion of the Architect, the conduit can be safely and properly installed and backfill can be properly tamped in such tunnelled sections.

C. No excavation or trenches shall be cut near or under footings without first consulting Architect.

D. Bottom of trench shall be shaped to give substantially uniform circumferential support to lower third of each pipe. Each pipe shall be laid true to line and grade and in such manner as to form a close concentric joint with adjoining pipe and to prevent sudden offset to flow line. As work progresses, interior of pipe shall be cleared of dirt and superfluous materials of every description.

E. Wherever wet or otherwise unstable soil that is incapable of properly supporting the pipe, as determined by the Architect, is encountered in the bottom of the trench, such soil shall be removed to the depth required and the trench backfilled to the proper grade with coarse sand, fine gravel, or other suitable material, as approved by the Architect.

F. Trenches for utilities shall be of a depth that will provide the following minimum depth of cover from existing grade or from indicated finish grade, whichever is lower, unless otherwise specifically shown:

24-Inch Minimum Cover - Electrical Conduit under 600 volts.
48-Inch Minimum Cover - Electrical Conduit over 600 volts.

G. Backfill shall be installed in layers 6" deep, adequately wetted (if approved by Architect) and tamped using materials as noted above. The surfaces shall be graded to a reasonable uniformity and the mounting over trenches left in a uniform and neat condition as approved by the Architect.

H. Restore all hard finished surfaces such as roadway, sidewalks, grass, shrubbery, etc., removed for installation of utilities (and not shown on Drawings or specified to be reworked under other sections of the work) to their original condition using the same type as original materials.

I. Carefully plan all work to avoid existing utilities and other interferences. Architect has not attempted to indicate all existing underground utilities. Existing utility lines to be retained that are shown on the Drawings or the locations of which are made known to the Contractor prior to excavation, as well as all utility lines uncovered during excavation operations, shall be protected from damage during excavation and backfilling and, if damaged, shall be repaired by the Contractor at his expense. Prior to doing any excavation with power tools, carefully investigate and locate any existing conduit, pipes, and other lines, so as to avoid them during excavation.

END OF SECTION 16051

SECTION 16055 - OVERCURRENT PROTECTIVE DEVICE COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies, and the setting of these devices.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals:

1. Coordination-study input data, including completed computer program input data sheets.
2. Coordination-study report.
3. Equipment evaluation report.
4. Setting report.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

C. Testing Agency Qualifications: Member company of the InterNational Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise testing specified in Part 3.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:

B. Computer Software Developers: Subject to compliance with requirements, provide computer software programs developed by one of the following:

1. CYME International, Inc.
2. EDSA Micro Corporation.
3. Electrical Systems Analysis, Inc.
4. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.

1. Optional Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.

3.2 FAULT-CURRENT STUDY

A. Source Impedance: As an infinite bus on primary side of utility transformer.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:

1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.
2. Low-Voltage Fuses: IEEE C37.46.
3. Circuit Breakers: IEEE C37.13.

E. Study Report: Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults.

F. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties.

3.3 COORDINATION STUDY

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 16 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical distribution system diagram showing the following:

    a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
    b. Circuit-breaker and fuse-current ratings and types.
    c. Relays and associated power and current transformer ratings and ratios.
    d. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    e. Generator kilovolt amperes, size, voltage, and source impedance.
    f. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.
    g. Busway ampacity and impedance.
    h. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Magnetic inrush current overload capabilities of transformers.

c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
d. Ratings, types, and settings of utility company's overcurrent protective devices.
e. Special overcurrent protective device settings or types stipulated by utility company.
f. Time-current-characteristic curves of devices indicated to be coordinated.
g. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
i. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

B. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.

C. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

D. Comply with **[IEEE 141] [IEEE 242]** recommendations for fault currents and time intervals.

E. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
b. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.

F. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

G. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

H. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists

between series devices, including power utility company's upstream devices. Show the following specific information:

a. Device tag.
b. Voltage and current ratio for curves.
c. Three-phase and single-phase damage points for each transformer.
d. No damage, melting, and clearing curves for fuses.
e. Cable damage curves.
f. Transformer inrush points.
g. Maximum fault-current cutoff point.

3. Completed data sheets for setting of overcurrent protective devices.

3.4 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to set overcurrent protective devices within equipment.

B. Testing: Owner will engage a qualified testing agency to perform device setting.

C. Testing: Engage a qualified testing agency to perform the following device setting and to prepare test reports.

D. Testing: Perform the following device setting and prepare reports:

1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:

a. Verify that overcurrent protective devices meet parameters used in studies.
b. Adjust devices to values listed in study results.

2. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 10.7 and 10.8 in NETA ATS.

END OF SECTION 16055

SECTION 16060 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment, **plus the following special applications:**
   1. Underground distribution grounding.
   2. Common ground bonding with lightning protection system.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

   1. Test wells.
   2. Ground rods.
   3. Ground rings.
   4. Grounding arrangements and connections for separately derived systems.
   5. Grounding for sensitive electronic equipment..

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

   1. Instructions for periodic testing and inspection of grounding features at **[test wells] [ground rings] [grounding connections for separately derived systems] <Insert locations>** based on **[NETA MTS] [NFPA 70B]**.

      a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
      b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Rectangular bars of annealed copper, **[1/4 by 2 inches (6 by 50 mm)]** in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: **Copper-clad** steel; **3/4 inch by 10 feet (19 mm by 3 m)**.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. **2/0** AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-

copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50-by-300-mm) grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

H. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 2 Section "Underground Ducts and Utility Structures," and shall be at least 12 inches (300 mm) deep, with cover.

1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed,

connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install [**tinned**]bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each **steel column** extending around the perimeter of **building**.

1. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than **24 inches (600 mm)** from building foundation.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).

5. Substations and Pad-Mounted Equipment: 5 ohms.

D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 16060

SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Identification for conductors and communication and control cable.
2. Warning labels and signs.
3. Equipment identification labels.

1.2 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

PART 2 - PRODUCTS

2.1 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Marker Tape: Vinyl or vinyl -cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.2 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Fasteners for Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

F. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 mm)."

2.3 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and ultraviolet-resistant seal for label.

B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

PART 3 - EXECUTION

3.1 APPLICATION

A. Auxiliary Electrical Systems Conductor and Cable Identification: Use marker tape to identify field-installed alarm, control, signal, sound, intercommunications, voice, and data wiring connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and cable pull points. Identify by system and circuit designation.
2. Use system of designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

B. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply **[self-adhesive warning labels] [baked-enamel warning signs] [metal-backed, butyrate warning signs]**. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:

a. Power transfer switches.

b. Controls with external control power connections.

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

C. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: **[Adhesive film label with clear protective overlay] [Self-adhesive, engraved, laminated acrylic or melamine label]**. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high.
b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, drilled for screw attachment.
c. Elevated Components: Increase sizes of labels and legend to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

a. Panelboards, electrical cabinets, and enclosures.
b. Electrical switchgear and switchboards.
c. Transformers.
d. Motor-control centers.
e. Disconnect switches.
f. Enclosed circuit breakers.
g. Motor starters.
h. Push-button stations.
i. Power transfer equipment.
j. Contactors.
k. **<Insert equipment.>**

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. Color-Coding for Phase[**and Voltage Level**] Identification, 600 V and Less: Use the colors listed below for ungrounded [**service**] [**feeder**] [**branch-circuit**] [**service, feeder, and branch-circuit**] conductors.

1. Color shall be factory applied.
2. Colors for 208/120-V Circuits:

    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.

3. Colors for 480/277-V Circuits:

    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.

END OF SECTION 16075

SECTION 16080 - ELECTRICAL TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general requirements for electrical field testing and inspecting. Detailed requirements are specified in each Section containing components that require testing. General requirements include the following:

1. Qualifications of testing agencies and their personnel.
2. Suitability of test equipment.
3. Calibration of test instruments.
4. Coordination requirements for testing and inspecting.
5. Reporting requirements for testing and inspecting.

B. Allowances: Electrical tests and inspections specified in various Division 13 and 16 Sections are covered by a testing and inspecting allowance specified in Division 1 Section "Allowances." See Division 1 Section "Allowances" for what is included in allowance amount, the amount of the allowance, payment procedures for allowances, changes to allowance amounts, and disposition of unused portions of allowance.

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: As specified in each Section containing electrical testing requirements and in subparagraph and associated subparagraph below.

1. Independent Testing Agencies: Independent of manufacturers, suppliers, and installers of components to be tested or inspected.

a. Testing Agency's Field Supervisor for Power Component Testing: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Division 16 power component Sections.

B. Test Equipment Suitability: Comply with NETA ATS, Section 5.2.

C. Test Equipment Calibration: Comply with NETA ATS, Section 5.3.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 GENERAL TESTS AND INSPECTIONS

A. If a group of tests are specified to be performed by an independent testing agency, prepare systems, equipment, and components for tests and inspections, and perform preliminary tests to ensure that systems, equipment, and components are ready for independent agency testing. Include the following minimum preparations as appropriate:

1. Perform insulation-resistance tests.
2. Perform continuity tests.
3. Perform rotation test (for motors to be tested).
4. Provide a stable source of single-phase, 208/120-V electrical power for test instrumentation at each test location.

B. Test and Inspection Reports: In addition to requirements specified elsewhere, report the following:

1. Manufacturer's written testing and inspecting instructions.
2. Calibration and adjustment settings of adjustable and interchangeable devices involved in tests.
3. Tabulation of expected measurement results made before measurements.
4. Tabulation of "as-found" and "as-left" measurement and observation results.

END OF SECTION 16080

SECTION 16120 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control test reports.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Copper Conductors: Comply with NEMA WC 70.

B. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

C. Multiconductor Cable: Comply with NEMA WC 70 for armored cable, Type AC and metal-clad cable, Type MC with ground wire.

2.2 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.

4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.4 SLEEVE SEALS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: **[EPDM] [NBR] <Insert sealing element>** interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: **[Plastic] [Carbon steel] [Stainless steel]**. Include two for each sealing element.
3. Connecting Bolts and Nuts: **[Carbon steel with corrosion-resistant coating] [Stainless steel]** of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THWN, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THWN, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN, single conductors in raceway

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THWN, single conductors in raceway.

H. Class 1 Control Circuits: Type THHN-THWN, in raceway.

I. Class 2 Control Circuits: Type THHN-THWN, in raceway, Power-limited tray cable, in cable tray.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 16 Section "Electrical Supports and Seismic Restraints."

F. Identify and color-code conductors and cables according to Division 16 Section "Electrical Identification."

G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

I. Wiring at Outlets: Install conductor at each outlet, with at least **[6 inches (150 mm)] [12 inches (300 mm)]** of slack.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

D. Cut sleeves to length for mounting flush with both wall surfaces.

E. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

F. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and cable unless sleeve seal is to be installed.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry **and with approved joint compound for gypsum board assemblies**.

H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 7 Section "Joint Sealants."

I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 7 Section "Through-Penetration Firestop Systems."

J. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

K. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

L. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 7 Section "Through-Penetration Firestop Systems."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 16120

SECTION 16124 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

1.3 SUBMITTALS

A. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.

B. Samples: 16-inch (400-mm) lengths of each type of cable indicated.

C. Qualification Data: For testing agency.

D. Source quality-control test reports.

E. Material Certificates: For each cable and accessory type, signed by manufacturers, certifying that cables comply with requirements specified in Part 2 Article "Source Quality Control."

F. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise testing specified in Part 3.

C. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C2 and NFPA 70.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect at least two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cables:

a. American Insulated Wire Corp.; a Leviton Company.
b. BICC Brand-Rex Company.
c. General Cable Corporation.
d. Kerite Co. (The); Hubbell Incorporated.
e. Okonite Company (The).
f. Pirelli Cables & Systems NA.
g. Rome Cable Corporation.
h. Southwire Company.

2. Cable Splicing and Terminating Products and Accessories:

a. Engineered Products Co.
b. G&W Electric Co.
c. MPHusky.
d. Raychem Corp.; Telephone Energy and Industrial Division.
e. RTE Components; Cooper Power Systems, Inc.
f. Scott Fetzer Co. (The); Adalet, Inc.
g. Thomas & Betts Corporation.
h. Thomas & Betts/Elastimold.
i. 3M Company; Electrical Products Division.

2.2 CABLES

A. Cable Type: MV-105.

B. Conductor: Copper.

C. Conductor Stranding: Compact round, concentric lay, Class B.

D. Strand Filling: Conductor interstices are filled with impermeable compound.

E. Conductor Insulation: Ethylene-propylene rubber complying with AEIC CS 6 and NEMA WC 74.

1. Voltage Rating: 25 kV.
2. Insulation Thickness: 133 percent insulation level.

F. Shielding: Copper tape, helically applied over semiconducting insulation shield.

G. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

H. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together with ground conductors.

1. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.

I. Cable Jacket: Sunlight-resistant PVC.

2.3 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
3. Premolded, cold-shrink-rubber, in-line splicing kit.
4. Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

2.4 SOLID TERMINATIONS

A. Multiconductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.

1. Compound-filled, cast-metal body, metal-clad cable terminator for metal-clad cable with external plastic jacket.
2. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.
3. Heat-shrink sheath seal kit with phase- and ground-conductor rejacketing tubes, cable-end sealing boot, and sealing plugs for unused ground-wire openings in boot.
4. Cast-epoxy-resin sheath seal kit with wraparound mold and packaged, two-part, epoxy-resin casting material.

B. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
3. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
4. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.
5. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
6. Class 3 Terminations: Kit with stress cone and compression-type connector.

C. Nonshielded-Cable Terminations: Kit with compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.

4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

F. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

G. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.6 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.

2.7 FAULT INDICATORS

A. Indicators: Manual-reset fault indicator, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect cables according to **[NEMA WC 7] [NEMA WC 8]** before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.

2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

D. Support cables according to Division 16 Section "Basic Electrical Materials and Methods."

E. Install direct-buried cables on leveled and tamped bed of 3-inch- (75-mm-) thick, clean sand. Separate cables crossing other cables or piping by a minimum of 4 inches (100 mm) of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

F. Install "buried-cable" warning tape 12 inches (305 mm) above cables.

G. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

H. Install cable splices at pull points and elsewhere as indicated; use standard kits.

I. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits.

J. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: Three.
3. Standoff Insulator: Three.

K. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with 1-inch- (25-mm-) wide bands of half-lapped, adhesive, glass-cloth tape 2 inches (50 mm) o.c.

L. Seal around cables passing through fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."

M. Install fault indicators on each phase where indicated.

N. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

O. Identify cables according to Division 16 Section Electrical Identification.

3.2 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

1. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.2. Certify compliance with test parameters.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 16124

SECTION 16130 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. See Division 2 Section "Underground Ducts and Utility Structures" for exterior ductbanks and manholes, and underground handholes, boxes, and utility construction.

1.2 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, details, and attachments to other work.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: ANSI C80.1.

B. IMC: ANSI C80.6.

C. EMT: ANSI C80.3.

D. FMC: Zinc-coated steel.

E. LFMC: Flexible steel conduit with PVC jacket.

F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.

2. Fittings for EMT: Steel, set-screw or compression type.

2.2 NONMETALLIC CONDUIT AND TUBING

A. ENT: NEMA TC 13.

B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

C. LFNC: UL 1660.

D. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

E. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type **[1] [12] [3R]**, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type

E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Thomas & Betts Corporation.
b. Walker Systems, Inc.; Wiremold Company (The).
c. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Butler Manufacturing Company; Walker Division.
   b. Enduro Systems, Inc.; Composite Products Division.
   c. Hubbell Incorporated; Wiring Device-Kellems Division.
   d. Lamson & Sessions; Carlon Electrical Products.
   e. Panduit Corp.
   f. Walker Systems, Inc.; Wiremold Company (The).
   g. Wiremold Company (The); Electrical Sales Division.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.

C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

D. Metal Floor Boxes: Cast or sheet metal, fully adjustable rectangular.

E. Nonmetallic Floor Boxes: Nonadjustable, round.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

I. Cabinets:

   1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

   1. Exposed Conduit: Rigid steel conduit.
   2. Concealed Conduit, Aboveground: Rigid steel conduit.

3. Underground Conduit: RNC, Type EPC-80-PVC, direct buried or flexible HDPE directionally bored.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4X stainless steel.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT (except RGS on first floors).
2. Exposed and Subject to Physical Damage: Rigid steel conduit. Includes raceways in the following locations:

   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.

3. Concealed in Ceilings and Interior Walls and Partitions: EMT (except RGS on first floors).
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Damp or Wet Locations: Rigid steel conduit.
6. Raceways for Optical Fiber or Communications Cable: EMT (except RGS on first floors).
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4X, stainless steel in damp or wet locations.

C. Minimum Raceway Size: **3/4-inch (21-mm)** trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

E. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

F. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

G. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.

H. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

I. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.

J. Raceways for Optical Fiber and Communications Cable: Install as follows:

1. 3/4-Inch (19-mm) Trade Size and Smaller: Install raceways in maximum lengths of 50 feet (15 m).
2. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

K. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

L. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for **recessed and semirecessed lighting fixtures,** equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations.

M. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

N. Set metal floor boxes level and flush with finished floor surface.

O. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 2 Section "Earthwork" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Division 2 Section "Earthwork."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of conduit.

3.4 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Through-Penetration Firestop Systems."

END OF SECTION 16130

SECTION 16139 - CABLE TRAYS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes aluminum cable trays and accessories.

1.2 SUBMITTALS

A. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

C. Field quality-control reports.

D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Chalfant Manufacturing Company.
2. Cooper B-Line, Inc.
3. Cope, T. J., Inc.; a subsidiary of Allied Tube & Conduit.
4. GS Metals Corp.; GLOBETRAY Products.
5. MONO-SYSTEMS, Inc.
6. MPHusky.
7. PW Industries.

2.2 MATERIALS AND FINISHES

A. Cable Trays, Fittings, and Accessories: Aluminum, complying with NEMA VE 1, Aluminum Association's Alloy 6063-T6 for rails, rungs, and cable trays, and Alloy 5052-H32 or Alloy 6061-T6 for fabricated parts; with chromium-zinc, ASTM F 1136 or Type 316 stainless-steel splice-plate fasteners, bolts, and screws.

B. Sizes and Configurations: Refer to the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

1. Center-hanger supports may be used only when specifically indicated.

2.3 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.4 WARNING SIGNS

A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. Materials and fastening are specified in Division 16 Section "Electrical Identification."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.

B. Remove burrs and sharp edges from cable trays.

C. Fasten cable tray supports to building structure.
1. Place supports so that spans do not exceed maximum spans on schedules.
2. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
3. Support bus assembly to prevent twisting from eccentric loading.
4. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.
5. Locate and install supports according to **NEMA FG 1 / NEMA VE 1**.

D. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.

E. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in **NEMA FG 1 / NEMA VE 1**. Space connectors and set gaps according to applicable standard.

F. Make changes in direction and elevation using standard fittings.

G. Make cable tray connections using standard fittings.

H. Seal penetrations through fire and smoke barriers according to Division 7 Section "Through-Penetration Firestop Systems."

I. Sleeves for Future Cables: Install capped sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

J. Workspace: Install cable trays with enough space to permit access for installing cables.

K. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

L. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

M. Install cables only when cable tray installation has been completed and inspected.

N. Fasten cables on horizontal runs with cable clamps or cable ties as recommended by NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

O. On vertical runs, fasten cables to tray every 18 inches (457 mm). Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

P. In existing construction, remove inactive or dead cables from cable tray.

Q. Install covers after installation of cable is completed.

R. Ground cable trays according to manufacturer's written instructions.

S. Install an insulated equipment grounding conductor with cable tray, in addition to those required by NFPA 70.

3.2 FIELD QUALITY CONTROL

A. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:

1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.

2. Verify that the number, size, and voltage of cables in cable tray do not exceed that permitted by NFPA 70. Verify that communication or data-processing circuits are separated from power circuits by barriers.
3. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.
4. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.
5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
6. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
7. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.

B. Report results in writing.

END OF SECTION 16139

SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Snap switches and wall-box dimmers.
3. Wall-switch and exterior occupancy sensors.
4. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

B. See Division 16 Section "Voice and Data Communication Cabling" for workstation outlets.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.4 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Wiring Devices:
      a. Bryant Electric, Inc./Hubbell Subsidiary
      b. Hubbell Incorporated; Wiring Device-Kellems
      c. Leviton Mfg. Company Inc
      d. Pass & Seymour/Legrand; Wiring Devices Div.
   2. Poke-Through, Floor Service Outlets and Telephone/Power Poles:
      a. Hubbell Incorporated; Wiring Device-Kellems
      b. Pass & Seymour/Legrand; Wiring Devices Div.
      c. Square D/Group Schneider NA.
      d. Thomas & Betts Corporation.
      e. Wiremold Company (The).
   3. Wiring Devices for Hazardous (Classified) Locations:
      a. Crouse-Hinds/Cooper Industries, Inc.; Arrow Hart Wiring Devices.
      b. EGS/Appleton Electric Company.
      c. Killark Electric Manufacturing Co./Hubbell Incorporated.

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

B. Straight-Blade and Locking Receptacles: Specification Grade

C. GFCI Receptacles: Straight blade, non-feed-through type, specification grade, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter. Include indicator light that is lighted when device is tripped.

D. TVSS Receptacles: Straight blade, NEMA WD 6, Configuration 5-20R, with integral TVSS in line to ground, line to neutral, and neutral to ground.
   1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp level rating of 500 volts and minimum single transient pulse energy dissipation of 140 J line to neutral, and 70 J line to ground and neutral to ground.
   2. Active TVSS Indication: Visual and audible with light visible in face of device to indicate device is "active" or "no longer in service."
   3. Receptacle Type: Specification grade.
   4. Identification: Distinctive marking on face of device to denote TVSS-type unit.

2.3 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A: Specification Grade, quiet type.

2.4 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.5 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: Smooth, high-impact thermoplastic
   3. Material for Unfinished Spaces: Galvanized steel.
   4. Material for Wet Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet locations.

2.6 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type , dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Round, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6, Configuration 5-20R, gray finish, unless otherwise indicated.

E. Extron Audio / Visual Inputs: As indicated on drawings.

F. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
   1. Closure Plug: Arranged to close unused 3-inch (75-mm) cored openings and reestablish fire rating of floor.

2.7 SERVICE POLES

A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
   1. Poles: Nominal 2.5-inch- (65-mm-) square cross section, with height adequate to extend from floor to at least 6 inches (150 mm) above ceiling, and with separate channels for power wiring and voice and data communication cabling.
   2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.

3. Finishes: Manufacturer's standard painted finish and trim combination.
4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors; and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.
5. Modular Furniture Connection: Flexible whips, end caps, openings with grommets, or other methods for connecting power and communication cables.

2.8 OCCUPANCY SENSORS

A. Wall-Switch Sensors:

1. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).

B. Wall-Switch Sensors:

1. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).

C. Long-Range Wall-Switch Sensors:

1. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, with a minimum coverage area of 1200 sq. ft. (111 sq. m).

D. Long-Range Wall-Switch Sensors:

1. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft. (111 sq. m).

E. Wide-Range Wall-Switch Sensors:

1. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft. (111 sq. m).

F. Exterior Occupancy Sensors:

1. Description: Passive-infrared type, 120/277 V, weatherproof, adjustable time delay up to 15 minutes, 180-degree field of view, and 110-foot (34-m) detection range. Minimum switch rating: 1000-W incandescent, 500-VA fluorescent.

2.9 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: Ivory unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. TVSS Devices: Blue.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 IDENTIFICATION

A. Comply with Division 16 Section "Electrical Identification."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with white-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

END OF SECTION 16140

SECTION 16145 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following lighting control devices:
   1. Outdoor photoelectric switches.
   2. Indoor occupancy sensors.
   3. Outdoor motion sensors.
   4. Emergency shunt relay.

B. See Division 16 Section "Lighting Controls" for low-voltage, manual and programmable lighting control systems.

C. See Division 16 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

D. See Division 16 Section "Dimming Controls" for architectural dimming system equipment.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control test reports.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Lithonia Lighting; Acuity Lighting Group, Inc.
   2. Square D; Schneider Electric.
   3. TORK.
   4. Touch-Plate, Inc.
   5. Watt Stopper (The).

B. Description: Solid state, with SPDT dry contacts rated for 1800-VA tungsten or 1000-VA inductive to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 INDOOR OCCUPANCY SENSORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Hubbell Lighting.
2. Leviton Mfg. Company Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Novitas, Inc.
5. RAB Lighting, Inc.
6. Sensor Switch, Inc.
7. TORK.
8. Watt Stopper (The).

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
4. Mounting:
    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.

C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.

1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.

2.3 OUTDOOR MOTION SENSORS (PIR)

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Bryant Electric; a Hubbell Company.
2. Hubbell Lighting.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Paragon Electric Co.; Invensys Climate Controls.
5. RAB Lighting, Inc.
6. TORK.
7. Watt Stopper (The).

B. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F (minus 40 to plus 54 deg C), rated as raintight according to UL 773A.

1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Mounting:

   a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
   b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

3. Bypass Switch: Override the on function in case of sensor failure.
4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc (11 to 215 lx); keep lighting off during daylight hours.

C. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).

D. Detection Coverage: **<Insert coverage area>**.

E. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.

F. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

1. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
2. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

2.4 EMERGENCY SHUNT RELAY

A. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

2.5 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 16 Section "Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 16 Section "Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 16 Section "Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

B. When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 16 Section "Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 16 Section "Electrical Identification."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

END OF SECTION 16145

SECTION 16146 - LIGHTING CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes manual and programmable, low-voltage lighting controls.

B. Related Sections include the following:

1. Division 16 Section "Wiring Devices" for wall-box dimmers and manual light switches.
2. Division 16 Section "Lighting Control Devices" for time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
3. Division 16 Section "Dimming Controls" for architectural dimming system equipment.

1.3 SUBMITTALS

A. Product Data: Include dimensions and data on features, components, and ratings for lighting controls.

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.

1. Wiring Diagrams: Detail specific systems tailored to this Project and differentiate between manufacturer-installed and field-installed wiring.

C. Operational Documentation: For software and firmware.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Maintenance Data: For lighting control equipment and system components to include in maintenance manuals specified in Division 1. Include software operating manuals.

F. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is an authorized representative of the programmable lighting system manufacturer for both installation and maintenance of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing programmable lighting controls similar to those indicated for this Project and with a record of successful in-service performance.

C. Source Limitations: Obtain low-voltage lighting control system components from a single manufacturer.

1. Provide total responsibility for compatibility of system components, including those provided in this Section and in Division 16 Sections "Lighting Control Devices" and "Dimming Controls."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for their indicated use and installation conditions by a testing agency acceptable to authorities having jurisdiction.

E. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

F. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate features of equipment and system components to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions.

B. Coordinate lighting controls specified in this Section with work specified in other Sections, including the following:

1. Division 15 Section "Sequence of Operation."
2. Division 16 Section "Lighting Control Devices."
3. Division 16 Section "Panelboards."
4. Division 16 Section "Dimming Controls."

1.6 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of programmable lighting controls that fail in materials or workmanship within specified warranty period.

C. Special Warranty Period for Programmable Systems: Two years from date of Substantial Completion.

D. Special Warranty Period for Electrically Held Relays: 10 years from date of Substantial Completion (for furnishing replacement relays only after second year).

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.

1. Modular Single-Pole Relays: 1 for every 10 installed. Furnish at least one of each type.
2. Electrically Operated, Molded-Case Circuit Breakers: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Cutler-Hammer Products; Eaton Corporation.
2. GE Lighting Controls.
3. Honeywell, Inc.; Home and Building Controls.
4. Johnson Controls, Inc.; Controls Group Div.
5. Lithonia Control Systems.
6. Lutron Electronics Co., Inc.
7. Square D Co.; Power Management Organization.
8. Tork, Inc.
9. The Watt Stopper
10. Triatek

2.2 GENERAL REQUIREMENTS

A. Expansion Capability of System: Adequate to increase the number of control functions in the future by 25 percent more than those indicated. This applies to equipment ratings, housing volumes, spare relays, terminals, and control cable conductor quantities.

B. Line-Voltage Surge Protection: Include in all 120-V solid-state equipment. Comply with UL 1449 and with ANSI C62.41 for Category A locations.

C. Comply with UL 916.

2.3 FUNCTIONAL SYSTEM DESCRIPTION

A. A control signal from a manual switch, an internal timing and control unit, or an external sensor or other control signal source is routed to the system control module. This module processes signal according to its programming and routes an "open" or "close" command to one or more relays in the power-supply circuits to groups of lighting fixtures or other loads.

2.4 SYSTEM COMPONENTS

A. Control Module Description: Programmable, microprocessor-based control unit mounted in preassembled modular relay panel. Low-voltage-controlled, latching-type, single-pole

lighting circuit relays are prime output circuit devices. Where indicated, a limited number of digital or analog, low-voltage control circuit outputs are supported by control unit and circuit boards associated with relays. Control unit receives inputs from indicated sensors and other sources. Line-voltage components and wiring are separated from low-voltage components and wiring by barriers. Control module is locally programmable. Modules and their associated control panels include the following features:

1. System Memory: Nonvolatile. Reboots program and resets time automatically without errors after power outages up to 90 days' duration.
2. Automatic Time Adjustment: System automatically adjusts for leap year and daylight saving time and provides weekly routine and annual holiday scheduling.
3. Astronomic Control: Automatic adjustment of dawn and dusk switching.
4. Demand Control: Demand is monitored through pulses from a remote meter and is controlled by programmed switching of loads. System capability includes sliding window averaging and programming of load priorities and characteristics. Minimum of two different time-of-day demand schedules execute load-management control actions by switching output circuits or by transmitting other types of load-control signals.
5. Confirmation: Each relay or contactor device operated by system has auxiliary contacts connected to provide a confirmation signal to the system of on or off status of device. On or off status confirmation for each electrically operated circuit breaker is provided by an auxiliary contact or by a sensing device at load terminal.

    a. Software interprets status signals, provides for their display, and initiates failure signals.
    b. Lamp or light-emitting diode at control module or display panel identifies status of each controlled circuit.

6. Remote Communications Capability: Allows programming, data-gathering interrogation, status display, and controlled command override from an IBM-compatible microcomputer at a remote location over telephone or data lines. System includes modem, communications and control software, and remote computer compatibility verification for this purpose. Microcomputer is not in this Contract.
7. Telephone Override Capability: Overrides programmed lighting shutdown commands by telephoning computer and entering a voice-menu-guided override touch-tone code specific to the zone being controlled.
8. Local Override Capability: Manual, low-voltage control devices override programmed shutdown of lighting and override other programmed control for intervals that may be duration programmed.
9. Automatic battery backup provides power to maintain program and system clock operation for 90 days' minimum duration when power is off.
10. Compatibility with dimmer controls permits commands that change preset scenes and dimmer settings according to programmed time signals.
11. Daylight Balancing Dimming Control: Control module interprets variable analog signal from photoelectric sensor and routes dimming signals to dimming fluorescent ballast control circuits. Signal controls dimming of fixture so illumination level remains constant as daylight contribution varies.
12. Daylight Compensating Switch Control: Control module interprets a preset threshold illumination-level signal from a photoelectric relay and activates relays controlling power to selected groups of lighting fixtures to turn them on and off to maintain adjustable minimum illumination level as daylight contribution varies.

13. Flick Warning: Programmable momentary turnoff of lights warns that programmed shutoff will occur after a preset interval. Warning is repeated after a second preset interval before end of programmed override period.
14. Diagnostics: When system operates improperly, software initiates factory-programmed diagnosis of failure and displays messages identifying problem and possible causes.
15. Interface to Energy Management System: Panels shall communicate and be capable of being controlled by the Energy Management System provided under Division 15.

B. Mechanically Held, Modular Single-Pole Relays: Split-coil, momentary-pulsed type.

1. Low-Voltage Leads: Five-pin plug connector.
2. Pilot Contacts: Single pole.
3. Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; and 20 A, 277-V ac for ballasts.
4. Endurance: 50,000 cycles at rated capacity.
5. Mounting: Knockout in modular relay panel, unless otherwise indicated.

C. Electrically Held, Modular Single-Pole Relays: As follows:

1. Rated Capacity (Mounted in Relay Panel): 20 A, 120- and 277-V ac for all types of fluorescent and HID ballasts; and 15 A, 120-V ac for tungsten filaments.
2. Operating Coil: DC.
3. Mounting: Modular printed circuit board. Board is held in place in modular relay panel by quick-release spring pins, unless otherwise indicated.
4. Pilot Device: Provides positive relay position indication.
5. Special Warranty: See Part 1 of this Section.

D. Modular Relay Panels: Steel cabinets, preassembled with modular single-pole relays, power supplies, and accessory components required for specified performance.

1. Barriers separate low-voltage and line-voltage components.
2. Cover: Hinged, lockable type.
3. Directory: Mounted on back of door. Identifies each relay as to bunch loads controlled, and each programmed pilot device, if any.
4. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.

2.5 MANUAL SWITCHES AND PLATES

A. Switches: Specification-grade, modular, momentary push-button, low-voltage type.

1. Color: White, unless otherwise indicated.
2. Integral Pilot Light: Indicates when circuit is on. Use where indicated.
3. Locator Light: Internal illumination helps locate switch in the dark. Use where indicated.
4. Wall Plates: Match those specified in Division 16 Section "Wiring Devices" to materials, finish, and color. Use multi-gang plates if more than one switch is indicated at a location.
5. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.6 LOW-VOLTAGE WIRING

A. Digital and Multiplexed Signal Wire: Shielded, twisted-pair cable as specified in Division 16 Section "Voice and Data Systems."

B. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.

1. Sheath: PVC, except in plenum-type spaces use sheath listed for plenums.
2. Ordinary Switch Circuits: Three conductors, unless otherwise indicated.
3. Switch Circuits with Pilot Lights or Locator Feature: Five conductors, unless otherwise indicated.

2 PART - EXECUTION

2.7 INSTALLATION

A. Install equipment level and plumb and according to manufacturer's written instructions.

B. Mount control equipment according to manufacturer's written instructions and requirements in Division 16 Section "Basic Electrical Materials and Methods."

C. Mounting heights indicated are to bottom of unit for suspended items and to center of unit for wall-mounting items.

2.8 CONTROL WIRING INSTALLATION

A. Install wiring between control devices as specified in Division 16 Section "Conductors and Cables" for low-voltage connections and Division 16 Section "Voice and Data Systems" for digital circuits.

B. Wiring Method: Install all wiring in raceway as specified in Division 16 Section "Raceways and Boxes."

C. Bundle, train, and support wiring in enclosures.

D. Ground equipment.

E. Connections: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

2.9 IDENTIFICATION

A. Identify components and power and control wiring according to Division 16 Section "Electrical Identification."

B. Label each system control module with a unique designation. Make designations on elevated components readable from floor.

2.10 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Engage a factory-authorized service representative to test, adjust, and program lighting control system.

B. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.

C. Inspect control components for defects and physical damage, testing laboratory labeling, and nameplate compliance with the Contract Documents.

D. Check tightness of electrical connections with torque wrench calibrated within previous six months. Use manufacturer's recommended torque values.

E. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:

1. Continuity tests of circuits.
2. Operational Tests: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.

    a. Where light balancing or other control involving equipment provided under other Sections is indicated, combine testing required by this Section with that required by Sections specifying other equipment. Test programmable control related to light balancing, occupancy sensing, and other controls under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

F. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

G. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

H. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

2.11 CLEANING

A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

2.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of eight hours' training.
2. Training Aid: Use the approved final version of maintenance manuals as a training aid.
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

2.13 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested, to adjust light levels, make program changes, and adjust sensors and controls to suit actual conditions.

END OF SECTION 16146

SECTION 16215 - ELECTRICAL POWER MONITORING AND CONTROL INTEGRATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes integration of new electrical distribution equipment to PC-based workstation(s) and Energy Management System software provided by Division 15 for monitoring and control of electrical power.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.

B. Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components.
2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cutler-Hammer Group; Eaton Electrical Inc.
2. GE Industrial Systems.
3. Siemens
4. Square D / Schneider Electric.

2.2 FUNCTIONAL DESCRIPTION

A. Instrumentation and Recording Devices: Monitoring equipment shall provide the following minimum information to the Energy Management System:

1. Total instantaneous power (kW)
2. Kilowatt-Hours
3. Power Factor
4. Voltage regulation and unbalance.
5. Continuous three-phase RMS voltage.
6. Continuous three-phase RMS current
7. Periodic max./min./avg. voltage and currnet samples.
8. Total Harmonic Distortion (THD).
9. Voltage excursions.

2.3 SYSTEM REQUIREMENTS

A. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Division 16 Section "Transient Voltage Suppression."

2.4 COMMUNICATION COMPONENTS AND NETWORKS

A. Transient Voltage Surge Suppression and Electromagnetic-Interference Immunity: Include in solid-state equipment. Comply with IEEE C37.90.

2.5 POWER MONITORS

A. RMS Real-Time Measurements:

1. Current: Each phase, neutral, average of three phases, percent unbalance.
2. Voltage: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases, line-to-neutral percent unbalance.
3. Power: Per phase and three-phase total.
4. Reactive Power: Per phase and three-phase total.
5. Power Factor: Per phase and three-phase total.
6. Frequency.
7. THD: Current and voltage.
8. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
9. Incremental Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
10. Conditional Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).

B. Demand Current Calculations, per Phase, Three-Phase Average and Neutral:

1. Present.
2. Running average.

3. Last completed interval.
4. Peak.

C. Demand Real Power Calculations, Three-Phase Total:

1. Present.
2. Running average.
3. Last completed interval.
4. Predicted.
5. Peak.
6. Coincident with peak kVA demand.
7. Coincident with kVAR demand.

D. Demand Reactive Power Calculations, Three-Phase Total:

1. Present.
2. Running average.
3. Last completed interval.
4. Predicted.
5. Peak.
6. Coincident with peak kVA demand.
7. Coincident with kVAR demand.

E. Average Power Factor Calculations, Demand Coincident, Three-Phase Total:

1. Last completed interval.
2. Coincident with kW peak.
3. Coincident with kVAR peak.
4. Coincident with kVA peak.

F. Sampling:

1. Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.
2. Power monitor shall provide continuous sampling at a rate of 128 samples per cycle on all voltage and current channels in the meter.

G. Minimum and Maximum Values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:

1. Line-to-line voltage.
2. Line-to-neutral voltage.
3. Current per phase.
4. Line-to-line voltage unbalance.
5. Line-to-neutral voltage unbalance.
6. Power factor.
7. Displacement power factor.
8. Total power.
9. Total reactive power.
10. THD voltage L-L.
11. THD voltage L-N.
12. THD current.

13. Frequency.

H. Harmonic Calculation: Display and record the following:

1. Harmonic magnitudes and angles for each phase voltage and current through 31st harmonic. Current and voltage information for all phases shall be obtained simultaneously from same cycle.
2. Harmonic magnitude reported as a percentage of the fundamental or as a percentage of RMS values, as selected by user.

I. Current and Voltage Ratings:

1. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
2. Withstand ratings shall be not less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
3. Designed for use with voltage inputs from standard instrument potential transformers with a 120-V secondary.

J. Accuracy:

1. Comply with ANSI C12.20, Class 0.5; and IEC 60687, Class 0.5 for revenue meters.
2. Accuracy from Light to Full Rating:

   a. Power: Accurate to 0.25 percent of reading, plus 0.025 percent of full scale.
   b. Voltage and Current: Accurate to 0.075 percent of reading, plus 0.025 percent of full scale.
   c. Power Factor: Plus or minus 0.002, from 0.5 leading to 0.5 lagging.
   d. Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.

K. Waveform Capture:

1. Capture and store steady-state waveforms of voltage and current channels; initiated manually. Each capture shall be for 3 cycles, 128 data points for each cycle, allowing resolution of harmonics to 31st harmonic of basic 60 Hz.
2. Store captured waveforms in internal nonvolatile memory; available for PC display, archiving, and analysis.

L. Input: One digital input signal(s).

1. Normal mode for on/off signal.
2. Demand interval synchronization pulse, accepting a demand synchronization pulse from a utility demand meter.
3. Conditional energy signal to control conditional energy accumulation.

M. Outputs:

1. Closed in either a momentary or latched mode as defined by user.
2. Each output relay used in a momentary contact mode shall have an independent timer that can be set by user.
3. Output Relay Control:

a. Relay outputs shall operate either by user command sent via communication link or in response to user-defined alarm or event.
b. Normally open and normally closed contacts, field configured to operate as follows:

1) Normal contact closure where contacts change state for as long as signal exists.
2) Latched mode when contacts change state on receipts of a pickup signal; changed state is held until a dropout signal is received.
3) Timed mode when contacts change state on receipt of a pickup signal; changed state is held for a preprogrammed duration.
4) End of power demand interval when relay operates as synchronization pulse for other devices.
5) Energy Pulse Output: Relay pulses quantities used for absolute kWh, absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
6) Output controlled by multiple alarms using Boolean-type logic.

N. Onboard Data Logging:

1. Store logged data, alarms, events, and waveforms in 80 KB of onboard nonvolatile memory.
2. Stored Data:
   a. Custom Data Logs: Three user-defined log(s) holding up to 96 parameters. Date and time stamp each entry to the second and include the following user definitions:

      1) Schedule interval.
      2) Event definition.
      3) Configured as "fill-and-hold" or "circular, first-in first-out."

   b. Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.
   c. Waveform Log: Store captured waveforms configured as "fill-and-hold" or "circular, first-in first-out."

3. Default values for all logs shall be initially set at factory, with logging to begin on device power up.

O. Alarms.

1. User Options:

   a. Define pickup, dropout, and delay.
   b. Assign one of four severity levels to make it easier for user to respond to the most important events first.
   c. Allow for combining up to four alarms using Boolean-type logic statements for outputting a single alarm.

2. Alarm Events:

   a. Over/undercurrent.
   b. Over/undervoltage.
   c. Current imbalance.
   d. Phase loss, current.
   e. Phase loss, voltage.
   f. Voltage imbalance.

g. Over kW demand.
h. Phase reversal.
i. Digital input off/on.
j. End of incremental energy interval.
k. End of demand interval.

P. Communications:

1. Communications shall be compatible with Energy Management System provided under Division 15.
2. Local plug-in connections shall be for RS-232 and 100 Base-T Ethernet.
3. In addition, power monitor shall be permanently connected to communicate via Modbus TCP via a 100 Base-T Ethernet.

Q. Display Monitor:

1. Backlighted LCD to display metered data with touch-pad selecting device.
2. Capable of displaying the following values:

a. Current, per phase RMS, three-phase average and neutral.
b. Voltage, phase to phase, phase to neutral, and three-phase averages of phase to phase and phase to neutral.
c. Real power, per phase and three-phase total.
d. Reactive power, per phase and three-phase total.
e. Apparent power, per phase and three-phase total.
f. Power factor, per phase and three-phase total.
g. Frequency.
h. Demand current, per phase and three-phase average.
i. Demand real power, three-phase total.
j. Accumulated energy (MWh and MVARh).
k. THD, current and voltage, per phase.

3. Reset: Allow reset of the following parameters at the display:

a. Peak demand current.
b. Peak demand power (kW) and peak demand apparent power (kVA).
c. Energy (MWh) and reactive energy (MVARh).

2.6 LOW-VOLTAGE WIRING

A. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.

1. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
2. Ordinary Switching Circuits: Three conductors, unless otherwise indicated.
3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors, unless otherwise indicated.

PART 3 - EXECUTION

3.1 CABLING

A. Comply with NECA 1.

B. Install cables and wiring according to requirements in Division 16 Section "Voice and Data Communication Cabling."

C. Wiring Method: Install wiring in raceway. Conceal raceway and wiring except in unfinished spaces.

D. Identify components and power and control wiring according to Division 16 Section "Electrical Identification."

E. Label each power monitoring and control module with a unique designation.

F. Grounding: Comply with IEEE 1100, "Power and Grounding Sensitive Electronic Equipment."

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Electrical Tests: Use caution when testing devices containing solid-state components.
2. Continuity tests of circuits.
3. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.

    a. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
    b. Test LANs according to requirements in Division 16 Section "Voice and Data Communication Cabling."
    c. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of calculated battery operating time.
    d. Verify accuracy of graphic screens and icons.
    e. Metering Test: Load feeders, measure loads on feeder conductor with an rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.

f. Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.

C. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

D. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

E. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

F. Remove and replace malfunctioning devices and circuits and retest as specified above.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems. Refer to Division 1 Section "Demonstration and Training."

1. Train Owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of 12 hours' training.
2. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

END OF SECTION 16215

SECTION 16231 - PACKAGED ENGINE GENERATOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes packaged engine-generator sets for **standby** power supply with the following features:

1. Diesel engine.
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.
4. Performance requirements for sensitive loads.
5. Outdoor enclosure.
6. Double wall, sub-base fuel tank.

B. Related Sections include the following:

1. Division 16 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. LP: Liquid petroleum.

1.4 SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.
2. Time-current characteristic curves for generator protective device.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: For installer, manufacturer, and testing agency.

D. Source quality-control test reports.

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

G. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within **200 miles (321 km)]** of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with ASME B15.1.

G. Comply with NFPA 37.

H. Comply with NFPA 70.

I. Comply with NFPA 99.

J. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

K. Comply with UL 2200.

L. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

M. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than seven <Insert number> days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without written permission.

B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 40 deg .
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to **1000 feet (300 m)**.

C. Unusual Service Conditions: Engine-generator equipment and installation are required to operate under the following conditions:

1. High salt-dust content in the air due to sea-spray evaporation.

1.7 COORDINATION

A. Coordinate size and location of bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 5 years from date of Substantial Completion.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Caterpillar; Engine Div.

2. Generac Power Systems, Inc.
3. Kohler Co.; Generator Division.
4. Onan/Cummins Power Generation; Industrial Business Group.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
2. Output Connections: Three-phase, four wire, reconnectable.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

E. Generator-Set Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

   a. Provide permanent magnet excitation for power source to voltage regulator.

10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: Grade DF-2 Diesel

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:

1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
3. Dual Natural Gas with LP-Gas Backup (Vapor-Withdrawal) System:

    a. Carburetor.
    b. Secondary Gas Regulators: One for each fuel type.
    c. Fuel-Shutoff Solenoid Valves: One for each fuel source.
    d. Flexible Fuel Connectors: One for each fuel source.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Electronic, adjustable isochronous, with speed sensing.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

    a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

I. Cooling System: Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump.

1. Configuration: Horizontal air discharge.
2. Radiator Core Tubes: Aluminum
3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
5. Fan: Driven by multiple belts from engine shaft
6. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

J. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 85 dBA or less.

K. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

L. Starting System: 12-V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times] without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

   a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
   b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
   c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
   d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
   e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
   f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:

1. Tank level indicator.
2. Capacity: Fuel for 72 hours' continuous operation at 100 percent rated power output.
3. Vandal-resistant fill cap.
4. Containment Provisions: Comply with requirements of authorities having jurisdiction.
5. Dual wall fire and ballistic rated.

2.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel features shall include the following:

1. Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
2. Current and Potential Transformers: Instrument accuracy class.

D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1system, and the following:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.

10. Fuel tank derangement alarm.
11. Fuel tank high-level shutdown of fuel supply alarm.
12. Generator overload.
13. Start-stop switch.
14. Overspeed shutdown device.
15. Coolant high-temperature shutdown device.
16. Coolant low-level shutdown device.
17. Oil low-pressure shutdown device.

E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

F. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for open protocol data-link transmission of indications to remote data terminals. Link shall be capatible with Energy Management System provided under Division 15.

G. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.
6. Engine high-temperature shutdown.
7. Lube-oil, low-pressure shutdown.
8. Overspeed shutdown.
9. Remote emergency-stop shutdown.
10. Engine high-temperature prealarm.
11. Lube-oil, low-pressure prealarm.
12. Fuel tank, low-fuel level.
13. Low coolant level.

H. Remote Alarm Annunciators: An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

I. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.

1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.

3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Generator Circuit Breaker: Insulated-case, electronic-trip type; 100 percent rated; complying with UL 489.

1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Three-phase, solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: 12 percent, maximum.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof aluminum housing, wind resistant up to 200 mph (322 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

B. Description: Prefabricated or pre-engineered walk-in enclosure with the following features:
1. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
2. Space Heater: Thermostatically controlled and sized to prevent condensation.
3. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
4. Hinged Doors: With padlocking provisions.
5. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
6. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
7. Muffler Location: Within enclosure.

C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

D. Interior Lights with Switch: Factory-wired, vapor-proof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

E. Convenience Outlets: Factory wired GFCI. Arrange for external electrical connection.

2.9 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.11 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with restrained spring isolators having a minimum deflection of **[1 inch (25 mm)]**. Secure sets to anchor bolts installed in bases.

D. Install Schedule 40, black steel piping with welded joints for cooling water piping between engine-generator set and heat exchanger. Piping materials and installation requirements are specified in Division 15 Section "Hydronic Piping."

E. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 15 Section "Hydronic Piping."

1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 15 Section "Hydronic Piping."

F. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 15 Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine-generator set and heat exchanger with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Connect fuel piping to engines with a gate valve and union and flexible connector.

1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems outside the building are specified in Division 2 Section "Fuel Oil Distribution."
2. Diesel fuel piping, valves, and specialties inside the building are specified in Division 15 Section "Fuel Oil Piping."
3. Natural- and LP-gas piping, valves, and specialties for gas distribution outside the building are specified in Division 2 Section "Natural Gas Distribution."
4. Natural- and LP-gas piping, valves, and specialties for gas piping inside the building are specified in Division 15 Section "Fuel Gas Piping."

F. Ground equipment according to Division 16 Section "Grounding and Bonding."

G. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 IDENTIFICATION

A. Identify system components according to Division 15 Section "Mechanical Identification" and Division 16 Section "Electrical Identification."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
c. Verify acceptance of charge for each element of the battery after discharge.
d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria.
8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

E. Coordinate tests with tests for transfer switches and run them concurrently.

F. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

G. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

H. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

I. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

J. Remove and replace malfunctioning units and retest as specified above.

K. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

L. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

M. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 16231

SECTION 16271 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of transformers with medium-voltage primaries:

1. Pad-mounted, liquid-filled transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.

B. Shop Drawings: Wiring and connection diagrams including power wiring.

C. Coordination Drawings: Floor plans drawn to scale and coordinating floor penetrations and floor-mounted items. Show the following:

1. Underground primary and secondary conduit stub-up location.
2. Dimensioned concrete base, outline of transformer, and required clearances.
3. Ground rod and grounding cable locations.

E. Qualification Data: For testing agency.

F. Source quality-control test reports.

G. Field quality-control test reports.

H. Follow-up service reports.

I. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C2.

E. Comply with ANSI C57.12.28, IEEE C57.12.10, IEEE C57.12.70, and IEEE C57.12.80.

F. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store transformers protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.6 PROJECT CONDITIONS

A. Service Conditions: IEEE C37.121, usual service conditions except for the following:

1. Exposure to significant solar radiation.
2. Exposure to fumes, vapors, or dust.
3. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
4. Exposure to excessively high or low temperatures.
5. Unusual grounding-resistance conditions.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Electric Corporation; Power Distribution Products Division.
2. Cooper Industries; Cooper Power Systems Division.
3. Cutler-Hammer.
4. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
5. GE Electrical Distribution & Control.
6. Hammond Manufacturing; Transformer Group.

7. Howard Industries.
8. Siemens Energy & Automation, Inc.
9. Square D/Groupe Schneider NA.
10. ABB

2.2 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

A. Description: ANSI C57.12.13, IEEE C57.12.00, IEEE C57.12.22 IEEE C57.12.26, pad-mounted, 2-winding transformers. Stainless-steel tank base cabinet, and sills.

B. Insulating Liquid: Less flammable, dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.

C. Insulation Temperature Rise: 65 deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.

D. Basic Impulse Level: 95 kV.

E. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

F. High-Voltage Switch: 200 A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for radial feed with 3-phase, 2-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.

G. Primary Fuses: 150-kV fuse assembly with fuses complying with IEEE C37.47. Rating of current-limiting fuses shall be 50-kA RMS at specified system voltage.

1. Current-limiting type in dry-fuse holder wells, mechanically interlocked with liquid-immersed switch in transformer tank to prevent disconnect under load.
2. Bay-O-Net liquid-immersed fuses in series with liquid-immersed current-limiting fuses. Bay-O-Net fuses shall be externally replaceable without opening transformer tank.
3. Bay-O-Net liquid-immersed current-limiting fuses that are externally replaceable without opening transformer tank.

H. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; support from tank wall within high-voltage compartment. Transformers shall have three arresters for radial-feed circuits.

I. High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:

1. Bushing-Well Inserts: One for each high-voltage bushing well.
2. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.
3. Parking Stands: One for each high-voltage bushing well.
4. Portable Insulated Bushings: Arranged for parking insulated, high-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.

J. Accessories:

1. Drain Valve: 1 inch (25 mm), with sampling device.
2. Dial-type thermometer.
3. Liquid-level gage.
4. Pressure-vacuum gage.
5. Pressure Relief Device: Self-sealing with an indicator.
6. Mounting provisions for low-voltage current transformers.
7. Mounting provisions for low-voltage potential transformers.
8. Busway terminal connection at low-voltage compartment.
9. Alarm contacts for gages and thermometer listed above.
10. Secondary circuit breaker.

2.5 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 16 Section Electrical Identification.

2.7 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components.

B. Factory Tests: Perform the following factory-certified tests on each transformer:

1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
2. Ratios on rated-voltage connection and on tap extreme connections.
3. Polarity and phase relation on rated-voltage connection.
4. No-load loss at rated voltage on rated-voltage connection.
5. Excitation current at rated voltage on rated-voltage connection.
6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
7. Applied potential.
8. Induced potential.
9. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class OA/FA or Class AA/FA rating.

    a. Temperature test is not required if record of temperature test on an essentially duplicate unit is available.

10. Owner will witness all required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and that requirements in Division 16 Section "Grounding and Bonding" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers on concrete bases.

1. Anchor transformers to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 16 Section "Seismic Controls for Electrical Work."
2. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and 4 inches (100 mm) high.
3. Use **3000-psi (20.7-MPa)** 28-day compressive-strength concrete and reinforcement.
4. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
5. Install epoxy-coated anchor bolts, for supported equipment, that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Tack-weld or bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 16 Section Electrical Identification.

3.4 CONNECTIONS

A. Ground equipment according to Division 16 Section "Grounding and Bonding."

B. Connect wiring according to Division 16 Section "Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

D. Perform the following field tests and inspections and prepare test reports:

1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.2. Certify compliance with test parameters.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Remove malfunctioning units, replace with new units, and retest as specified above.

F. Test Reports: Prepare written reports to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: If requested by Owner, perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:

   a. Adjust transformer taps.
   b. Prepare written request for voltage adjustment by electric utility.

3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.
4. Report: Prepare written report covering monitoring and corrective actions performed.

B. Infrared Scanning: Perform as specified in Division 16 Section "Medium-Voltage Switchgear."

END OF SECTION 16271

SECTION 16289 - TRANSIENT VOLTAGE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes TVSSs for low-voltage power equipment.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.

B. Field quality-control test reports.

C. Operation and Maintenance Data.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."

D. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."

E. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Transient Voltage Surge Suppressors."

1.4 PROJECT CONDITIONS

A. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet (6090 m) above sea level.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cutler-Hammer, Inc.; Eaton Corporation.
2. General Electric Company.
3. Siemens Energy & Automation, Inc.
4. Square D; Schneider Electric.

2.2 SERVICE ENTRANCE SUPPRESSORS

A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:

1. LED indicator lights for power and protection status.
2. Audible alarm, with silencing switch, to indicate when protection has failed.
3. Fuses, rated at 200-kA interrupting capacity.
4. Integral disconnect switch.
5. Redundant suppression circuits.
6. Surge-event operations counter.

B. Peak Single-Impulse Surge Current Rating: 320 kA per phase.

C. Connection Means: Integral, permanently wired.

D. Protection modes and UL 1449 suppressed voltage rating for grounded wye circuits with voltages of 480Y/277 and 208Y/120, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 800 V for 480Y/277 and 400 V for 208Y/120.
2. Line to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.
3. Neutral to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.

2.3 PANELBOARD SUPPRESSORS

A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:

1. LED indicator lights for power and protection status.
2. Audible alarm, with silencing switch, to indicate when protection has failed.
3. Fuses, rated at 200-kA interrupting capacity.
4. Integral disconnect switch.
5. Redundant suppression circuits.
6. Surge-event operations counter.

B. Peak Single-Impulse Surge Current Rating: 120 kA per phase.

C. Connection Means: Bus-connected

D. Protection modes and UL 1449 suppressed voltage rating for grounded wye circuits with voltages of 480Y/277 and 208Y/120, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 800 V for 480Y/277 and 400 V for 208Y/120.
2. Line to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.
3. Neutral to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.

2.4 SUPPRESSORS FOR ELECTRONIC-GRADE PANELBOARDS

A. Surge Protection Device Description: Sine-wave-tracking type, panel-mounted design with the following features and accessories:

1. LED indicator lights for power and protection status.
2. Audible alarm, with silencing switch, to indicate when protection has failed.
3. Arrangement with wire connections to phase buses, neutral bus, and ground bus.

B. Peak Single-Impulse Surge Current Rating: 160 kA per phase.

C. Connection Means: Bus Connected

D. Protection modes and UL 1449 suppressed voltage rating for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 400 V for 208Y/120.
2. Line to Ground: 400 V for 208Y/120.
3. Neutral to Ground: 400 V for 208Y/120.

2.5 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTION DEVICES

A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install devices for panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide multipole, 60-A circuit breaker as a dedicated disconnect for suppressor, unless otherwise indicated.

3.2 PLACING SYSTEM INTO SERVICE

A. Do not energize or connect service entrance equipment, panelboards, or data terminals to their sources until surge protection devices are installed and connected.

3.3 FIELD QUALITY CONTROL

A. Testing: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports:

B. Testing: Perform the following field tests and inspections and prepare test reports:

1. Complete startup checks according to manufacturer's written instructions.
2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.

END OF SECTION 16289

SECTION 16410 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following individually mounted, enclosed switches and circuit breakers:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers.
4. Enclosures.

1.2 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider.

B. Fusible Switch, 1200 A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Nonfusible Switch, 1200 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Moeller Electric Corporation.
4. Siemens Energy & Automation, Inc.
5. Square D/Group Schneider.

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.
4. GFCI Circuit Breakers: Single- and two-pole configurations with **[5]** **[30]**-mA trip sensitivity.

C. Molded-Case Circuit-Breaker Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
4. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
   1. Outdoor and other Wet or Damp Indoor Locations: NEMA 250, Type 4X stainless steel

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

C. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section Electrical Identification.

3.2 FIELD QUALITY CONTROL

A. Prepare for acceptance testing as follows:

   1. Inspect mechanical and electrical connections.
   2. Verify switch and relay type and labeling verification.
   3. Verify rating of installed fuses.

B. Perform the following field tests and inspections and prepare test reports:

   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION 16410

SECTION 16415 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes automatic transfer switches rated 600 V and less.

1.2 SUBMITTALS

A. Product Data: Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 70.

D. Comply with NFPA 99.

E. Comply with NFPA 110.

F. Comply with UL 1008 unless requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Contactor Transfer Switches:
   a. Caterpillar; Engine Div.

b. Emerson; ASCO Power Technologies, LP.
c. Generac Power Systems, Inc.
d. GE Zenith Controls.
e. Kohler Power Systems; Generator Division.
f. Onan/Cummins Power Generation; Industrial Business Group.

2. Transfer Switches Using Molded-Case Switches or Circuit Breakers:

a. AC Data Systems, Inc.
b. Eaton Electrical Inc.; Cutler-Hammer.
c. GE Zenith Controls.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

I. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

J. Enclosures: General-purpose NEMA 250, Type 1 (indoors) and Type 3R (outdoors), complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw, center-off, programmed transition type, unless otherwise indicated.

C. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

D. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

E. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase.

F. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated.

G. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer.

H. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support.

B. Identify components according to Division 16 Section "Electrical Identification."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Ground equipment according to Division 16 Section "Grounding and Bonding."

B. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
    f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

    a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 1 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 16415

SECTION 16441 – SWITCHBOARDS AND DISTRIBUTION BOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes service and distribution switchboards rated 600 V and less.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. RFI: Radio-frequency interference.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

   a. Enclosure types and details for types other than NEMA 250, Type 1.
   b. Bus configuration, current, and voltage ratings.
   c. Short-circuit current rating of switchboards and overcurrent protective devices.
   d. Descriptive documentation of optional barriers specified for electrical insulation and isolation.
   e. Utility company's metering provisions with indication of approval by utility company.
   f. Mimic-bus diagram.
   g. UL listing for series rating of installed devices.

h. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Samples: Representative portion of mimic bus with specified finish, for color selection.

D. Qualification Data: For testing agency.

E. Field quality-control test reports including the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

C. Source Limitations: Obtain switchboards through one source from a single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with NEMA PB 2, "Deadfront Distribution Switchboards."

G. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections or lengths that can be moved past obstructions in delivery path.

B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchboards; install electric heating (250 W per section) to prevent condensation.

D. Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.7 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2000 m).

C. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without written permission.

1.8 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Potential Transformer Fuses: Equal to 10 percent of amount installed for each size and type, but no fewer than 2 of each size and type.
2. Control-Power Fuses: Equal to 10 percent of amount installed for each size and type, but no fewer than 2 of each size and type.
3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.
4. Fuses for Fused Switches: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.
6. Indicating Lights: Equal to 10 percent of amount installed for each size and type, but no fewer than 1 of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 MANUFACTURED UNITS

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Protection Div.
3. Siemens Energy & Automation, Inc.
4. Square D.

B. Front-Connected, Front-Accessible Switchboard: Fixed, individually mounted main device, panel-mounted branches, and sections rear aligned.

C. Enclosure: Steel, NEMA 250, Type 1 (indoors) and type 3R (outdoors).

D. Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer's standard color, undersurfaces treated with corrosion-resistant undercoating.

E. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

F. Barriers: Between adjacent switchboard sections.

G. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

H. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
2. Space-Heater Power Source: Transformer, factory installed in switchboard.

I. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

J. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Set back from front to clear circuit-breaker removal mechanism.
3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

K. Buses and Connections: Three phase, four wire, unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.

2. Load Terminals: Insulated, rigidly braced, silver-plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full ampere rating of circuit-breaker position.
3. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
4. Contact Surfaces of Buses: Silver plated.
5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
7. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

L. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

M. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating: 105 deg C.

2.3 TRANSIENT VOLTAGE SUPPRESSION DEVICES

A. IEEE C62.41, integrally mounted, plug-in-style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules.

B. Minimum single-impulse current rating shall be as follows:

1. Line to Neutral: 100,000 A.
2. Line to Ground: 100,000 A.
3. Neutral to Ground: 50,000 A.

C. Protection modes shall be as follows:

1. Line to neutral.
2. Line to ground.
3. Neutral to ground.

D. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.

E. Maximum Category C combination wave clamping voltage shall not exceed 1000 V, line to neutral and line to ground on 277/480 V systems.

F. Maximum UL 1449 clamping levels shall not exceed 800 V, line to neutral and line to ground on 277/480 V systems.

G. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.

H. Accessories:

1. Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.
2. Audible alarm activated on failure of any surge diversion module.
3. Six-digit transient-counter set to total transient surges that deviate from the sine-wave envelope by more than 125 V.

2.4 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:

a. Instantaneous trip.
b. Long- and short-time pickup levels.
c. Long- and short-time time adjustments.

d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and two-pole configurations with **[5]** [**30**]-mA trip sensitivity.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
4. Communication Capability: Integral communication module with functions and features compatible with energy managment system, specified in Division 15
5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
7. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
9. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

C. Enclosed, Insulated-Case Circuit Breaker: Fully rated, encased-power circuit breaker with interrupting capacity rating to meet available fault current.

1. Draw-out circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Microprocessor-based trip units with interchangeable rating plug, LED trip indicators, and the following field-adjustable settings:

   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments with I^2t response.
   d. Ground-fault pickup level, time delay, and I^2t response.

4. Remote trip indication and control.
5. Communication Capability: Integral communication module with functions and features compatible with energy management system specified in Division 15.
6. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
7. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
8. Control Voltage: 125-V, ac.

D. High-Pressure, Butt-Type Contact Switch: Operating mechanism uses butt-type contacts and a spring-charged mechanism to produce and maintain high-pressure contact when switch is closed.

2.5 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.
4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondaries to ground overcurrent relays to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 1 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d. Megawatts: Plus or minus 2 percent.
e. Megavars: Plus or minus 2 percent.
f. Power Factor: Plus or minus 2 percent.
g. Frequency: Plus or minus 0.5 percent.
h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Ammeters, Voltmeters, and Power-Factor Meters: ANSI C39.1.

1. Meters: 4-inch (100-mm) diameter or 6 inches (150 mm) square, flush or semiflush, with antiparallax 250-degree scales and external zero adjustment.
2. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.

D. Instrument Switches: Rotary type with off position.

1. Voltmeter Switches: Permit reading of all phase-to-phase voltages and, where a neutral is indicated, phase-to-neutral voltages.
2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.

E. Feeder Ammeters: 2-1/2-inch- (64-mm-) minimum size with 90- or 120-degree scale. Meter and transfer device with an off position, located on overcurrent device door for indicated feeder circuits only.

F. Watt-Hour Meters: Flush or semiflush type, rated 5 A, 120 V, 3 phase, 3 wire, with 3 elements, 15-minute-indicating-demand register, and provision for testing and adding pulse initiation.

G. Recording Demand Meter: Usable as totalizing relay or as indicating and recording maximum-demand meter with 15-minute interval. Meter shall count and control a succession of pulses entering two channels. House in drawout, back-connected case arranged for semiflush mounting.

2.6 CONTROL POWER

A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.

B. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Furnish one portable, floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

D. Furnish overhead circuit-breaker lifting device, mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

E. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

F. Fungus Proofing: Permanent fungicidal treatment for switchboard interior, including instruments and instrument transformers.

2.8 IDENTIFICATION

A. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

B. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

PART 3 - EXECUTION

3.1 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.2 EXAMINATION

A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.

B. Install and anchor switchboards level on concrete bases, 4-inch (100-mm) nominal thickness. Concrete base is specified in Division 16 Section "Electrical Supports and Seismic Restraints," and concrete materials and installation requirements are specified in Division 3.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For switchboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

F. Install spare-fuse cabinet.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."

B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

C. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
    c. Instruments, Equipment, and Reports:

        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
        2) Prepare a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 16441

SECTION 16442 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

1.2 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

    a. Enclosure types and details for types other than NEMA 250, Type 1.
    b. Bus configuration, current, and voltage ratings.
    c. Short-circuit current rating of panelboards and overcurrent protective devices.
    d. UL listing for series rating of installed devices.
    e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.
3. Field quality-control test reports.
4. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:

a. Eaton Corporation; Cutler-Hammer Products.
b. General Electric Co.; Electrical Distribution & Protection Div.
c. Siemens Energy & Automation, Inc.
d. Square D.

2.2 MANUFACTURED UNITS

A. Enclosures: Surface mounted cabinets. NEMA PB 1, Type 1.

1. Rated for environmental conditions at installed location.
a. Outdoor, Wet or Damp Indoor Locations: NEMA 250, Type 4X Stainless Steel

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

B. Phase and Ground Buses: Hard-drawn copper, 98 percent conductivity.

C. Conductor Connectors: Suitable for use with conductor material.

1. Ground Lugs and Bus Configured Terminators: Compression type.

D. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

F. Panelboard Short-Circuit Rating:

1. UL label indicating series-connected rating with integral or remote upstream overcurrent protective devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.
2. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.3 DISTRIBUTION PANELBOARDS

A. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.

B. Main Overcurrent Protective Devices: Circuit breaker.

C. Branch Overcurrent Protective Devices:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
3. Fused switches.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. GFCI Circuit Breakers: Single- and two-pole configurations with 30-mA trip sensitivity.
3. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

    a. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    b. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
    c. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

C. Fuses are specified in Division 16 Section "Fuses."

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Furnish portable test set to test functions of solid-state trip devices without removal from panelboard.

C. Fungus Proofing: Permanent fungicidal treatment for panelboard interior, including overcurrent protective devices and other components.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mount top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.

C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Install overcurrent protective devices and controllers.

1. Set field-adjustable switches and circuit-breaker trip ranges.

E. Install filler plates in unused spaces.

F. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

G. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section Electrical Identification.

H. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

I. Ground equipment according to Division 16 Section "Grounding and Bonding."

J. Connect wiring according to Division 16 Section "Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION 16442

SECTION 16461 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

1.2 SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Indicate dimensions and weights.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Division 16 Section "Electrical Supports and Seismic Restraints."

D. Field quality-control test reports.

E. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ACME Electric Corporation; Power Distribution Products Division.

2. Eaton Electrical Inc.; Cutler-Hammer Products.
3. General Electric Company.
4. Siemens Energy & Automation, Inc.
5. Square D; Schneider Electric.
6. Powersmiths
7. MIRUS International, Inc.
8. Liebert

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Division 16 Section "Electrical Supports and Seismic Restraints."

C. Cores: Three phase, common core construction.

D. Enclosure: Ventilated NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: ANSI 61 gray.

F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of **115** deg C rise above 40 deg C ambient temperature.

I. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.
3. 98% minimum.

J. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance. Transformers shall be double shielded with a minimum common mode noise attenuation of 120dB

K. Phase Shift: 0 degrees

L. Neutral Bus: 200% of rated secondary phase current.

M. Treatment of triplen (3rd, 9th, and 15th) harmonic load currents: Secondary winding configuration must cancel fluxes due to zero sequence harmonic currents without coupling them to the primary winding.

N. Transformer shall support non-linear loads with a K-factor up to 20 and a crest factor up to 4.5.

O. Low-Sound-Level Requirements: Maximum sound level, when factory tested according to IEEE C57.12.91, of 50 dBA.

P. Wall and Ceiling Brackets: Manufacturer's standard brackets.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate. Nameplates are specified in Division 16 Section "Electrical Identification."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Brace wall-mounting transformers as specified in Division 16 Section "Electrical Supports and Seismic Restraints."

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

a. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
b. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
c. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

3.3 ADJUSTING

A. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION 16461

SECTION 16511 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.
5. Retrofit kits for fluorescent lighting fixtures.

B. Related Sections include the following:

1. Division 13 Section "Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
2. Division 16 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
3. Division 16 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
4. Division 16 Section "Stage Lighting" for theatrical lighting fixtures and their controls.
5. Division 16 Section "Dimming Controls" for architectural dimming systems.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. HID: High-intensity discharge.

E. LER: Luminaire efficacy rating.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

G. RCR: Room cavity ratio.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast.
4. Energy-efficiency data.
5. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Submittals" Article in Division 15 Section "Diffusers, Registers, and Grilles."
6. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 15 Section "Diffusers, Registers, and Grilles."
7. Life, output, and energy-efficiency data for lamps.
8. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

    a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
    b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.

1. Wiring Diagrams: Power and control wiring.

C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Lighting fixtures.
2. Suspended ceiling components.
3. Structural members to which suspension systems for lighting fixtures will be attached.
4. Other items in finished ceiling including the following:

    a. Air outlets and inlets.
    b. Speakers.
    c. Sprinklers.
    d. Smoke and fire detectors.
    e. Occupancy sensors.
    f. Access panels.

5. Perimeter moldings.

D. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:

1. Lamps: Specified units installed.
2. Accessories: Cords and plugs.

E. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

F. Qualification Data: For agencies providing photometric data for lighting fixtures.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

I. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

E. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of fixtures for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.
2. Warranty Period for Electromagnetic Ballasts: Three years from date of Substantial Completion.

C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Two year(s) from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
3. Battery and Charger Data: One for each emergency lighting unit.
4. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Basis-of-Design Product: The design for each lighting fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

I. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

a. Lens Thickness: At least **0.125 inch (3.175 mm)** minimum unless different thickness is indicated.
b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

J. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

K. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 15 Section "Diffusers, Registers, and Grilles."

1. Air Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
2. Heat Removal Units: Air path leads through lamp cavity.
3. Combination Heat Removal and Air Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air supply units.
4. Dampers: Operable from outside fixture for control of return-air volume.
5. Static Fixture: Air supply slots are blanked off, and fixture appearance matches active units.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. Electronic Ballasts: Comply with ANSI C82.11; instant or programmed-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.

1. Sound Rating: A.
2. Total Harmonic Distortion Rating: Less than 10 percent.
3. Transient Voltage Protection: IEEE C62.41, Category A or better.
4. Lamp Current Crest Factor: 1.7 or less.
5. BF: 0.95 or higher.
6. Power Factor: 0.95 or higher.
7. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Electronic Programmed-Start Ballasts for 5 and T5HO Lamps: Comply with ANSI C82.11 and the following:

1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: A.
4. Total Harmonic Distortion Rating: Less than 10 percent.
5. Transient Voltage Protection: IEEE C62.41, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher, unless otherwise indicated.
9. Power Factor: 0.95 or higher.

C. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.

1. Ballast Manufacturer Certification: Indicated by label.

D. Ballasts for Low-Temperature Environments:

1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic or electromagnetic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.

E. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.

F. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 5 percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 20 percent of normal.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

G. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.

1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.

   a. High-Level Operation: 100 percent of rated lamp lumens.
   b. Low-Level Operation: 50 percent of rated lamp lumens.

2. Ballast shall provide equal current to each lamp in each operating mode.
3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: A.
4. Total Harmonic Distortion Rating: Less than 10 percent.
5. Transient Voltage Protection: IEEE C62.41, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher, unless otherwise indicated.
9. Power Factor: 0.95 or higher.
10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
11. Ballast Case Temperature: 75 deg C, maximum.

B. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 5 percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 20 percent of normal.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

2.5 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate fluorescent lamp(s) continuously at an output of **1200** lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.

2. Night-Light Connection: Operate fluorescent lamps continuously.
3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.6 BALLASTS FOR HID LAMPS

A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single-lamp ballasts.
3. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
4. Open-circuit operation that will not reduce average life.
5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Sound Rating: A.
3. Total Harmonic Distortion Rating: Less than 15 percent.
4. Transient Voltage Protection: IEEE C62.41, Category A or better.
5. Lamp Current Crest Factor: 1.5 or less.
6. Power Factor: .90 or higher.
7. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
8. Protection: Class P thermal cutout.
9. Retain subparagraph and associated subparagraphs below for bi-level ballasts.
10. Bi-Level Dimming Ballast: Ballast circuit and leads provide for remote control of the light output of the associated fixture between high- and low-level and off.

    a. High-Level Operation: 100 percent of rated lamp lumens.
    b. Low-Level Operation: 50 percent of rated lamp lumens.
    c. Compatibility: Certified by ballast manufacturer for use with specific bi-level control system and lamp type indicated. Certified by lamp manufacturer that ballast

operating modes are free from negative effect on lamp life and color-rendering capability.

11. Continuous Dimming Ballast: Dimming range shall be from 100 to 35 percent of rated lamp lumens without flicker.

    a. Ballast Input Watts: Reduced to a maximum of 50 percent of normal at lowest dimming setting.
    b. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.

C. Auxiliary Instant-On Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent light output.

2.7 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
   1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
   2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

      a. Battery: Sealed, maintenance-free, nickel-cadmium type.
      b. Charger: Fully automatic, solid-state type with sealed transfer relay.
      c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
      d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
      f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
      g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.8 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

   1. Battery: Sealed, maintenance-free, lead-acid type.

2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.9 FLUORESCENT LAMPS

A. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

B. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours, unless otherwise indicated.

C. T5 rapid-start low-mercury lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.

D. T5HO rapid-start, high-output low-mercury lamps, rated 54 W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.

E. Compact Fluorescent Lamps: 4-Pin, low mercury, CRI 85 (minimum), color temperature 3000 K, average rated life of 10,000 hours at 3 hours operation per start, and suitable for use with dimming ballasts, unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

2.10 HID LAMPS

A. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65 and color temperature 4000 K.

B. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.

C. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80 and color temperature 4000 K.

2.11 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

B. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, **12 gage (2.68 mm).**

D. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, **12 gage (2.68 mm).**

E. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.12 RETROFIT KITS FOR FLUORESCENT LIGHTING FIXTURES

A. Comply with UL 1598 listing requirements.

1. Reflector Kit: UL 1598, Type I. Suitable for two- to four-lamp, surface-mounted or recessed lighting fixtures by improving reflectivity of fixture surfaces.
2. Ballast and Lamp Change Kit: UL 1598, Type II. Suitable for changing existing ballast, lamps, and sockets.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.

1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.

4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

E. Adjust aimable lighting fixtures to provide required light intensities.

F. Connect wiring according to Division 16 Section "Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 16511

SECTION 16521 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Exterior luminaires with lamps and ballasts.
2. Luminaire-mounted photoelectric relays.
3. Poles and accessories.

B. See Division 16 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.2 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports and supporting structure, applied as stated in AASHTO LTS-4.

B. Ice Load: Load of 3 lbf/sq. ft. (143.6 Pa), applied as stated in AASHTO LTS-4.

C. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.

1. Wind speed for calculating wind load for poles 50 feet (15 m) or less in height is **130 mph (209 km/h)**.

1.3 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.

B. Shop Drawings: Include anchor-bolt templates keyed to specific poles and certified by manufacturer.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

B. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by another manufacturer.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Steel Luminaires: Color as selected by Architect. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

N. Factory-Applied Finish for Aluminum Luminaires: Color shall be black. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.

1. Relay with locking-type receptacle shall comply with NEMA C136.10.
2. Adjustable window slide for adjusting on-off set points.

2.4 FLUORESCENT BALLASTS AND LAMPS

A. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures **0 deg F (minus 18 deg C)** and higher.

B. Ballast Characteristics:

1. Power Factor: 90 percent, minimum.
2. Sound Rating: A.
3. Total Harmonic Distortion Rating: Less than 10 percent.
4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
6. Transient-Voltage Protection: Comply with IEEE C62.41 Category A or better.

C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures **0 deg F (minus 18 deg C)** and higher.

D. Fluorescent Lamps: Low-mercury type. Comply with the EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

2.5 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction average life. Include the following features, unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).
3. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

2.6 HID LAMPS

A. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65 and color temperature 4000 K.

B. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.

C. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80 , and color temperature 4000 K.

2.7 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-4.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.8 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); 1-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.

1. Shape: Round, tapered or straight.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole and bracket, then bolted together with stainless steel bolts.
2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch (381-mm) vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet (3 m) above finished grade.

F. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 16 Section "Grounding and Bonding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

G. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

H. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

I. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.

J. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Color shall be as selected by Architect.

2.9 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.

B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

C. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 16 Section "Grounding and Bonding," listed for attaching grounding

and bonding conductors of type and size listed in that Section, and accessible through handhole.

D. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
2. Finish: Same as pole and luminaire.

E. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

F. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Color shall black.

2.10 POLE ACCESSORIES

A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 16 Section "Wiring Devices" for ground-fault circuit-interrupter type.

1. Recessed, [**12 inches (300 mm)**] above pole base.
2. Nonmetallic polycarbonate plastic or reinforced fiberglass cover that when mounted results in NEMA 250, Type 4X enclosure.
3. With cord opening.
4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.

B. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.

C. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

3.2 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: **[60 inches (1520 mm)]**.
2. Water, Gas, Electric, Communication, and Sewer Lines: **[10 feet (3 m)]**.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 3 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
3. Install base covers, unless otherwise indicated.
4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.

F. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top **[4 inches (100 mm)]** above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top **[4 inches (100 mm)]** above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 16 Section "Raceways and Boxes." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

A. Ground metal poles and support structures according to Division 16 Section "Grounding and Bonding."

1. Install grounding electrode for each pole, unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 16 Section "Grounding and Bonding."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundations.

END OF SECTION 16521

SECTION 16570 - DIMMING CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Manual, modular dimming controls.
2. Integrated, multipreset, modular dimming controls.
3. Multichannel, remote-controlled dimmers.
4. Remote-controlled dimming stations.
5. Manual switches and plates.

B. Related Sections include the following:

1. Division 16 Section "Wiring Devices" for wall-box dimmers and manual light switches.
2. Division 16 Section "Lighting Control Devices" for time switches, photoelectric switches, occupancy sensors, and multipole contactors.

1.3 DEFINITIONS

A. Channel: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a "zone."

B. Fade:

1. Fade Override: The ability to temporarily set fade times to zero for all lighting scenes.
2. Fade Rate: The time it takes each channel to arrive at the next scene, depending on the degree of change in lighting level.
3. Fade Time: The time it takes a channel to fade from one lighting scene to another.

C. LED: Light-emitting diode.

D. NRTL: Nationally recognized testing laboratory.

E. Scene: The lighting effect created by adjusting several channels of lighting to the desired intensity.

F. Wall-Box Dimmer: A self-contained dimmer that fits into a switch box.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

1. For dimming controls, include dimensions, features, characteristics, and ratings.
2. Device plates and plate color and material.
3. Ballasts and lamp combinations compatible with dimmer controls.
4. Sound data including results of operational tests of dimming controls.
5. Operational documentation for software and firmware.

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.

1. Include elevation views of front panels of control and indicating devices and control stations.
2. Wiring Diagrams: Power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes and technical features for flush-mounting, dimming control station faceplates.

D. Samples for Verification: Manufacturer's standard sizes for flush-mounting, dimming control station faceplates.

E. Operation and Maintenance Data: For dimming controls with remote-mounting dimmers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:

1. Software manuals.
2. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
3. Operation of adjustable zone controls.
4. Testing and adjusting of panic and emergency power features.

F. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain dimming controls from a single source with total responsibility for compatibility of lighting control system components specified in this Section, and in Division 16 Section "Lighting Control Devices."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

D. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate features of devices specified in this Section with systems and components specified in other Sections to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions. Include coordination with the following:
   1. Division 16 Section "Lighting Control Devices."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of dimming controls that fail in materials or workmanship within specified warranty period.

   1. Failures include, but are not limited to, the following:

      a. Damage from transient voltage surges.

   2. Warranty Period: Cost to repair or replace any parts for five years from date of Substantial Completion.
   3. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for ten years, that failed in service due to transient voltage surges.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Dimmer Modules: Full-size units equal to 5 percent of amount installed for each size indicated, but no fewer than 5 units.
   2. Fuses: Equal to 3 percent of amount installed for each size installed, but no fewer than three.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 GENERAL DIMMING DEVICE REQUIREMENTS

A. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state dimmers and control panels.

1. Alternative Line-Voltage Surge Suppression: Field-mounting surge suppressors that complies with UL 1449 and with IEEE C62.41, for Category A locations.

B. Compatibility: Dimming control components shall be compatible with other elements of lighting fixture types, ballasts, transformers, and lighting controls.

C. Dimmers and Dimmer Modules: Comply with UL 508.

1. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
2. Dimmer or Dimmer-Module Rating: As indicated, but not less than 125 percent of connected load.

D. Panic Switch: Include where indicated or required by authorities having jurisdiction. Switch operation overrides dimmer settings and restores lights on connected output circuits to full brightness regardless of settings.

2.3 MANUAL, MODULAR DIMMING CONTROLS

A. Manufacturers:
1. Leviton Mfg. Company, Inc.
2. Lightolier Controls; a Genlyte Company.
3. Lithonia Lighting.
4. Lutron Electronics Co., Inc.
5. The Watt Stopper

B. Description: Factory-fabricated equipment providing manual dimming control consisting of a wall-box mounted master station and indicated number of wall-box remote stations. Integrate controls and dimmers for mounting in one-, two-, or three-gang wall box under a single wall plate.

1. Surge Suppression: Factory-installed, line-voltage suppression for master station.
2. Device Plate: Style, material, and color shall comply with Division 16 Section "Wiring Devices.

C. Fluorescent Dimmer: Suitable for operating electronic ballasts specified with the lighting fixtures.

1. Master Station:

a. Class 1, low-voltage controls.
b. Manual intensity-control slider ranging from instant on, to a set lighting level, to off.
c. Preset Switch: On position turns master station to its set lighting level, and off position turns master station off.
d. LED indicator that is lighted when off.

2. Remote Station Switch: On position turns master station to its set lighting level, and off position turns master station off.

D. Incandescent Dimmer: Suitable for controlling incandescent lamps at line voltage.

1. Master Station:

   a. Push button for on and off, manual intensity-control slider ranging from off to a set lighting level.
   b. Preset Switch: On position turns master station to its set lighting level, and off position turns master station off.
   c. LED indicator that is lighted when off.

2. Remote Station Switch: On position turns master station to its set lighting level, and off position turns master station off.

E. Dimmers for Transformer-Based Lighting: Suitable for controlling low-voltage, neon, cold-cathode, incandescent, or quartz-halogen lighting.

1. Master Station: For controlling primaries of transformers.

   a. Line-voltage controls.
   b. Manual intensity-control slider ranging from instant on, to a set lighting level, to off.
   c. Preset Switch: On position turns master station to its set lighting level, and off position turns master station off.
   d. LED indicator that is lighted when off.

2. Remote Station Switch: On position turns master station to its set lighting level, and off position turns master station off.

2.4 INTEGRATED, MULTIPRESET, MODULAR DIMMING CONTROLS

A. Manufacturers:
1. Leviton Mfg. Company, Inc.
2. Lightolier Controls; a Genlyte Company.
3. Lithonia Lighting.
4. Lutron Electronics Co., Inc.
5. Strand Lighting.
6. The Watt Stopper

B. Description: Microprocessor-based, solid-state controls.

1. Operation: Automatically changes variable dimmer settings of indicated number of channels simultaneously from one preset scene to another when a push button is operated.
2. Each system includes a master control and remote controls.
3. Each channel shall be configurable to control the following:

   a. Fluorescent lamps with electronic ballasts.
   b. Incandescent lamps.
   c. Low-voltage incandescent lamps.

4. Memory: Retain presets and fade settings through power failures for at least seven days by retaining physical settings of controls or by an on-board, automatically recharged battery.

C. Master Station: Contains control panel and indicated number of control and dimmer modules.

1. Controls and commands for adjustment of each dimmer-channel setting for each scene change from one preset scene to another.

    a. Master channel raises and lowers lighting level.
    b. Adjustable fade rate for each scene from zero fade to one hour.

2. Rear illuminate all scene-select buttons.
3. Show lighting-level setting and fade-rate setting graphically using LEDs or backlighted bar- graph indicator.
4. Mounting: Single, flush-mounting wall box with manufacturer's standard faceplate.

D. Remote-Control Stations:

1. Numbered push buttons to select scenes.
2. Off switch to turn master station off.
3. On switch turns all scenes of master station to full bright.
4. Control Wiring: NFPA 70, Class 1 or 2.
5. Mounting: Single, flush-mounting wall box with manufacturer's standard faceplate.

2.5 MULTICHANNEL, REMOTE-CONTROLLED DIMMERS

A. Manufacturers:
1. Leviton Mfg. Company, Inc.
2. Lightolier Controls; a Genlyte Company.
3. Lithonia Lighting.
4. Lutron Electronics Co., Inc.
5. Strand Lighting.
6. The Watt Stopper

B. Description: Microprocessor-based, solid-state controls.

1. System shall consist of control stations and a separately mounted dimmer cabinet.
2. Operation: Automatically changes variable dimmer settings of indicated number of channels simultaneously from one preset scene to another when a push button is operated.
3. Each system shall include a master control and remote controls.
4. Each channel shall be configurable to control the following:

    a. Fluorescent lamps with electronic ballasts.
    b. Incandescent lamps.
    c. Low-voltage incandescent lamps.

5. Memory: Retain presets and fade settings through power failures for at least 90 days by retaining physical settings of controls or by an on-board, automatically recharged battery.

C. Master Digital Network Control Station:

1. Controls and commands for adjustment of each dimmer-channel setting for each scene change from one preset scene to another.

    a. Master channel raises and lowers lighting level.
    b. Adjustable fade rate for each scene from zero fade to one hour.

c. On and off scene controls for non-dim channel contactors.
d. Emergency control push button to bypass all controls, turning all dimmers to full bright and turn on non-dim channel contactors.
e. Master on and off switch; off position enables housekeeping controls.
f. Housekeeping controls to turn on selected lighting fixtures for housekeeping functions.

2. Rear illuminate all scene-select buttons.
3. Show lighting-level setting and fade-rate setting graphically using LEDs or backlighted bar- graph indicator.
4. Mounting: Single flush-mounting wall box with manufacturer's standard faceplate.

D. Submaster Digital Network Control Stations:

1. Numbered push buttons to select scenes.
2. Off switch to turn master station off.
3. On switch turns all scenes of master station to full bright.
4. Control Wiring: NFPA 70, Class 1 or 2.
5. Mounting: Single, flush-mounting wall box with manufacturer's standard faceplate.

E. Dimmer Cabinet:

1. Factory wired and suitable for the following ambient conditions:

a. Temperature: 60 to 95 deg F (15 to 35 deg C).
b. Relative Humidity: 10 to 90 percent, noncondensing.
c. Filtered air supply.

2. Dimmer Cabinet Assembly: NRTL listed and labeled.
3. Plug-in type, modular, and accepting dimmers of each specified type in any plug-in position.
4. Control Voltage: 24- or 10.6-V dc.
5. Integrated Fault-Current Rating: 10,000-A RMS symmetrical.

F. Dimmers: Solid state, with silicon-controlled rectifiers.

1. Primary Protection: Magnetic or thermal-magnetic circuit breaker, also serving as the disconnecting means.
2. Dimmer response to control signal shall follow the "Square Law Dimming Curve" specified in IESNA's "IESNA Lighting Handbook."
3. Dimmed circuits shall be filtered to provide a minimum 350-microsecond current-rise time at a 90-degree conduction angle and 50 percent of rated dimmer capacity. Rate of current rise shall not exceed 30 mA/microsecond, measured from 10 to 90 percent of load-current waveform.
4. Protect controls of each dimmer with a fuse.

G. Non-dim modules shall include relays with contacts rated to switch 20-A tungsten-filament load at 120-V ac and 20-A electronic ballast load at 277-V ac.

H. Digital Control Network:

1. Dimmers shall receive digital signals from digital network control stations that are linked to the dimmer cabinet with a common network data cable.

2. Functions of digital network control stations shall be set up at the dimmer cabinet's electronic controls that include indicated number and arrangement of scene presets, channels, and fade times.

I. Emergency Power Transfer Switch: Factory prewired and pretested to automatically transfer load circuits from normal to emergency power supply when normal supply fails, and complying with UL 1008.

1. Transfer from normal to emergency supply when normal supply voltage drops to 55 percent or less.
2. Retransfer immediately to normal on failure of emergency supply and after an adjustable time-delay of 10 to 90 seconds on restoration of normal supply while emergency supply is available.
3. Integrated Fault-Current Rating: 10,000-A RMS symmetrical.
4. Test Switch: Simulate failure of normal supply to test controls associated with transfer scheme.

2.6 MANUAL SWITCHES AND PLATES

A. Switches: Modular, momentary push-button, low-voltage type.

1. Color: White, unless otherwise indicated.
2. Integral Pilot Light: Indicate when circuit is on. Use where indicated.
3. Locator Light: Internal illumination.
4. Wall Plates: Match those specified in Division 16 Section "Wiring Devices" for materials, finish, and color. Use multigang plates if more than one switch is indicated at a location.
5. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.7 CONDUCTORS AND CABLES

A. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG, complying Division 16 Section Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 18 AWG, complying with Division 16 Section "Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 14 AWG, complying with Division 16 Section "Conductors and Cables."

D. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Division 16 Section "Voice and Data Communication Cabling."

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Wiring Method: Comply with Division 16 Section "Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Install field-mounting, transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.2 IDENTIFICATION

A. Identify components and power and control wiring according to Division 16 Section Electrical Identification.

B. Label each dimmer module with a unique designation.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Continuity tests of circuits.
2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.

    a. Include testing of dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

3. Emergency Power Transfer: Test listed functions.

C. Remove and replace malfunctioning dimming control components and retest as specified above.

D. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

E. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.4 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 13 Section "Lighting Controls."

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain dimming controls.

END OF SECTION 16570

SECTION 16721 – ADDRESSABLE FIRE ALARM DETECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including general and supplementary conditions and Division 1 specification sections, apply to this Section.

B. Requirements of the following Division 16 Sections apply to this Section:
1. "Basic Electrical Requirements."
2. "Basic Electrical Materials and Methods."

C. The complete installation is to conform to the applicable sections of NFPA 72 and the National Electrical Code with particular attention to Article 760.

D. NFPA 90A

E. NFPA 101 - Life Safety Code

F. ADA

G. ASME/ANSI A17.1 and A17.3

1.2 SUMMARY

A. This section includes fire alarm system components, including, but not limited to, voice evacuation equipment, annunciation equipment, network interface equipment, addressable manual stations, analog sensors, notification appliances, addressable interfaces, and addressable controls.

B. Work covered by this specification section includes the furnishing of labor, equipment, materials, and complete operational performance required for installation of the Fire Alarm System as shown on the drawings, as specified, and as directed by the Architect/Engineer.

C. The work covered by this section of the specification shall be coordinated with the related work as specified elsewhere under the project specifications.

1.3 SYSTEM DESCRIPTION

A. General: Complete, microprocessor-based, networked, addressable fire detection and alarm system with manual and automatic alarm initiation, and addressable analog initiating devices as indicated.

B. The fire alarm system shall allow for loading and editing special instructions and operating sequences as required. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software-programmed operations

shall be stored in a non-volatile memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.

C. The system shall have the capability of recalling alarm and trouble conditions in chronological order for the purpose of recreating an event history.

D. System connections for alarm-notification circuits and voice/alarm communication circuits shall be Class A / Style Z.

E. System connections for signaling line addressable device circuits shall be Class A/Style 6.

F. Networked fire alarm panels and multiplexed fire alarm panels shall be connected Class A, Style 7.

G. Functional Description: The following are required fire alarm control panel functions and operating features:
1. System shall be 100% compatible with the existing, proprietary Simplex Fire Alarm Network.
2. System shall interface the Building Automation / Management System and shut down HVAC equipment under selected, emergency conditions.
3. A signal from one device shall not prevent the receipt of signals from any other device.
4. Automatically route alarm, supervisory, and trouble signals to a proprietary monitoring station at Jackson Barracks, using listed and approved equipment.
5. Loss of primary power at a FACP shall sound a trouble signal and shall indicate at that FACP when the systems operating on an alternate power supply.
6. Communication between fire alarm control panel and addressable devices shall be completely digital. Panels that transmit data from addressable devices in analog format (voltage variances) are not acceptable.
7. Smoker Sensor Sensitivity and Environmental Compensation:
   a. The sensitivity of each addressable sensor shall be able to be remotely adjusted and displayed at the FACP.
   b. The alarm decision for each sensor shall be determined by the FACP.
   c. The FACP shall maintain a moving average of the sensors smoke chamber value to automatically compensate (move the threshold) for dust, dirt, and component degradation conditions that could affect detection operations. The control unit shall automatically maintain constant smoke obscuration sensitivity for each sensor by compensating for environmental factors.
   d. The FACP shall automatically indicate when individual sensors are excessively dirty, dirty, or almost dirty so that maintenance can be done on all sensors simultaneously.
   e. The FACP shall be listed for automatic compliance with NFPA 72 Sensitivity Testing requirement.
8. Annunciation: Manual and automatic operation of alarm and supervisory initiating devices shall be annunciated on the FACP display indicating the location and type of device.
9. The panel shall include a one-person test operation mode during which control functions are bypassed and the monitoring station is disconnected.
10. The panel shall have provisions for disabling and enabling all circuits individually for maintenance or testing purposes.
11. Voice / Alarm Communications: It shall be possible to selectively page all connected speakers simultaneously or individual floors/zones at a time via switches at the voice command center.
12. Network Functions:

a. Each node shall communicate to the next in a style 7, class A token ring configuration for maximum survivability. A single open or short anywhere on the network shall not prevent normal network communication.
b. Should multiple open circuits exist, all remaining connected nodes shall automatically form "sub-networks" and communicate only with each other. It shall not be necessary for a "master" node to be online for network communications to exist.
c. Network systems shall have the capability of loading software operations from a single node to all other nodes on the network.
d. Each node shall be capable of standalone notification operation without depending on information from another node should network communications fail.
e. The failure of any one node shall not prevent network communication. The failed node shall be bypassed and continuously interrogated until it is back online.
f. It shall be possible to use either copper cable or fiber optic cable (or both) for network communication media without having to replace the network interface card.

H. System Operational Sequence:
1. General Alarm Sequence: Upon activation of any manual station or any automatic alarm detection device (except duct-mounted smoke sensors) the following shall take place:
   a. An audible and visual general alarm condition is indicated at the FACP, at the annunciator(s), at the Voice Command Center, and at the campus proprietary monitoring station.
   b. The alarm is recorded in a separate alarm history log.
   c. Audible and visible alarm notification signals throughout the building are activated. Audible alarms remain on until silenced by the alarm silence switch at the FACP; visual alarms remain in until the system reset switch is operated. Any subsequent alarm shall reactivate the alarm notification appliances.
   d. All designated doors are unlocked.
   e. The building automatic temperature control system is signaled to being smoke control sequences.
   f. A supervised signal is transmitted to notify the monitoring station(s).
2. AHU Shutdown Sequence: The activation of any duct-mounted smoke sensor shall cause the associated air handling unit to be shut down and shall initiate the Supervisory Control Sequence.
3. Door Holder Sequence: The activation of a smoke sensor within 5 feet of a smoke door, or integral to the door holder, shall cause the associated smoke door to close and shall initiate the General Alarm Sequence.
4. Elevator Recall Sequence: The activation of any elevator lobby, elevator pit, elevator shaft, or elevator machine room smoke sensor shall initiate the General Alarm Sequence and cause the associated elevator cabs to be recalled according to the following sequence:
   a. If the alarmed device is on any floor other than the main level of egress, the elevator cabs shall be recalled to the main level of egress.
   b. If the alarmed device is on the main egress level, the elevator cabs shall be recalled to the predetermined alternate recall level as determined by the local authority having jurisdiction.
5. Elevator Shunt Trip Sequence: The activation of any elevator pit, elevator shaft, or elevator machine room heat sensor shall, in addition to the operations listed above, cause the associated elevators to be shunt tripped.
6. Atrium Exhaust Sequence: Upon detection of smoke in the Atrium, in additional to the General Alarm sequence defined above, the Fire Alarm Control System shall initiate smoke control functions. Main lobby doors shall be opened and Atrium Exhaust Fans shall be started.

7. Alarm Verification Sequence: Upon activation of any smoke sensor, the control panel initiates a 60 second delay during which a second alarm from the same device must occur before the alarm sequence is activated.
   a. The alarm verification operation shall be selectable by addressable device.
   b. The control Unit shall have the capability to display the number of times (tally) a device had gone into a verification mode. Should this smoke verification tally reach a pre-programmed number, a trouble condition shall occur.
8. Supervisory and Trouble Sequence:
   a. An audible and visual supervisory or trouble condition (separate and distinguishable) is indicated at the FACP, at the annunciator(s), at the Voice Command Center, and at the campus proprietary monitoring station.
   b. A record of the supervisory or trouble condition shall be kept in the associated FACP historical log.

I. Power Requirements
1. All system panels shall receive 120 VAC power via dedicated fused disconnect circuits.
2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in normal supervisory mode for a period of 24 hours plus an additional15 minutes of alarm operation at the end of this period. Provide 25% spare capacity for future expansion. Include additional battery cans and chargers as necessary.
3. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
4. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visibly indicated at the control unit, annunciator(s), and Voice Command Center.

1.4 SUBMITTALS

A. General: Submit the following according to conditions of contract and Division 1 specification sections.
1. Product data for system components. Include list of materials.
2. Battery calculations for every panel and remote power supply.
3. Power calculations indicating exactly what devices (and how much current they draw) are on each notification appliance circuit. Include a voltage drop table in the submittal to insure maximum distances are not exceeded.
4. A list of labels for every addressable device in the system for approval by the owner.
5. A wire legend describing the manufacturer's recommended cables and cable characteristics.
6. Project specific system sequence of operation description.
7. Riser diagram showing all panel interconnections and the quantity of devices on each circuit.
8. Floor plans showing the locations of all devices, their addresses and/or circuit designations.
9. Locations of all control panels, voice evacuation panels, and remote power supplies.
10. Control panel circuit board wiring diagrams.
11. Peripheral device wiring diagrams. Show all terminals and interconnections.

1.5 QUALITY ASSURANCE

A. All fire alarm system products provided shall be warranted free from defects in material and workmanship for a period of one year from the date of final system acceptance.

B. All control equipment must have transient protection to comply with UL864 requirements.

C. Where Fire Alarm circuits leave the building, additional transient protection must be provided for each circuit. Devices must be UL listed under standard # 497B.

D. Fire alarm system provider shall employ manufacturer's factory trained and NICET level III certified technicians and shall be located within 50 miles of this project location. A minimum of 10 year experience in the fire alarm and protective signaling systems field is required.

1.6 EXTRA MATERIALS

A. Smoke sensors, heat sensors, and addressable manual stations: Furnish a spare quantity equal 10 percent of the number of units of each type installed but not less than one of each type.

B. Addressable bases: Furnish a quantity equal to 2 percent of the number of bases installed.

C. Visual and audible/visual devices: Furnish a quantity equal to 5 percent of the number of units of each type and candela rating installed, but not less than one of each.

PART 2 - PRODUCTS

2.1 GENERAL

A. All equipment be U.L. listed for fire alarm use according to the applicable section of the U.L. directory.

2.2 NETWORK FIRE ALARM CONTROL PANELS (FACP's)

A. FACP construction shall be modular with solid state, microprocessor-based electronics. All modules shall be of the plug-in-type. FACP's that require the removal of field wiring for module replacement are not acceptable.

B. FACP shall display only those primary controls and displays essential to operation during a fire alarm condition. Keyboards or keypads shall not be required to operate the system during fire alarm conditions. A local audible device shall sound during each key press to provide an audible feedback to ensure that the key had been pressed properly.

C. An alphanumeric display shall be arranged to provide the basic interface between operator at FACP and addressable system components, including annunciation, supervision, and control. The display shall contain a minimum of 80 characters for alarm, supervisory, and component status messages and shall indicate control commands to be entered into the system for control of smoke sensor sensitivity and other parameters.

D. FACP shall be capable of supporting a minimum of 100 addressable devices of any type on a single addressable circuit, 1000 addressable devices per node. Provide 25% spare capacity for each addressable circuit.

E. Provide integral with the FACP a Voice command center (VCC) which shall control all voice alarm control and fire fighter phone communications for the entire system per the following:

1. Include all necessary amplifiers, microphone, master telephone, tone generator, audio controller, and control switches.
2. Provide at a minimum 1 paging zone per floor and 1 paging zone per audio riser.
3. Digital message splicing capability. It shall be possible to splice any phrase contained in the standard message set to produce customized voice messages.
4. Provide custom messages as required by the LAARNG to integrate with the campus Mass Notification System.
5. Provide 50% spare capacity on all audio circuits.
6. Size amplifiers for 150% of the actual load or 1-watt per speaker, whichever is greater.

F. FACP shall contain separate alarm, trouble, and supervisory logs to prevent alarm and supervisory conditions from being overwritten by intermittent trouble conditions.

G. Provide integral DACT that can communicates alarm, trouble, and supervisory conditions to a UL listed remote station.

H. The FACP shall be capable of being tested by one person. Should the one-person test feature be on for an inappropriate amount of time it shall revert to the normal mode automatically. It shall be possible to separate addressable devices into test groups. Test groups shall be programmable and field editable. The FACP shall be capable of a minimum of 8 test groups.

I. FACP shall be provided with a minimum of 2 RS-232 outputs capable of operating a remote maintenance terminal and/or printers; outputs shall be ASCII from an EIA RS-232C connection with an adjustable baud rate. Each output shall be field configurable for supervised or for unsupervised operation.

2.3 REMOTE POWER SUPPLIES

A. Where additional notification power is required, provide addressable remote power supplies as necessary to support the notification current load.

B. Provide all necessary batteries and charging equipment to meet the power requirements specified in paragraph 1.3 "SYSTEM DESCRIPTION".

C. Remote power supplies shall have a minimum of 4 DC output circuits and 8 amps of available power.

D. Surface mount remote power supplies as necessary in locations to be approved by the owner. Show remote power supply locations on submittal shop drawings.

2.4 MANUAL PULL STATIONS

A. Pull stations shall be addressable, double-action, push-pull type, fabricated of high impact red polycarbonate, and finished in red with molded, raised-letter operating instructions of contrasting color. Stations requiring the breaking of a glass panel are not acceptable.

2.5 SENSORS AND BASES

A. Sensor and associated encapsulated electronic components shall be mounted in a fixed base with a twist-locking plug connection. Removal of the sensor head shall cause a trouble signal at the FACP.

B. Each sensor shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.

C. Each sensor shall be scanned by the FACP for its type identification to prevent inadvertent substitution of another sensor type. If an incorrect sensor type is installed in a base, the FACP shall provide default alarm operation with he installed device but shall initiate a "Wrong Device" trouble condition until the proper type is installed or the programmed sensor type is changed.

D. Device address setting shall be in the sensor base to maintain program integrity.

E. Where noted, provide bases with auxiliary, 1-amp contacts and/or integral piezoelectric sounders.

F. Modular Photoelectric Sensor: Sensitivity range shall be programmable from 0.5% per foot to 3.5% per foot of smoke obscuration. Sensor shall transmit actual % per foot obscuration values to the FACP for display.

G. Modular Ionization Sensor: Sensitivity range shall be programmable from 0.5% per fit it 1.5% per foot of smoke obscuration. Sensor shall transmit actual % per foot obscuration values to the FACP for display.

H. Modular Thermal Sensor: Thermal Sensors shall have a programmable sensitivity of 135° F or 155° F Fixed Temperature, and 15° F or 20° F Rater of Rise. The Rate of Rise operation shall be capable of being disabled. Sensor shall transmit actual temperature values to the FACP for display.

I. Duct Mounted Smoke Sensor: Provide addressable housing and sampling tubes as required for installation. Sensitivity range shall be programmable from 0.5% per foot to 3.5% per foot smoke obscuration. Photoelectric sensor shall transmit actual % per foot obstruction values to the FACP for display. Housing shall also contain 2 programmable "form c" SPDT contacts rated at 2 amps. Provide a remote alarm/test station for each duct mounted smoke sensor.

2.6 CONVENTIONAL DETECTION DEVICES

A. General: Unless otherwise noted, all detectors shall contain a separate base and head, and shall be resetable after an alarm condition. Where conventional devices are required to be connected to an addressable system, a proper addressable circuit interface shall be provided for each conventional device. All two-wire detectors shall be UL cross-listed with the device or panel they are connected to.

B. Modular Bases: Bases shall contain an integral alarm/trouble LED and contain a magnetically operated test switch. Where noted, provide bases with auxiliary contacts rated a minimum of 1-amp.

C. Explosion-Proof and / or Moisture-Proof Heat Detectors: Unless otherwise noted, detectors need not be modular or resetable, shall be rated 135-degrees, shall be fixed-type only, shall be

listed for the environment for which they will be installed, and shall contain a minimum of 1 auxiliary contact rated 1-amp or higher.

D. Beam Detectors: Shall be listed to UL 268, shall consist of a separate transmitter and receiver, shall operate on the light obscuration principal, shall be microprocessor-controlled, shall be microprocessor-controlled, shall contain adjustable optics, and shall contain a minimum of 6 sensitivity levels. Detector shall also contain a minimum of 1 auxiliary alarm contact and 1 auxiliary trouble contact. All contacts shall be rated a minimum of 1-amp. Provide a remote indicator/test unit with each beam detector pair. Test unit shall consist of normal, alarm, and trouble LED's and a key-operated test switch.

2.7 ALARM NOTIFICATION APPLIANCES

A. Fire Alarm Speakers: Speakers shall be 4-inch cone type with a frequency response from 400 Hz to 4 kHz. Speakers shall have power taps up to a minimum of 2 watts. Tap speakers to provide a minimum of 85dB at 10 feet from the speaker. Re-tap speakers as necessary to achieve a sound level of 15dB above the actual ambient noise. All audible speaker pre-tones shall be in the NFPA recognized temporal code format.

B. Visual Notification Appliances: Strobes shall be of the appropriate candela rating as indicated on drawings and shall be compatible with ADA requirements with the word "FIRE" clearly visible. All strobes on a single circuit shall be synchronized.

C. Combination audible and visual notification appliances shall consist of a factory combined, audible and visual notification unit in a single mounting assembly. The audible and visual characteristics shall be as specified above.

D. Where required, provide protective guards that are UL listed with the device it is intended to protect.

2.8 ADDRESSABLE CIRCUIT INTERFACE MODULES

A. Provide addressable, completely supervised control and monitor modules as required for a completely addressable system. The use of panel mounted conventional zone or relay circuits is not acceptable unless otherwise indicated on drawings.

B. Addressable Circuit Interface Modules shall be capable of mounting in a standard electric outlet box.

C. The circuit interface module shall be compatible with addressable manual stations and addressable sensors on the same multiplexing signaling line circuit.

2.9 MAGNETIC DOOR HOLDERS / CLOSERS

A. Electromagnetic holders shall be 24 VDC and shall develop a minimum of 25 pounds of holding force.

2.10 REMOTE LCD ANNUNCIATOR

A. Annunciators shall use the same Primary Acknowledge, Silence, and Reset Keys, Status LEDs and LCD Display as the FACP.

B. Operator keys shall be key-switch enabled to prevent unauthorized use, The key shall only be removable in the disabled position.

C. Annunciators shall display alarm, trouble, and supervisory status information for every device connected to the same FACP as the annunciator.

2.11 BATTERIES

A. Batteries shall be sealed lead-acid, maintenance-free-type. Size all batteries to meet the requirements set in paragraph 1.3 "SYSTEM DESCRIPTION"

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans; to be wired, connected, and left in first class operating condition.

B. Mount manual pull stations semi-flush in recessed back boxes (non-rated walls) and surface on red painted manufacturer provided backboxes (rated walls) with operating handles 48 inches above finished floor.

C. Install smoke and heat sensors where shown on drawings in accordance with NFPA 72 guidelines.

D. Install all notification devices 80 inches above the finished floor or 6 inches below the ceiling, whichever is lower, as measured from the bottom of the device. Mount devices semi-flush in recessed backboxes (non-rated walls) and surface on red painted, manufacturer provided back boxes (rated walls).

E. Surface mount FACP's with tops of cabinets not more than 6 feet above the finished floor.

3.2 WIRING INSTALLATION

A. Install wiring in metal raceway according to Division 16 Section "Raceways. Conceal raceway except in unfinished spaced and as indicated.

B. Install conductors in enclosures parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the wiring diagrams of the system. Make all connections with approved crimp-on terminal spade lugs pressure-type terminal blocks, or plug connectors.

C. Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where any circuit tap is made.

D. Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction (AHJ) and shall be installed in accordance with the appropriate articles from the current approved edition of the National Electric Code.

E. Color-code fire alarm conductors differently from the normal building power wiring. Color-code notification appliance circuits differently from addressable circuits. Paint fire alarm system junction boxes and covers red.

F. Install 2 vertical audio, power, and communication risers (class A) to serve the fire alarm system. Separate risers by a minimum 1-hour rated wall. Include all power, data, communication, and audio wiring in each riser so that the loss of one riser does not affect the performance of the system.

3.3 GROUNDING

A. Ground equipment and cable shields as specified by the equipment manufacturer.

3.4 FIELD QUALITY CONTORL

A. Provide the services of a factory-authorized service representative to make final program changes as necessary for a fully functional system.

B. Provide the services of a NICET level III project installation manager to supervise the total installation, including the field assembly and connection of components.

C. Test the system according to the procedures outlined in NFPA 72.

D. Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the specifications and complies with applicable standards.

E. Provide a written record of inspections, test, and detailed test results in the form of a test log. Submit log to the owner upon the satisfactory completion of tests.

F. Perform a final test as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy. Demonstrate that the system meets the specifications and complies with applicable standards. This final test shall be witnessed by a representative of the Authority Having Jurisdiction, a representative of the owner, the architect, and a factory-authorized service representative.

3.5 TRAINING

A. Provide the services of a factory-authorized service representative to demonstrate the system and train owner's maintenance personnel.

B. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 24 hours' training.

END OF SECTION 16721

SECTION 16726 - PUBLIC ADDRESS AND MUSIC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes equipment for amplifying, distributing, and reproducing sound signals.

1.2 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

C. VU: Volume unit.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Preamplifiers.
2. Power amplifiers.
3. Microphone.
4. Equipment rack.
5. Loudspeakers.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Comply with UL 50.

1.5 COORDINATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alpha Communications.
2. Altec Lansing Technologies, Inc.
3. Atlas Soundolier; Atlas Sound.
4. Bogen Communications International, Inc.
5. Dukane Corporation; Communications Systems Div.
6. Electro-Voice, Inc.
7. Executone Information Systems, Inc.
8. Federal Signal Corporation; Electrical Products Division.
9. Peavey Electronics Corporation.
10. Rauland-Borg Corporation.
11. Whelen Engineering Company, Inc.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. System Functions: Include the following:

1. Selectively connecting separate zones to different signal channels.
2. Selectively amplifying sound among various microphone outlets and other inputs.
3. Communicating simultaneously to all zones regardless of zone or channel switch settings.
4. Paging, by dialing an extension from any local telephone instrument and speaking into the telephone.
5. Producing a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
6. Reproducing high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; and output free of nonuniform coverage of amplified sound.

2.3 EQUIPMENT AND MATERIALS

A. Coordinate features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Modular type using solid-state components, fully rated for continuous duty, unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

2.4 PREAMPLIFIERS

A. Comply with TIA/EIA SE-101-A; either separately mounted or as an integral part of power amplifier.

B. Output Power: Plus 4 dB above 1 mW at matched power-amplifier load.

C. Total Harmonic Distortion: Less than 1 percent.

D. Frequency Response: Within plus or minus 2 dB from 20 to 20,000 Hz.

E. Input Jacks: Minimum of two. One matched for low-impedance microphone; the other matchable to cassette deck, CD player, or radio tuner signals without external adapters.

F. Minimum Noise Level: Minus 55 dB below rated output.

G. Controls: On/off, input levels, and master gain.

2.5 POWER AMPLIFIERS

A. Comply with TIA/EIA SE-101-A.

B. Mounting: Rack mounted.

C. Output Power: 70-W balanced line.

D. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.

E. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.

F. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.

G. Output Regulation: Less than 2 dB from full to no load.

H. Controls: On/off, input levels, and low-cut filter.

I. Input Sensitivity: Matched to preamplifier and providing full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

2.6 COMPONENTS

A. Microphone: Comply with TIA/EIA SE-105.

1. Type: Dynamic, with cardioid polar or omnidirectional characteristic.
2. Impedance: 150 ohms.
3. Frequency Response: Uniform, 50 to 14,000 Hz.
4. Output Level: Minus 58 dB minimum.
5. Finish: Satin chrome.
6. Cable: C25J.

B. Equipment Rack: Comply with TIA/EIA-310-D. House amplifiers and auxiliary equipment in standard TIA/EIA 19-inch (483-mm) racks.

1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically.
2. Power-Supply Connections: Approved plugs and receptacles.
3. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
4. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.
5. Enclosure Panels: Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.
6. Finish: Uniform, baked-enamel factory finish over rust-inhibiting primer.
7. Power-Control Panel: On front of equipment housing, with master power on/off switch and pilot light; and with socket for 5-A cartridge fuse for rack equipment power.
8. Service Light: At top rear of rack with an adjacent control switch.
9. Vertical Plug Strip: Grounded receptacles, 12 inches (300 mm) o.c. the full height of rack, to supply rack-mounted equipment.
10. Maintenance Receptacles: Duplex convenience outlets supplied independent of vertical plug strip and located in front and bottom rear of rack.
11. Spare Capacity: 25 percent spare space capacity in rack for future equipment.

C. Cone-Type Loudspeakers: Comply with TIA/EIA SE-103.

1. Minimum Axial Sensitivity: TIA/EIA pressure rating of 45 dB.
2. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
3. Size: 8-inches (200 mm) with 1-inch (25-mm) voice coil and minimum 5-oz. (140-g) ceramic magnet.
4. Minimum Dispersion Angle: 100 degrees.
5. Rated Output Level: 10 W.
6. Matching Transformer: Comply with TIA/EIA-160. Full-power rated with four TIA/EIA standard taps. Maximum insertion loss of 0.5 dB.
7. Surface-Mounting Units: Ceiling, wall, or pendant mounting, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inch (1.2-mm) steel and whole assembly rust proofed and shop primed for field painting.
8. Flush-Ceiling-Mounting Units: In steel back boxes, acoustically dampened. Metal ceiling grille with white baked enamel.

D. Microphone Outlet: Three-pole, polarized, locking-type, microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed outlet covers.

E. Conductors and Cables: Jacketed, twisted pair and twisted multipair, untinned solid copper.

1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.
2. Microphone Cables: Neoprene jacketed, not less than 2/64 inch (0.8 mm) thick, over shield with filled interstices. Shield No. 34 AWG tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
3. Plenum Cable: Listed and labeled for plenum installation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wiring Method: Install wiring in raceways except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum-board partitions where cable wiring method may be used. Use plenum cable in environmental air spaces including plenum ceilings. Conceal cables and raceways except in unfinished spaces.

B. Install exposed cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings so designed and installed to avoid damage to cables. Secure cable at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, or fittings.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.

D. Control-Circuit Wiring: Install number and size of conductors as recommended by system manufacturer for control functions indicated.

E. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

F. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

G. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

H. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

I. Wall-Mounting Outlets: Flush mounted.

J. Floor-Mounting Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

K. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

L. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

M. Connect wiring according to Division 16 Section "Conductors and Cables."

3.2 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes as specified in Division 16 Section "Grounding and Bonding."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Schedule tests with at least seven days' advance notice of test performance.
2. After installing public address and music equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

    a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
    b. Repeat test for each separately controlled zone of loudspeakers.
    c. Minimum acceptance ratio is 50 dB.

5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in the same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.

7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
8. Signal Ground Test: Measure and report ground resistance at pubic address equipment signal ground. Comply with testing requirements specified in Division 16 Section "Grounding and Bonding."

B. Retesting: Correct deficiencies, revising tap settings of speaker-line matching transformers where necessary to optimize volume and uniformity of sound levels, and retest. Prepare a written record of tests.

C. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

3.4 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain public address and music equipment.

END OF SECTION 16726

SECTION 16750 - VOICE AND DATA COMMUNICATION CABLING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes wire, cable, connecting devices, installation, and testing for wiring systems to be used as signal pathways for voice and high-speed data transmission.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. IDC: Insulation displacement connector.

C. LAN: Local area network.

D. PVC: Polyvinyl chloride.

E. STP: Shielded twisted pair.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A. Product Data: Include data on features, ratings, and performance for each component specified.

B. Shop Drawings: Include dimensioned plan and elevation views of each individual component. Show equipment assemblies, method of field assembly, workspace requirements, and access for cable connections.

1. System labeling schedules, including electronic copy of labeling schedules, as specified in Part 3, in software and format selected by Owner.
2. Wiring diagrams. Show typical wiring schematics including the following:

    a. Workstation outlets, jacks, and jack assemblies.
    b. Patch cords.
    c. Patch panels.
    d. Fiber-optic boxes.

C. Cable Administration Drawings: As specified in Part 3.

D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates for color selection and evaluation of technical features.

E. Product Certificates: For each type of cable, connector, and terminal equipment, signed by product manufacturer.

F. Manufacturer Seismic Qualification Certification: Submit certification that distribution racks and their components will withstand seismic forces defined in Division 16 Section "Seismic Controls for Electrical Work." Include the following:

1. Basis for Certification: Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based. Indicate whether withstand certification is based on actual test of assembled components or on calculation.

   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity of each rack-mounted component and of each assembled rack type, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

G. Qualification Data: For Installer.

H. Field quality-control test reports.

I. Operation and Maintenance Data: For voice and data communication cabling to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: System installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain all products through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of voice and data communication cabling with Owner's telecommunications and LAN equipment suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute to other participants.
3. Adjust arrangements and locations of distribution frames and cross-connect and patch panels in equipment rooms and wiring closets to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cable: 250 feet (76 m) of each size and type used for Project. Furnish on reels.
2. Patch-Panel Units: One of each type for every six installed, but no fewer than one.
3. Connecting Blocks: One of each type for every 25 installed, but no fewer than one.
4. Outlet Assemblies: One of each type for every 25 installed, but no fewer than one.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cable:

a. Belden Inc.; Electronics Division.
b. Berk-Tek; an Alcatel Company.
c. Brand-Rex Co.; Unit of BICC Cables Corp.
d. Champlain Cable Corporation.
e. Chromatic Technologies, Incorporated.
f. General Cable Corporation.
g. HeLix/HiTemp Cables, Inc.
h. ICC.
i. Lucent Technologies; Global Service Provider.
j. Mohawk/CDT; a division of Cable Design Technologies.
k. Montrose/CDT; a division of Cable Design Technologies.
l. Optical Cable Corporation.
m. Panduit Corp.

n. Prestolite Wire Corp.
o. Remee Products Corp.
p. Siecor.
q. Superior Essex; Superior Telecommunications Inc.

2. Terminal and Connector Components and Distribution Racks:

a. AMP Incorporated; a Tyco International Ltd. Company.
b. Hubbell Premise Wiring.
c. Leviton Telecom.
d. Lucent Technologies; Global Service Provider.
e. Panduit Corp.
f. Thomas & Betts Corporation.

2.2 SYSTEM REQUIREMENTS

A. General: Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance.

B. Expansion Capability: Unless otherwise indicated, provide spare fibers and conductor pairs in cables, positions in cross-connect and patch panels, and terminal strips to accommodate 20 percent future increase in active workstations.

2.3 MOUNTING ELEMENTS

A. Cable Trays: Comply with Division 16 Section "Cable Trays."

B. Raceways and Boxes: Comply with Division 16 Section "Raceways and Boxes."

C. Backboards: 3/4-inch (19-mm), interior-grade, fire-retardant-treated plywood.

D. Distribution Racks: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.

1. Approximate Module Dimensions: 84 inches (2130 mm) high by 22 inches (560 mm) wide.
2. Finish: Baked-polyester powder coat.

2.4 TWISTED-PAIR CABLES, CONNECTORS, AND TERMINAL EQUIPMENT

A. Cables: Listed as complying with Category 6 of TIA/EIA-568-A.

B. Conductors: Solid copper.

C. UTP Cable: Comply with TIA/EIA-568-A. Four, thermoplastic-insulated, individually twisted pairs of conductors; No. 24 AWG, color-coded; enclosed in PVC jacket.

D. STP Workstation Cable: Comply with TIA/EIA-568-A. Two, thermoplastic-insulated, individually twisted pairs of conductors; No. 22 AWG, color-coded, overall aluminum and polyester shield and No. 22 AWG, tinned-copper drain wire; enclosed in PVC jacket.

E. UTP and STP Plenum Cable: Listed for use in air-handling spaces. Features are as specified for cables, conductors, UTP cable, and STP workstation cable except materials are modified as required for listing.

F. UTP Cable Connecting Hardware: Comply with TIA/EIA-568-A. IDC type, using modules designed for punch-down caps or tools.

1. IDC Terminal Block Modules: Integral with connector bodies, including plugs and jacks where indicated.
2. IDC Connecting Hardware: Consistent throughout Project.

G. STP Cable Connecting Hardware: Comply with TIA/EIA-568-A for connectors, plugs, and jack assemblies.

H. Cross-Connect Panel: Modular array of IDC terminal blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.
2. Mounting: Backboard.

I. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables. Panels shall have punch downs on the back and RJ45 connectors on the front. All 8 wires per cable shall be punched down.

1. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to satisfy specified expansion criteria.
2. Mounting: Rack.

J. Jacks and Jack Assemblies for UTP Cable: Modular, color-coded, RJ-45 receptacle units with integral IDC-type terminals. Use keyed jacks for data service.

K. UTP Patch Cords: Four-pair cables in 48-inch (1200-mm) lengths, terminated with RJ-45 plug at each end. Use keyed plugs for data service.

L. STP Patch Cords: Two-pair cables in 48-inch (1200-mm) lengths, terminated with STP plug connectors at both ends. Match plug connectors with patch-panel connectors.

M. Workstation Outlets: Quad or Octal jack-connector assemblies mounted in single or multigang faceplate.

1. Faceplate: High-impact plastic; color as selected by Architect.
2. Mounting: Flush, unless otherwise indicated.
3. Legend: Factory labeled, top jack "Voice" and bottom jack "Data," by silk-screening or engraving.

2.5 FIBER-OPTIC CABLES, CONNECTORS, AND TERMINAL EQUIPMENT

A. Cables: Factory fabricated, jacketed, low loss, glass type, fiber optic, multimode, graded index, operating at 850 and 1300 nm.

1. Workstation, Strands per Cable: Two.
2. Backbone, Strands per Cable: 12, unless otherwise indicated.
3. Dimensions: 62.5-micrometer core diameter; 125-micrometer cladding diameter.

4. Maximum Attenuation: Minus 3.75 dB/km at 850 nm; minus 1.5 dB/km at 1300 nm.
5. Minimum Modal Bandwidth: 160 MHz/km at 850 nm; 500 MHz/km at 1300 nm.
6. Operating Temperature Range: Minus 20 to plus 70 deg C.

B. Plenum Cable: Listed for use in plenums.

C. Cable Connectors: Quick-connect, simplex- and duplex-type SC couplers with self-centering, axial alignment mechanisms. Insertion loss not more than 0.7 dB.

D. Patch Panel: Modular panels housing multiple-numbered, duplex cable connectors.

1. Permanent Connection: Permanently connect one end of each connector module to installed cable fiber.
2. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to satisfy specified expansion criteria.
3. Mounting: Backboard or Rack.

E. Patch Cords: Dual fiber cables in 36-inch (900-mm) lengths.

1. Terminations: Two duplex connectors arranged to mate with patch-panel connectors, one at each end of each fiber in cord.

F. Workstation Outlets: Flush dual fiber-optic connector assemblies mounted in two-gang faceplate with flush dual RJ-45 jack assembly.

1. Faceplate: High-impact plastic; color as selected by Architect.
2. Mounting: Flush, unless otherwise indicated.
3. Legend: Factory labeled, fiber-optic connectors "Data" and RJ-45 jacks "Voice," by engraving.

2.6 IDENTIFICATION PRODUCTS

A. Comply with Division 16 Section Electrical Identification and the following:

1. Cable Labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION OF MEDIA

A. Backbone Cable for Data Service: Use fiber-optic cable for runs between equipment rooms and wiring closets and for runs between wiring closets.

B. Backbone Cable for Voice Service: Use UTP Category 6 cable for runs between equipment rooms and wiring closets and for runs between wiring closets.

C. Horizontal Cable for Data Service: Use UTP Category 6 cable for runs between wiring closets and workstation outlets.

D. Horizontal Cable for Voice Service: Use UTP Category 6 cable for runs between wiring closets and workstation outlets.

3.3 INSTALLATION

A. Wiring Method: Install wiring and optical fiber in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

B. Install cables using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.

C. Install cables without damaging conductors, shield, or jacket.

D. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.

E. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

1. Pull cables simultaneously if more than one is being installed in same raceway.
2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.

F. Install exposed cables parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.

H. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

I. Wiring within Wiring Closets and Enclosures: Provide conductors of adequate length. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

J. Separation of Wires: Comply with TIA/EIA-569-A rules for separating unshielded copper voice and data communication cabling from potential EMI sources, including electrical power lines and equipment.

K. Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect and patch panels.

L. Use splice and tap connectors compatible with media types.

3.4 GROUNDING

A. Comply with Division 16 Section "Grounding and Bonding."

B. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Bond shields and drain conductors to ground at only one point in each circuit.

D. Signal Ground Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.

E. Signal Ground Bus: Mount on wall of main equipment room with standoff insulators.

F. Signal Ground Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.5 INSTALLATION IN EQUIPMENT ROOMS AND WIRING CLOSETS

A. Install plywood backboards on walls of equipment rooms and wiring closets from floor to ceiling.

B. Mount patch panels, terminal strips, and other connecting hardware on backboards, unless otherwise indicated.

C. Group connecting hardware for cables into separate logical fields.

D. Use patch panels to terminate cables entering the space, unless otherwise indicated.

3.6 INSTALLATION STANDARDS

A. Comply with requirements in TIA/EIA-568-A and TIA/EIA-569-A.

3.7 IDENTIFICATION

A. In addition to requirements in this Article, comply with applicable requirements in Division 16 Section Electrical Identification and TIA/EIA-606.

B. System: Use a unique, three-syllable, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with same designation. Use logical and systematic designations for facility's architectural arrangement.

1. First syllable identifies and locates equipment room or wiring closet where cables originate.
2. Second syllable identifies and locates cross-connect- or patch-panel field in which cables terminate.
3. Third syllable designates type of media (copper or fiber) and position occupied by cable pairs or fibers in field.

C. Workstation: Label cables within outlet boxes.

D. Distribution Racks and Frames: Label each unit and field within that unit.

E. Within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Cables, General: Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

G. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).

H. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project, in software and format selected by Owner.

I. Cable Administration Drawings: Show building floor plans with cable administration point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606. Furnish electronic record of all drawings, in software and format selected by Owner.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.
2. Copper Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA-TSB67, "Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems." Link performance for UTP cables must meet minimum criteria of TIA/EIA-568-A.
3. Fiber-Optic Cable Procedures: Perform each visual and mechanical inspection and electrical test, including optional procedures, stated in NETA ATS, Section 7.25. Certify compliance with test parameters and manufacturer's written recommendations. Test optical performance with optical power meter capable of generating light at all appropriate wavelengths.

C. Remove malfunctioning units, replace with new units, and retest as specified above.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and extending wiring to establish new workstation outlets.

END OF SECTION 16750

SECTION 16950 - LIGHTNING PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes lightning protection for buildings and building elements.

1.3 SUBMITTALS

A. Product Data: For air terminals and mounting accessories.

B. Shop Drawings: Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway and data on how concealment requirements will be met.

C. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by nationally recognized testing laboratory (NRTL) or trade association.

D. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.

E. Field inspection reports indicating compliance with specified requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage and experienced installer who is NRTL listed or who is certified by LPI as a Master Installer/Designer.

B. Listing and Labeling: As defined in NFPA 780, Article 2-2, "Definitions."

C. Provide UL Master Label.

D. Provide LPI certification of system.

E. Provide ETL Master Label indicating system complies with specified requirements.

1.5 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to single-membrane roof systems with roofing manufacturer and installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. A-C Lightning Security, Inc.
2. Automatic Lightning Protection.
3. Harger Lightning Protection, Inc.
4. Heary Bros. Lightning Protection Co. Inc.
5. Independent Protection Company, Inc.
6. Robbins Lightning, Incorporated.
7. Thompson Lightning Protection, Inc.

2.2 LIGHTING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96.

B. Roof-Mounting Air Terminals: NFPA Class I, copper, solid, unless otherwise indicated.

C. Stack-Mounting Air Terminals: Solid copper.

D. Ground Rods, Ground Loop Conductors, and Concrete-Encased Electrodes: Comply with Division 16 Section "Grounding and Bonding" and standards referenced in this Section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A, LPI-175, and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.

C. Conceal following conductors:
1. System conductors.
2. Down conductors
3. Interior conductors

4. Conductors within normal view from exterior locations grade within 200 feet of building.
5. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

D. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. Periodic Inspections: Engage an LPI inspector to perform periodic inspections during construction and at its completion, according to LPI-177.

B. UL Inspection: Apply for inspection by UL as required to obtain a UL Master Label for system.

END OF SECTION 16950

SECTION 17000 - SYSTEMS INTEGRATION – FACILITIES MANAGEMENT SYSTEMS

PART 1 - GENERAL

1. 1 DESCRIPTION OF WORK

A. Extent of electronic direct digital control (DDC) temperature control system work is indicated by drawings and schedules, and by requirements of this section.

B. Control sequences shall be as specified in section 15950.

C. Furnish all labor, materials, equipment, and service necessary for a complete and operating integration to the control system specified in Section 15950. Points shall be specified in the points list shall be added to and made viewable through the LonTalk™ I/O point interface to existing TAC VISTA workstations.

D. The system shall utilize the same open architecture describe in Section 15950 and described as the following. An open architecture that utilizes EIA standard 709.1, the LonTalk™ protocol, as the common communication protocol between all controllers. Where necessary or desired, LonTalk™ packets may be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth. Any such encapsulation of the LonTalk™ protocol into IP datagrams shall conform to existing LonMark™ guidelines for such encapsulation and shall be based on industry standard protocols. The products used in constructing the BMS shall be LonMark™ compliant. In those instances in which LonMark™ devices are not available, the BMS contractor shall provide LonWorks™ devices with application source code, device resource files, and external interface definitions.

1.2 RELATED DOCUMENTS

A. Refer to Section 15950 for related work concerning temperature control contractor responsibilities.

B. Drawings and general provisions of Contract apply to work of this section.

C. Refer to Division-15 sections for related work, including Basic Mechanical Materials and Methods, apply to this section.

1.3 QUALITY ASSURANCE

A. Standards

1. Systems Integration: Integration to the existing LON workstations of the Direct digital control (DDC)/electronic, which meets in every respect all operational and quality standards specified herein; by factory employed technicians qualified for this work and in the regular employment of the system integration manufacturer's field office. Supervision and checkout of the system shall be by the employees of the manufacturer's local temperature control contracting field office. The manufacturer shall be ISO 9001 certified.

2. The systems integration contractor shall be a factory owned single source responsibility provider for the product, installation and technical services. Wholesalers and/or distributors in combination with dealer/contractors are not acceptable and will not be approved.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURES REPRESENTATIVES

A. TAC as provided by TAC factory branch. Contact Roger Flud at (918) 664-4145.

2.3 NETWORK ACCESS

A. Remote Access to Installations on the Owner's Intranet:

1. The owner shall provide the IP address(es) for remote access by the contractor to the control system via the Internet.

B. Remote Access to Installations on a Contractor-provided Intranet:

1. The Owner shall provide a connection to the Internet to enable this access via high-speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line or T1 Line. The Owner agrees to pay monthly access charges for connection and ISP.

2.4 LON ROUTERS, REPEATERS AND TRANSCEIVERS

A. General

1. Routers shall utilize LonTalk® protocol transport, network, session layers to transparently route messages bound for a node address in another sub-net or domain.

2. Routers and repeaters shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing LONWORKS® software tool.

3. The routers and repeaters shall be capable of DIN rail or panel mounting and be equipped with status LED lights for Network traffic and power.

B. Ethernet IP Router

1. Equip each router with an Ethernet IP communication on one side and a LonTalk® transceiver Type 1 FTT or Type 2 - TP on the other side.

2. The network router shall be designed to route messages from a segment, sub-net, or domain in full duplex communication mode.

3. On Ethernet IP side, the router shall utilize Ethernet IP protocol transport to route messages.

4. On the LonTalk® side, the routers shall utilize LonTalk® protocol transport, network, session layers to transparently route messages bound for a node address in another sub-net or domain.

5. Routers shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing LonWorks® software tool.

6. The routers shall be capable of DIN rail or panel mounting and be equipped with status LED lights for Network traffic and power.

2.5 GRAPHICS

A. Dynamic Graphic Programming: The operator shall have the ability to construct "dynamic" graphics pages for monitoring and system control. This graphics utility shall be usable both for online control such as override and alarm acknowledgment, and for display of system status and alarm activity. The graphics program shall have the following features:

1. The System Integrator on the TAC LON workstation shall do all graphics and operator interface under this section.
2. A separate or optional graphics generation program or package is unacceptable.
3. Page summary feature for all graphic pages.
4. Operator modification of set points and adjustable parameters.
5. User-friendly development of graphics.
6. This contractor shall include graphics as approved by the owner's representative for this project. The following graphic pages shall be provided as a minimum:

    a. Index page of all graphics, with direct selection
    b. Floor plan of each floor, with mechanical room status and space temperatures.
    c. System graphics: Provide the following graphic displays:

        1. Create one graphic page for each piece of mechanical equipment, including rooftop units, air handlers, VAV boxes, and hot/chilled water system.
        2. Dynamic temperature, airflows, and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.
        3. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several graphics at a time to analyse total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

    d. Dynamic Graphic Flow Chart Programming: The integrator shall construct "dynamic" graphic flow charts of system control logic/sequences. This flow chart utility shall be usable both for online and live displays of the interactive process variables occurring throughout the sequences of operations. Flow chart elements shall consist of "Icons" selected from a "toolkit". Discrete Icons shall exist for

        1. Each point type (AI, DO, etc.)
        2. Each DDC Module or Block

            a. Relay
            b. Relay, Delay before break
            c. Relay, Delay before make
            d. Relay, Interval timer
            e. PID modules
            f. Two Position Modules
            g. Reset modules

        3. Each application program appended to a point

a. Calculations
b. Event sequences
c. Time schedules
d. Trend
e. Alarm inhibit/enable

4. "Lines" (values passed between DDC modules or points)
5. Pages
6. Graphic pages shall have the capability to display an active ASC Icon for each ASC connected to the system.
7. Text may be inserted into the graphic to describe the control logic in sentence format. Once completed the graphics shall be able to be printed out for permanent records.
8. During and/or after completing construction of the dynamic graphic flow chart, the cursor may be placed on the Icon, and by "clicking" the mouse, the Icon may be expanded into the associated database editor for adding, deleting, or modifying the point, module, or application program. Similarly, the point may have its "pop-up" window called up to issue point commands, or overrides.
9. Graphic Display: Graphic development shall be completed on all LON workstations connected to the LAN either as "hard-wired" direct connect or via remote dial-in.
10. The systems graphic development shall provide the following minimum features:
    a. "Page Linking" such that it is possible to "zoom" into any other page through a sequence of graphics without using anything but the system mouse.
    b. Animated objects for discrete points.
    c. The real time value of each input or output from the DDC control block modules shall be displayable on the Dynamic Graphic Flow Chart Programming.

PART 3 - EXECUTION

3.1 TRAINING

A. Operator training shall include 2 initial eight-hour sessions or, if the owner desires this time may be allotted differently. The initial operator training program shall be to establish a basic understanding of software, functions, commands, etc for this building. The training shall encompass as a minimum:

1. Troubleshooting of input devices, i.e., bad sensors.
2. Sequence of operation review.
3. Sign on - sign off.
4. Selection of all displays and reports.
5. Commanding of points, keyboard and mouse mode.
6. Use of all dialogue boxes and menus.
7. System initialization.
8. GUI Software.
9. LonMaker Network Management Software.

3.2 WARRANTY

A. The workstation programming shall be free from defects in workmanship and material under normal use and service. If within twelve (12) months from the date of substantial completion, the workstation graphics or software is found to be defective in operation, workmanship , the Systems Integrator contractor shall adjust the defect at no cost.

B. The warranty shall extend to material that is supplied and installed by the Contractor. Material supplied but not installed by the Contractor shall be covered per the above to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation.

C. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.

END OF SECTION 17000